Jon Niermann, *Chairman*
Emily Lindley, *Commissioner*
Bobby Janecka, *Commissioner*
Toby Baker, *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

May 12, 2020

Docket No. 2019-0660-SIP
Project No. 2019-079-SIP-NR

Ken McQueen
Regional Administrator
U.S. Environmental Protection Agency - Region 6
1201 Elm Street, suite 500
Dallas, Texas 75270

Dear Mr. McQueen:

On March 4, 2020, the Texas Commission on Environmental Quality (Commission) adopted revisions to the State Implementation Plan (SIP).

The Commission adopted the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) Serious Classification Reasonable Further Progress (RFP) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone Standard. This RFP SIP revision demonstrates that the DFW and HGB 2008 eight-hour ozone nonattainment areas will achieve emissions reductions in ozone precursors (volatile organic compounds (VOC) and/or nitrogen oxides (NO_x) consistent with the serious ozone nonattainment area requirements of FCAA, §182(c)(2)(B) and the 2008 eight-hour ozone standard SIP requirements rule according to the following increments:

- a 9% emissions reduction in NO_x and/or VOC for all counties in each area for the three-year period from January 1, 2018 through December 31, 2020; and
- a 3% emissions reduction in NO_x and/or VOC for the one-year period from January 1, 2021 through December 31, 2021 for all counties in each area as an attainment year RFP contingency.

In addition to demonstrating the required emissions reductions, this SIP revision also provides motor vehicle emissions budgets (MVEB) for the 2020 attainment year.
This SIP revision demonstrates RFP for the DFW and HGB serious nonattainment areas for the 2020 attainment year as well as the 2021 contingency year.

Enclosed are the adopted revisions to the SIP, a public hearing certification, a complete record of the public hearings, and the accompanying order. I look forward to your expeditious approval of these SIP revisions.

Sincerely,

Jon Niermann
Chairman

JN/jmm

Enclosures

cc: The Honorable Greg Abbott, Governor of Texas
Mr. Jordan Rodriquez, Office of Budget and Policy, Office of the Governor
Mr. Toby Baker, Executive Director, Texas Commission on Environmental Quality

Texas Commission on Environmental Quality
Public Hearings
October 14 and 17, 2020

Dallas-Fort Worth and Houston-Galveston-Brazoria Serious Classification Reasonable Further Progress State Implementation Plan Revision for the 2008 Eight-Hour Ozone National Ambient Air Quality Standard

Project No. 2019-079-SIP-NR

INTRODUCTION

The Texas Commission on Environmental Quality (TCEQ or commission) scheduled a public hearing in Houston on October 14, 2019 and in Arlington on October 17, 2019, to receive testimony regarding the proposed revisions to the state implementation plan (SIP) requesting consideration of the adoption of the Dallas-Fort Worth and Houston-Galveston-Brazoria Serious Classification Reasonable Further Progress (RFP) State Implementation Plan Revision for the 2008 Eight-Hour Ozone National Ambient Air Quality Standard (NAAQS). To meet Federal Clean Air Act requirements, the SIP revision includes an analysis of RFP toward attainment of the 2008 eight-hour ozone NAAQS, demonstrating a 9% emissions reduction in ozone precursors from January 1, 2018 through December 31, 2020, a 3% emissions reduction from January 1, 2021 through December 31, 2021 for attainment year RFP contingency, and RFP motor vehicle emissions budgets for the 2020 attainment year.

The comment period closed on October 28, 2019. All testimony and comments have been reviewed and seriously considered. This hearing record contains a complete record of the public hearing and is divided into the following four sections:

- Public Notification and Proposal
- Written and Oral Testimony
- Evaluation of Testimony
- Staff Recommendation (including Order)

Additional copies of this hearing record are maintained in the TCEQ central office at 12100 Park 35 Circle, Austin, Texas 78753. For further information, please contact Denine Calvin at (512) 239-0613.

PUBLIC NOTICE & PROPOSAL

PUBLIC NOTIFICATION

Notification to the public of the proposed revision was conducted by the following procedures:

1. Publication of notice of the public hearing in the following newspapers on the date listed:

   The Houston Chronicle: September 13, 2019

   The Dallas Morning News: September 13, 2019

2. Publication of the Notices of Public Hearing in the September 27, 2019 issue of the *Texas Register* (44 TexReg 5658).

3. Correspondence forwarding the Notice of Public Hearing to the following officials and agencies:

   Alamo Area Council of Governments
   Capital Area Planning Council
   City of Arlington, Mayor's Office
   City of Dallas, Department of Aviation
   City of Dallas, Office of Environmental Quality
   City of El Paso, Environmental Services
   City of Fort Worth, Code Compliance Environmental Section
   City of Houston, Department of Health and Human Services
   City of Houston, Mayor's Office
   East Texas Council of Governments
   El Paso Metropolitan Planning Organization
   Federal Highway Administration
   Galveston County Health District

Harris County Judge

Harris County Public Health and Environmental Services

Houston-Galveston Area Council

North Central Texas Council of Governments

South East Texas Regional Planning Commission

Tarrant County Judge

Texas Department of Transportation

Victoria Metropolitan Planning Organization

Arkansas Department of Pollution Control and Ecology

Central States Air Resource Agencies Association

Louisiana Department of Environmental Quality

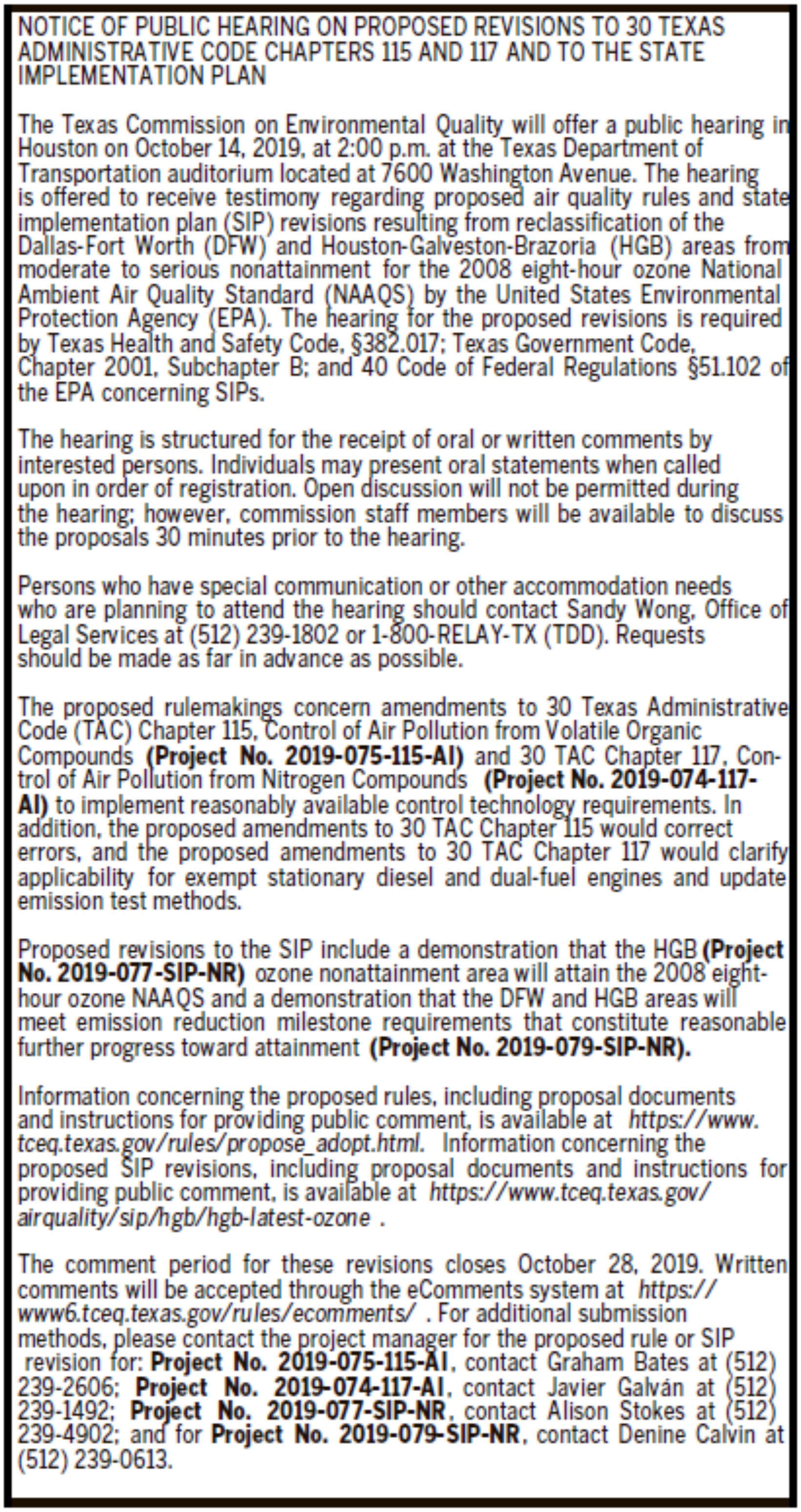
New Mexico Environmental Department

Oklahoma Department of Environmental Quality

United States Environmental Protection Agency

EXAMPLE OF NEWSPAPER CLASSIFIED AD

The Houston Chronicle, September 13, 2019



NOTICE OF PUBLIC HEARING ON PROPOSED REVISIONS TO 30 TEXAS ADMINISTRATIVE CODE CHAPTERS 115 AND 117 AND TO THE STATE IMPLEMENTATION PLAN

The Texas Commission on Environmental Quality will offer a public hearing in Houston on October 14, 2019, at 2:00 p.m. at the Texas Department of Transportation auditorium located at 7600 Washington Avenue. The hearing is offered to receive testimony regarding proposed air quality rules and state implementation plan (SIP) revisions resulting from reclassification of the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) areas from moderate to serious nonattainment for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) by the United States Environmental Protection Agency (EPA). The hearing for the proposed revisions is required by Texas Health and Safety Code, §382.017; Texas Government Code, Chapter 2001, Subchapter B; and 40 Code of Federal Regulations §51.102 of the EPA concerning SIPs.

The hearing is structured for the receipt of oral or written comments by interested persons. Individuals may present oral statements when called upon in order of registration. Open discussion will not be permitted during the hearing; however, commission staff members will be available to discuss the proposals 30 minutes prior to the hearing.

Persons who have special communication or other accommodation needs who are planning to attend the hearing should contact Sandy Wong, Office of Legal Services at (512) 239-1802 or 1-800-RELAY-TX (TDD). Requests should be made as far in advance as possible.

The proposed rulemakings concern amendments to 30 Texas Administrative Code (TAC) Chapter 115, Control of Air Pollution from Volatile Organic Compounds **(Project No. 2019-075-115-AI)** and 30 TAC Chapter 117, Control of Air Pollution from Nitrogen Compounds **(Project No. 2019-074-117-AI)** to implement reasonably available control technology requirements. In addition, the proposed amendments to 30 TAC Chapter 115 would correct errors, and the proposed amendments to 30 TAC Chapter 117 would clarify applicability for exempt stationary diesel and dual-fuel engines and update emission test methods.

Proposed revisions to the SIP include a demonstration that the HGB **(Project No. 2019-077-SIP-NR)** ozone nonattainment area will attain the 2008 eight-hour ozone NAAQS and a demonstration that the DFW and HGB areas will meet emission reduction milestone requirements that constitute reasonable further progress toward attainment **(Project No. 2019-079-SIP-NR).**

Information concerning the proposed rules, including proposal documents and instructions for providing public comment, is available at *https://www.tceq.texas.gov/rules/propose_adopt.html*. Information concerning the proposed SIP revisions, including proposal documents and instructions for providing public comment, is available at *https://www.tceq.texas.gov/airquality/sip/hgb/hgb-latest-ozone* .

The comment period for these revisions closes October 28, 2019. Written comments will be accepted through the eComments system at *https://www6.tceq.texas.gov/rules/ecomments/* . For additional submission methods, please contact the project manager for the proposed rule or SIP revision for: **Project No. 2019-075-115-AI**, contact Graham Bates at (512) 239-2606; **Project No. 2019-074-117-AI**, contact Javier Galván at (512) 239-1492; **Project No. 2019-077-SIP-NR**, contact Alison Stokes at (512) 239-4902; and for **Project No. 2019-079-SIP-NR**, contact Denine Calvin at (512) 239-0613.

INFORMATION.

If you need more information about the hearing process for this application, please call the Public Education Program, toll free, at (800) 687-4040. General information about the TCEQ can be found at our web site at www.tceq.texas.gov.

Further information may also be obtained from Markum Land Properties, LLC at the address stated above or by calling Mr. Kyle Wilks at (817) 850-3600.

Persons with disabilities who need special accommodations at the hearing should call the SOAH Docketing Department at (512) 475-3445, at least one week prior to the hearing.

Issued: September 13, 2019

TRD-201903352
Bridget C. Bohac
Chief Clerk
Texas Commission on Environmental Quality
Filed: September 18, 2019

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Notice of Public Hearing on Proposed Revisions to 30 Texas Administrative Code Chapters 115 and 117 and to the State Implementation Plan

The Texas Commission on Environmental Quality will offer a public hearing in Houston on October 14, 2019, at 2:00 p.m. at the Texas Department of Transportation auditorium located at 7600 Washington Avenue. The hearing is offered to receive testimony regarding proposed air quality rules and state implementation plan (SIP) revisions resulting from reclassification of the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) areas from moderate to serious nonattainment for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) by the United States Environmental Protection Agency (EPA). The hearing for the proposed revisions is required by Texas Health and Safety Code, §382.017; Texas Government Code, Chapter 2001, Subchapter B; and 40 Code of Federal Regulations §51.102 of the EPA concerning SIPs.

The hearing is structured for the receipt of oral or written comments by interested persons. Individuals may present oral statements when called upon in order of registration. Open discussion will not be permitted during the hearing; however, commission staff members will be available to discuss the proposals 30 minutes prior to the hearing.

Persons who have special communication or other accommodation needs who are planning to attend the hearing should contact Sandy Wong, Office of Legal Services at (512) 239-1802 or (800) RELAY-TX (TDD). Requests should be made as far in advance as possible.

The proposed rulemakings concern amendments to 30 Texas Administrative Code (TAC) Chapter 115, Control of Air Pollution from Volatile Organic Compounds (Project No. 2019-075-115-AI) and 30 TAC Chapter 117, Control of Air Pollution from Nitrogen Compounds (Project No. 2019-074-117-AI) to implement reasonably available control technology requirements. In addition, the proposed amendments to 30 TAC Chapter 115 would correct errors, and the proposed amendments to 30 TAC Chapter 117 would clarify applicability for exempt stationary diesel and dual-fuel engines and update emission test methods.

Proposed revisions to the SIP include a demonstration that the HGB (Project No. 2019-077-SIP-NR) ozone nonattainment area will attain the 2008 eight-hour ozone NAAQS and a demonstration that the DFW and HGB areas will meet emission reduction milestone requirements that constitute reasonable further progress toward attainment (Project No. 2019-079-SIP-NR).

Information concerning the proposed rules, including proposal documents and instructions for providing public comment, is available at https://www.tceq.texas.gov/rules/propose_adopt.html. Information concerning the proposed SIP revisions, including proposal documents and instructions for providing public comment, is available at https://www.tceq.texas.gov/airquality/sip/hgb/hgb-latest-ozone.

The comment period for these revisions closes October 28, 2019. Written comments will be accepted through the eComments system at https://www6.tceq.texas.gov/rules/ecomments/. For additional submission methods, please contact the project manager for the proposed rule or SIP revision for: Project No. 2019-075-115-AI, contact Graham Bates at (512) 239-2606; Project No. 2019-074-117-AI, contact Javier Galván at (512) 239-1492; Project No. 2019-077-SIP-NR, contact Alison Stokes at (512) 239-4902; and for Project No. 2019-079-SIP-NR, contact Denine Calvin at (512) 239-0613.

TRD-201903240
Robert Martinez
Director, Environmental Law Division
Texas Commission on Environmental Quality
Filed: September 13, 2019

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Notice of Public Hearing on Proposed Revisions to 30 Texas Administrative Code Chapters 115 And 117 and to the State Implementation Plan

The Texas Commission on Environmental Quality will offer a public hearing in Arlington on October 17, 2019, at 2:00 p.m. at the Arlington City Council Chambers located at 101 Abram Street. The hearing is offered to receive testimony regarding proposed air quality rules and state implementation plan (SIP) revisions resulting from reclassification of the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) areas from moderate to serious nonattainment for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) by the United States Environmental Protection Agency (EPA). The hearing for the proposed revisions is required by Texas Health and Safety Code, §382.017; Texas Government Code, Chapter 2001, Subchapter B; and 40 Code of Federal Regulations §51.102 of the EPA concerning SIPs.

The hearing is structured for the receipt of oral or written comments by interested persons. Individuals may present oral statements when called upon in order of registration. Open discussion will not be permitted during the hearing; however, commission staff members will be available to discuss the proposals 30 minutes prior to the hearing.

Persons who have special communication or other accommodation needs who are planning to attend the hearing should contact Sandy Wong, Office of Legal Services at (512) 239-1802 or (800) RELAY-TX (TDD). Requests should be made as far in advance as possible.

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Proposed revisions to the SIP include a demonstration that the DFW **(Project No. 2019-078-SIP-NR)** ozone nonattainment area will attain the 2008 eight-hour ozone NAAQS and a demonstration that the DFW and HGB areas will meet emission reduction milestone requirements that constitute reasonable further progress toward attainment **(Project No. 2019-079-SIP-NR).**

Information concerning the proposed rules, including proposal documents and instructions for providing public comment, is available at *https://www.tceq.texas.gov/rules/propose_adopt.html.* Information concerning the proposed SIP revisions, including proposal documents and instructions for providing public comment, is available at *https://www.tceq.texas.gov/airquality/sip/dfw/dfw-latest-ozone.*

The comment period for these revisions closes October 28, 2019. Written comments will be accepted through the eComments system at *https://www6.tceq.texas.gov/rules/ecomments/.* For additional submission methods, please contact the project manager for the proposed rule or SIP revision for: **Project No. 2019-075-115-AI,** contact Graham Bates at (512) 239-2606; **Project No. 2019-074-117-AI,** contact Javier Galván at (512) 239-1492; **Project No. 2019-078-SIP-NR,** contact Kristin Jacobsen at (512) 239-4907; and for **Project No. 2019-079-SIP-NR,** contact Denine Calvin at (512) 239-0613.

TRD-201903241
Robert Martinez
Director, Environmental Law Division
Texas Commission on Environmental Quality
Filed: September 13, 2019

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Notice of Public Hearings and Opportunity for Comment on the Edwards Aquifer Protection Program

The Texas Commission on Environmental Quality (TCEQ, agency, or commission) will conduct public hearings to receive comments from the public on actions the commission should take to protect the Edwards Aquifer from pollution, as required under Texas Water Code, §26.046.

Annual public hearings are held for the Edwards Aquifer Protection Program and the TCEQ rules, found at 30 Texas Administrative Code, Chapter 213, which regulate development over the delineated contributing, recharge and transition zones of the Edwards Aquifer. These annual public hearings assist the commission in its shared responsibility with local governments, such as cities, counties and groundwater conservation districts, to protect the water quality of the aquifer. The TCEQ is specifically seeking feedback on the following topics related to the Edwards Aquifer Protection Program:

-Revisions to the Edwards Aquifer Protection Program technical guidance manual, RG-348, including the method for calculating removal of total suspended solids;

-Review of innovative technology applications;

-Regulation of aggregate production operations (APOs) located over the Edwards Aquifer; and

-Compliance monitoring of plan-related best management practices following installation.

The hearings will be held at the following times and locations:

Monday, October 28, 2019, at 2:00 p.m. at the Tesoro Building, Alamo Area Council of Governments, Room 1A, 8700 Tesoro Drive, Suite 100, San Antonio; and

Tuesday, October 29, 2019, at 1:30 p.m. at the TCEQ Park 35 Office Complex, 12100 Park 35 Circle, Building E, Room 201S, Austin.

These hearings will be structured for the receipt of oral or written comments by interested persons. Individuals may present oral statements when called upon. There will be no open discussion during the hearings; however, agency staff members will be available to answer questions 30 minutes prior to and 30 minutes after the conclusion of the hearing. Registration will begin 30 minutes prior to the hearing.

Persons with disabilities who have special communication or other accommodation needs who are planning to attend the Austin hearing should contact the Office of Administrative Services Facilities Liaison at (512) 239-0080. Persons requesting accommodations for the San Antonio hearing should contact Ms. Anne Ruthstrom at (512) 239-1336. Requests should be made as far in advance as possible.

Written comments should reference the Edwards Aquifer Protection Program and may be sent to Ms. Anne Ruthstrom, Texas Commission on Environmental Quality, Program Support Section, MC 174, P.O. Box 13087, Austin, Texas 78711-3087, faxed to (512) 239-2249, or e-mailed to *anne.ruthstrom@tceq.texas.gov.* Comments must be received by **5:00 p.m., October 29, 2019.** For further information or questions concerning these hearings, please contact Ms. Ruthstrom, or visit *https://www.tceq.texas.gov/permitting/eapp/history.html.*

TRD-201903335
Robert Martinez
Director, Environmental Law Division
Texas Commission on Environmental Quality
Filed: September 17, 2019

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General Land Office

Notice and Opportunity to Comment on Requests for ConsistencyAgreement/Concurrence Under the Texas Coastal Management Program

On January 10, 1997, the State of Texas received federal approval of the Coastal Management Program (CMP) (62 *Federal Register* pp. 1439 - 1440). Under federal law, federal agency activities and actions affecting the Texas coastal zone must be consistent with the CMP goals and policies identified in 31 TAC Chapter 501. Requests for federal consistency review were deemed administratively complete for the following project(s) during the period of August 26, 2019 to September 13, 2019. As required by federal law, the public is given an opportunity to comment on the consistency of proposed activities in the coastal zone undertaken or authorized by federal agencies. Pursuant to 31 TAC §§506.25, 506.32, and 506.41, the public comment period extends 30 days from the date published on the Texas General Land Office web site. The notice was published on the web site on Friday, September 20, 2019. The public comment period for this project will close at 5:00 p.m. on Sunday, October 20, 2019.

FEDERAL AGENCY ACTIONS:

Applicant: Galveston County

Location: The project site is located along the beach-front of Bolivar Peninsula, in Galveston County, Texas.

Latitude & Longitude (NAD 83): Little Beach: Begin 29.367065, -94.754760; End 29.369902, -94.750989. Rest of Project Area: Begin 29.382358, -94.722974; End 29.555957, -94.370668.

Project Description: The applicant proposes to perform mechanized beach maintenance associated with the removal of Sargassum and

Jon Niermann, *Chairman*
Emily Lindley, *Commissioner*
Toby Baker, *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

NOTICE OF PUBLIC HEARING ON PROPOSED REVISIONS TO 30 TEXAS ADMINISTRATIVE CODE CHAPTERS 115 AND 117 AND TO THE STATE IMPLEMENTATION PLAN

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Proposed revisions to the SIP include a demonstration that the HGB (**Project No. 2019-077-SIP-NR**) ozone nonattainment area will attain the 2008 eight-hour ozone NAAQS and a demonstration that the DFW and HGB areas will meet emission reduction milestone requirements that constitute reasonable further progress toward attainment (**Project No. 2019-079-SIP-NR**).

Information concerning the proposed rules, including proposal documents and instructions for providing public comment, is available at *https://www.tceq.texas.gov/rules/propose_adopt.html*. Information concerning the proposed SIP revisions, including proposal documents and instructions for providing public comment, is available at *https://www.tceq.texas.gov/airquality/sip/hgb/hgb-latest-ozone.*

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

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REVISIONS TO THE STATE OF TEXAS AIR QUALITY IMPLEMENTATION PLAN FOR THE CONTROL OF OZONE AIR POLLUTION

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA 2008 EIGHT-HOUR OZONE STANDARD NONATTAINMENT AREAS

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
P.O. BOX 13087
AUSTIN, TEXAS 78711-3087

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Proposal
September 11, 2019

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EXECUTIVE SUMMARY

The 1990 Federal Clean Air Act (FCAA) Amendments, §182, require ozone nonattainment areas designated with a classification of moderate or higher to submit plans showing reasonable further progress (RFP) toward attainment of the ozone National Ambient Air Quality Standard (NAAQS). On March 12, 2008, the United States Environmental Protection Agency (EPA) revised the eight-hour ozone standard from 0.08 parts per million (ppm) to 0.075 ppm (75 *Federal Register* (FR) 16436). On May 21, 2012, the EPA published final designations for the 2008 eight-hour ozone standard with an effective date of July 20, 2012 (77 FR 30088). The EPA designated the 10-county Dallas-Fort Worth (DFW) area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties) as nonattainment with a moderate classification. The EPA designated the eight-county Houston-Galveston-Brazoria (HGB) area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) as nonattainment with a marginal classification. The HGB area was later reclassified from marginal to moderate nonattainment on December 14, 2016 (81 FR 90207). The Texas Commission on Environmental Quality (TCEQ) adopted moderate classification RFP SIP revisions for the DFW area on June 3, 2015 and for the HGB area on December 15, 2016. The EPA published final approval of the DFW moderate classification RFP SIP revision on December 7, 2016 (81 FR 88124) and published final approval of the HGB moderate classification RFP SIP revision on February 13, 2019 (84 FR 3708).

As indicated in the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) published on March 6, 2015, the attainment date for the moderate classification was July 20, 2018 with a 2017 attainment year (80 FR 12264). Based on 2017 monitoring data, both the DFW and HGB areas did not attain the 2008 eight-hour ozone NAAQS in 2017[1] and did not qualify for a one-year attainment date extension in accordance with FCAA, §181(a)(5).[2] On November 14, 2018, the EPA proposed to reclassify the DFW and HGB areas to serious nonattainment for the 2008 eight-hour ozone NAAQS (83 FR 56781). On August 7, 2019, the EPA signed the final reclassification notice.

Since the DFW and HGB areas have been reclassified by the EPA, they are now subject to the serious ozone nonattainment area requirements in FCAA, §182(c), and the TCEQ is required to submit serious classification attainment demonstration (AD) and RFP SIP revisions to the EPA. According to the final 2008 eight-hour ozone standard SIP requirements rule, the attainment date for a serious classification is July 20, 2021 with a 2020 attainment year (80 FR 12264). The EPA set an August 3, 2020 deadline for

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[1] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment deadline.

[2] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 ppb). The DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor (C63/C679). The DFW area's design value for 2017 was 79 ppb. The HGB area's fourth highest daily maximum eight-hour average for 2017 was 79 ppb as measured at the Conroe Relocated monitor (C78/A321). The HGB area's design value for 2017 was 81 ppb.

states to submit AD and RFP SIP revisions to address the 2008 eight-hour ozone standard serious nonattainment area requirements.

This proposed RFP SIP revision is not required to demonstrate attainment of the 2008 eight-hour ozone NAAQS but rather to demonstrate that the DFW and HGB nonattainment areas will meet the RFP requirements for serious ozone nonattainment areas. RFP requirements for serious ozone nonattainment areas, as specified in Section 182(c)(2) of the 1990 FCAA Amendments and in 40 CFR §51.910, involve reducing ozone precursor emissions of (nitrogen oxides (NO_X) and volatile organic compounds (VOC)) at annual increments between the base year and the attainment year.

The proposed RFP SIP revision demonstrates that the DFW and HGB nonattainment areas will achieve emissions reductions in NO_X and/or VOC consistent with the serious ozone nonattainment area requirements of FCAA, §182(c)(2)(B) and the 2008 eight-hour ozone standard SIP requirements rule according to the following increments:

- a 9% emissions reduction in NO_X and/or VOC for all counties for the three-year period from January 1, 2018 through December 31, 2020; and
- a 3% emissions reduction in NO_X and/or VOC for the one-year period from January 1, 2021 through December 31, 2021 for all counties as an attainment year RFP contingency.

The RFP methodology involves development of the base year, attainment year, and contingency year emissions inventories, and emissions reductions for each analysis year. The amount of emissions reductions is determined through the RFP methodology. Once calculated, the target levels and emissions inventories can be compared to determine if the forecasted controlled (post-control) emissions inventories are less than the target level, thus meeting FCAA RFP requirements. The results of the DFW RFP analysis year comparisons are provided in Chapter 3: *Progress Toward Meeting Target Emissions Levels*.

In addition to demonstrating the required emissions reductions, this proposed SIP revision also sets the NO_X and VOC motor vehicle emissions budgets (MVEBs) for transportation conformity purposes for a 2020 attainment year as detailed in Chapter 5 *Motor Vehicle Emissions Budget*. An MVEB is the on-road mobile source allocation of the total allowable emissions for each applicable criteria pollutant or precursor, as defined in the SIP. Transportation conformity determinations must be performed using the budget test once the EPA determines the budget adequate for transportation conformity purposes. To pass the budget test, areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the MVEB for the established year.

This proposed SIP revision demonstrates RFP for the DFW and HGB serious nonattainment areas for the 2020 attainment year as well as the 2021 contingency year.

SECTION V-A: LEGAL AUTHORITY

General

The Texas Commission on Environmental Quality (TCEQ) has the legal authority to implement, maintain, and enforce the National Ambient Air Quality Standards (NAAQS) and to control the quality of the state's air, including maintaining adequate visibility.

The first air pollution control act, known as the Clean Air Act of Texas, was passed by the Texas Legislature in 1965. In 1967, the Clean Air Act of Texas was superseded by a more comprehensive statute, the Texas Clean Air Act (TCAA), found in Article 4477-5, Vernon's Texas Civil Statutes. The legislature amended the TCAA in 1969, 1971, 1973, 1979, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015, and 2017. In 1989, the TCAA was codified as Chapter 382 of the Texas Health and Safety Code.

Originally, the TCAA stated that the Texas Air Control Board (TACB) is the state air pollution control agency and is the principal authority in the state on matters relating to the quality of air resources. In 1991, the legislature abolished the TACB effective September 1, 1993, and its powers, duties, responsibilities, and functions were transferred to the Texas Natural Resource Conservation Commission (TNRCC). In 2001, the 77th Texas Legislature continued the existence of the TNRCC until September 1, 2013 and changed the name of the TNRCC to the TCEQ. In 2009, the 81st Texas Legislature, during a special session, amended section 5.014 of the Texas Water Code, changing the expiration date of the TCEQ to September 1, 2011, unless continued in existence by the Texas Sunset Act. In 2011, the 82nd Texas Legislature continued the existence of the TCEQ until 2023. With the creation of the TNRCC, the authority over air quality is found in both the Texas Water Code and the TCAA. Specifically, the authority of the TNRCC is found in Chapters 5 and 7. Chapter 5, Subchapters A - F, H - J, and L, include the general provisions, organization, and general powers and duties of the TNRCC, and the responsibilities and authority of the executive director. Chapter 5 also authorizes the TNRCC to implement action when emergency conditions arise and to conduct hearings. Chapter 7 gives the TNRCC enforcement authority.

The TCAA specifically authorizes the TCEQ to establish the level of quality to be maintained in the state's air and to control the quality of the state's air by preparing and developing a general, comprehensive plan. The TCAA, Subchapters A - D, also authorizes the TCEQ to collect information to enable the commission to develop an inventory of emissions; to conduct research and investigations; to enter property and examine records; to prescribe monitoring requirements; to institute enforcement proceedings; to enter into contracts and execute instruments; to formulate rules; to issue orders taking into consideration factors bearing upon health, welfare, social and economic factors, and practicability and reasonableness; to conduct hearings; to establish air quality control regions; to encourage cooperation with citizens' groups and other agencies and political subdivisions of the state as well as with industries and the federal government; and to establish and operate a system of permits for construction or modification of facilities.

Local government authority is found in Subchapter E of the TCAA. Local governments have the same power as the TCEQ to enter property and make inspections. They also may make recommendations to the commission concerning any action of the TCEQ that affects their territorial jurisdiction, may bring enforcement actions, and may execute cooperative agreements with the TCEQ or other local governments. In addition, a city or town may enact and enforce ordinances for the control and abatement of air pollution not inconsistent with the provisions of the TCAA and the rules or orders of the commission.

Subchapters G and H of the TCAA authorize the TCEQ to establish vehicle inspection and maintenance programs in certain areas of the state consistent with the requirements of the Federal Clean Air Act; coordinate with federal, state, and local transportation planning agencies to develop and implement transportation programs and measures necessary to attain and maintain the NAAQS; establish gasoline volatility and low emission diesel standards; and fund and authorize participating counties to implement vehicle repair assistance, retrofit, and accelerated vehicle retirement programs.

Applicable Law

The following statutes and rules provide necessary authority to adopt and implement the state implementation plan (SIP). The rules listed below have previously been submitted as part of the SIP.

Statutes

All sections of each subchapter are included, unless otherwise noted.

TEXAS HEALTH & SAFETY CODE, Chapter 382	September 1, 2017
TEXAS WATER CODE	September 1, 2017

Chapter 5: Texas Natural Resource Conservation Commission
- Subchapter A: General Provisions
- Subchapter B: Organization of the Texas Natural Resource Conservation Commission
- Subchapter C: Texas Natural Resource Conservation Commission
- Subchapter D: General Powers and Duties of the Commission
- Subchapter E: Administrative Provisions for Commission
- Subchapter F: Executive Director (except §§5.225, 5.226, 5.227, 5.2275, 5.231, 5.232, and 5.236)
- Subchapter H: Delegation of Hearings
- Subchapter I: Judicial Review
- Subchapter J: Consolidated Permit Processing
- Subchapter L: Emergency and Temporary Orders (§§5.514, 5.5145, and 5.515 only)
- Subchapter M: Environmental Permitting Procedures (§5.558 only)

Chapter 7: Enforcement
- Subchapter A: General Provisions (§§7.001, 7.002, 7.0025, 7.004, and 7.005 only)
- Subchapter B: Corrective Action and Injunctive Relief (§7.032 only)
- Subchapter C: Administrative Penalties
- Subchapter D: Civil Penalties (except §7.109)
- Subchapter E: Criminal Offenses and Penalties: §§7.177, 7.179-7.183

Rules

All of the following rules are found in 30 Texas Administrative Code, as of the following latest effective dates:

Chapter 7: Memoranda of Understanding, §§7.110 and 7.119	December 13, 1996 and May 2, 2002
Chapter 19: Electronic Reporting	March 15, 2007
Chapter 35: Subchapters A-C, K: Emergency and Temporary Orders and Permits; Temporary Suspension or Amendment of Permit Conditions	July 20, 2006
Chapter 39: Public Notice, §§39.402(a)(1) - (6), (8), and (10) - (12), 39.405(f)(3) and (g), (h)(1)(A) - (4), (6), (8) - (11), (i) and (j), 39.407, 39.409, 39.411(a), (e)(1) - (4)(A)(i) and (iii), (4)(B), (5)(A) and (B), and (6) - (10), (11)(A)(i) and (iii) and (iv), (11)(B) - (F), (13) and (15), and (f)(1) - (8), (g) and (h), 39.418(a), (b)(2)(A), (b)(3), and (c), 39.419(e), 39.420 (c)(1)(A) - (D)(i)(I) and (II), (D)(ii), (c)(2), (d) - (e), and (h), and 39.601 - 39.605	May 31, 2018
Chapter 55: Requests for Reconsideration and Contested Case Hearings; Public Comment, all of the chapter except §55.125(a)(5) and (6)	May 31, 2018
Chapter 101: General Air Quality Rules	October 12, 2017
Chapter 106: Permits by Rule, Subchapter A	April 17, 2014
Chapter 111: Control of Air Pollution from Visible Emissions and Particulate Matter	August 3, 2017
Chapter 112: Control of Air Pollution from Sulfur Compounds	July 16, 1997
Chapter 113: Standards of Performance for Hazardous Air Pollutants and for Designated Facilities and Pollutants	May 14, 2009
Chapter 114: Control of Air Pollution from Motor Vehicles	April 26, 2018
Chapter 115: Control of Air Pollution from Volatile Organic Compounds	January 5, 2017
Chapter 116: Permits for New Construction or Modification	November 24, 2016
Chapter 117: Control of Air Pollution from Nitrogen Compounds	June 25, 2015
Chapter 118: Control of Air Pollution Episodes	March 5, 2000
Chapter 122: §122.122: Potential to Emit	February 23, 2017
Chapter 122: §122.215: Minor Permit Revisions	June 3, 2001

Chapter 122: §122.216: Applications for Minor Permit Revisions	June 3, 2001
Chapter 122: §122.217: Procedures for Minor Permit Revisions	December 11, 2002
Chapter 122: §122.218: Minor Permit Revision Procedures for Permit Revisions Involving the Use of Economic Incentives, Marketable Permits, and Emissions Trading	June 3, 2001

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    5. Regional Strategies (No change)
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D. Carbon Monoxide (No change)
E. Lead (No change)
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ABY	adjusted base year
AD	attainment demonstration
AERR	Air Emissions Reporting Requirements
APU	auxiliary power unit
ASLRRA	American Short Line and Regional Railroad Association
BY	Base Year
CFR	Code of Federal Regulations
CMV	commercial marine vessel
DFW	Dallas-Fort Worth
EDMS	Emission and Dispersion Modeling System
EI	emissions inventory
EIA	United States Energy Information Administration
EPA	United States Environmental Protection Agency
ERG	Eastern Research Group
FAA	Federal Aviation Administration
FCAA	Federal Clean Air Act
FMVCP	Federal Motor Vehicle Control Program
FR	*Federal Register*
GSE	ground support equipment
HGB	Houston-Galveston-Brazoria
I/M	inspection and maintenance
MOVES	Motor Vehicle Emissions Simulator
MVEB	motor vehicle emissions budget
NAAQS	National Ambient Air Quality Standard
NCTCOG	North Central Texas Council of Governments
NEI	National Emissions Inventory
NO_X	nitrogen oxides
ppb	parts per billion
ppm	parts per million
PN	percent of NO_X
PV	percent of VOC
RFG	reformulated gasoline

RFP	reasonable further progress
ROP	rate of progress
RRC	Railroad Commission of Texas
SCC	source classification code
SI	spark ignition
SIP	state implementation plan
STARS	State of Texas Air Reporting System
TAC	Texas Administrative Code
TACB	Texas Air Control Board
TCAA	Texas Clean Air Act
TCEQ	Texas Commission on Environmental Quality (commission)
TDM	travel demand model
TexN	Texas NONROAD Model
TNRCC	Texas Natural Resource Conservation Commission
tpd	tons per day
TTI	Texas A&M Transportation Institute
TxLED	Texas Low Emission Diesel
VMT	vehicle miles traveled
VOC	volatile organic compounds

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CHAPTER 1: GENERAL

1.1 REASONABLE FURTHER PROGRESS (RFP) BACKGROUND

Information on the Texas State Implementation Plan (SIP) and a list of SIP revisions and other air quality plans adopted by the commission can be found on the Texas State Implementation Plan webpage (http://www.tceq.texas.gov/airquality/sip) on the Texas Commission on Environmental Quality's (TCEQ) website (http://www.tceq.texas.gov/).

1.1.1 One-Hour Ozone National Ambient Air Quality Standard (NAAQS)

On February 8, 1979 the United States Environmental Protection Agency (EPA) set the one-hour ozone standard at 0.12 parts per million (ppm) (44 *Federal Register* (FR) 8202). A design value of 0.124 ppm, or 124 parts per billion (ppb), would round down and meet the NAAQS while a design value of 0.125 ppm, or 125 ppb, would round up and exceed the NAAQS. Because of these rounding conventions the one-hour ozone NAAQS of 0.12 ppm is commonly referenced as 124 ppb. Violation of the one-hour ozone NAAQS is based on the maximum number of expected exceedances over all the monitors in an area with a threshold of 1.0 expected exceedances per year averaged over a three-year period. The one-hour ozone NAAQS was revoked on June 15, 2005 (69 FR 23951).

1.1.1.1 Dallas-Fort Worth (DFW) One-Hour Ozone NAAQS History

Under the one-hour ozone NAAQS of 0.12 ppm, the EPA designated a four-county DFW area (Collin, Dallas, Denton, and Tarrant Counties) as moderate nonattainment in 1991 with an attainment date of November 15, 1996. The Texas Natural Resources Conservation Commission (TNRCC), a predecessor to the TCEQ, adopted a rate of progress (ROP) SIP revision on July 24, 1996, which demonstrated a 15% reduction in volatile organic compounds (VOC) between 1990 and 1996 for the moderate DFW one-hour ozone nonattainment area. The EPA fully approved the ROP SIP revision on April 12, 2005 (70 FR 18993).

On February 18, 1998, the EPA published a final determination that the DFW moderate one-hour ozone nonattainment area failed to attain the standard by the November 15, 1996 attainment date (63 FR 8128). The EPA reclassified the four-county DFW nonattainment area from moderate to serious, effective March 20, 1998, and established a new attainment date of November 15, 1999. On October 15, 1999, the TNRCC adopted a 9% ROP SIP revision for the DFW serious nonattainment area that included emissions reductions necessary to complete the ROP requirements for the years between 1996 and 1999. The EPA approved the 9% ROP SIP revision on January 12, 2000 (65 FR 1862).

In June 2005, the one-hour ozone standard was revoked after being replaced by the more stringent 1997 eight-hour ozone standard. By 2006, certified ambient monitoring data reflected attainment of the one-hour ozone standard. On October 16, 2008, the EPA published a final determination that the DFW area one-hour ozone nonattainment counties (Collin, Dallas, Denton, and Tarrant) had attained the one-hour ozone standard with a design value of 124 ppb, based on certified 2004 through 2006 ambient monitoring data (73 FR 61357).

On August 18, 2015, the TCEQ submitted a Redesignation Substitute Report for the DFW area for the one-hour ozone standard. This report fulfilled the EPA's redesignation substitute requirements in its *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) to lift anti-backsliding obligations under a revoked ozone NAAQS by ensuring that specific redesignation requirements are met for the DFW area under the revoked standard (78 FR 34178). This redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. On November 8, 2016, the EPA published its final approval of the DFW area redesignation substitute for the one-hour ozone and 1997 eight-hour ozone NAAQS effective December 8, 2016 (81 FR 78688).

1.1.1.2 Houston-Galveston-Brazoria (HGB) One-Hour Ozone NAAQS History

Under the one-hour ozone NAAQS of 0.12 ppm, the EPA designated an eight-county HGB area(Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) as a severe-17 nonattainment area in 1991 with an attainment date of November 15, 2007.

The TNRCC adopted an ROP SIP revision on December 6, 2000. The ROP SIP revision provided emissions inventories; ROP analyses for 2002, 2005, and 2007; and motor vehicle emissions budgets (MVEBs) for nitrogen oxides (NO_X) and VOC. On September 26, 2001, the Follow-Up One-Hour Ozone Attainment Demonstration and ROP SIP Revision was adopted. This revision incorporated changes to several control strategies and described how the state would fulfill the commitment to obtain the additional emission reductions necessary to address the remainder of the emission reductions shortfall and demonstrate attainment of the one-hour ozone standard in the HGB area. On November 14, 2001, the EPA approved both the December 2000 and September 2001 SIP revisions (66 FR 57159).

On October 27, 2004, the commission adopted the HGB One-Hour Ozone Post-1999 ROP SIP Revision. This revision provided updated emissions inventories and ROP analyses for 2002, 2005, and 2007 and revised MVEBs for the HGB area based on new models for estimating on-road and non-road mobile emissions sources. The SIP revision replaced the previous versions of the Post-1999 ROP that the EPA approved in November 2001. On February 14, 2005, the EPA approved the HGB One-Hour Ozone Post-1999 ROP SIP revision (70 FR 7407).

In June 2005, the one-hour ozone standard was revoked after being replaced by the more stringent 1997 eight-hour ozone standard. Although the EPA revoked the one-hour ozone NAAQS, former one-hour ozone nonattainment areas remain subject to certain anti-backsliding requirements. The HGB area failed to attain the one-hour ozone standard by the November 15, 2007 attainment deadline as required in 1991. On June 19, 2012, the EPA published a failure-to-attain determination effective July 19, 2012 (77 FR 36400).

As part of the transition to the 1997 eight-hour ozone standard, the EPA created a submittal termed a termination determination to address anti-backsliding requirements for the one-hour ozone standard. In May 2010, the TCEQ requested a determination regarding termination of the one-hour ozone anti-backsliding obligations associated with the transition from the one-hour ozone standard to the 1997 eight-hour ozone standard. As a result of court action, the EPA was unable to propose approval of the request.

The HGB area demonstrated attainment of the one-hour ozone NAAQS based on 2011 through 2013 monitoring data. On May 30, 2014, the EPA concurred that the data met all the quality requirements, and that the HGB area met the one-hour ozone standard.[3] On July 22, 2014, the TCEQ submitted a Redesignation Substitute Report for the HGB One-Hour Ozone Standard Nonattainment Area. This report fulfilled the EPA's redesignation substitute requirements in its 2008 eight-hour ozone standard SIP requirements rule to lift anti-backsliding obligations for the revoked one-hour ozone NAAQS by ensuring that specific redesignation requirements are met for the HGB area under the revoked standard (78 FR 34178). The redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. On October 20, 2015, the EPA approved the one-hour ozone HGB redesignation substitute demonstration effective November 19, 2015 (80 FR 63429).

1.1.2 1997 Eight-Hour Ozone NAAQS

On July 18, 1997, the EPA revised the NAAQS for ground-level ozone effective on September 16, 1997 (62 FR 38856). The EPA phased out and replaced the previous one-hour ozone NAAQS with an eight-hour NAAQS set at 0.08 ppm based on the three-year average of the annual fourth-highest daily maximum eight-hour average ozone concentrations measured at each monitor within an area. A design value of 0.084 ppm, or 84 ppb, would round down and meet the NAAQS while a design value of 0.085 ppm, or 85 ppb, would round up and exceed the NAAQS. Because of these rounding conventions the 1997 eight-hour ozone NAAQS is commonly referenced as 84 ppb. The EPA revoked the 1997 eight-hour ozone standard in its 2008 eight-hour ozone standard SIP requirements rule, effective April 6, 2015 (80 FR 12264).

1.1.2.1 DFW 1997 Eight-Hour Ozone NAAQS History

On April 30, 2004, nonattainment area designations were published as part of the first phase of the EPA's implementation rule for the 1997 eight-hour ozone standard, effective June 15, 2004 (69 FR 23936). The DFW nonattainment area was redefined as Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties. The DFW 1997 eight-hour ozone nonattainment area was classified as a moderate, with an attainment date of June 15, 2010. The TCEQ was required to submit an RFP SIP revision to the EPA for the DFW eight-hour ozone nonattainment area by June 15, 2007.

The second phase of EPA's implementation rule for the 1997 eight-hour ozone standard established RFP submittal guidelines that required nonattainment areas partially composed of one-hour ozone standard nonattainment areas with approved 15% ROP SIP revisions, like the DFW area, to choose between two options (70 FR 71612). The first option was to submit a 1997 eight-hour ozone standard RFP SIP revision demonstrating 15% VOC emissions reductions for the entire eight-hour

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[3] Mark Hansen, Acting Associate Director for Air Programs, EPA. Letter to Richard A. Hyde, Executive Director, TCEQ. May 30, 2014

nonattainment area. The second option was to submit a 1997 eight-hour ozone standard RFP SIP revision demonstrating 15% VOC emissions reductions for the newly designated portion of the eight-hour nonattainment area and VOC and/or NO_x emissions reductions for the portion of the nonattainment area containing an approved one-hour ozone standard 15% ROP SIP revision. On May 23, 2007, the commission adopted the 2007 Dallas-Fort Worth Eight-Hour Ozone Nonattainment Area Reasonable Further Progress State Implementation Plan Revision (Project No. 2006-031-SIP-NR) based on the second option. Since Collin, Dallas, Denton, and Tarrant Counties already had an approved plan containing the 15% VOC-only emissions reduction, only the five newly designated counties were required to demonstrate a 15% VOC reduction while the one-hour ozone nonattainment counties were permitted to substitute NO_x for VOC. The EPA approved the 1997 eight-hour ozone RFP SIP revision for the DFW nonattainment area on October 7, 2008 (73 FR 58475), including the 15% VOC-only emissions reduction for the newly designated counties.

The DFW area failed to meet the June 15, 2010 attainment deadline under its moderate classification. Effective January 19, 2011, the EPA published a final determination of failure to attain and reclassification of the DFW area from a moderate to a serious nonattainment area for the 1997 eight-hour ozone standard (75 FR 79302). The EPA set January 19, 2012 as the deadline for Texas to submit attainment demonstration and RFP SIP revisions addressing the serious ozone nonattainment area requirements of the Federal Clean Air Act (FCAA).

On December 7, 2011, the TCEQ adopted the 2011 DFW 1997 Eight-Hour Ozone RFP SIP Revision (Project No. 2010-023-SIP-NR). The 2011 RFP SIP revision demonstrated a 9% emissions reduction between 2008 and 2011 and a 3% emissions reduction between 2011 and 2012 and also included MVEBs for each milestone year and a contingency plan. The 2011 RFP SIP revision used the EPA’s Motor Vehicle Emission Simulator (MOVES) model to develop the base year and milestone year on-road mobile emissions inventories and the milestone year MVEBs. The EPA published final approval of the 2011 DFW RFP SIP revision on November 12, 2014 (79 FR 67068).

Under the serious classification, the DFW nonattainment area was given until June 15, 2013 to attain the 1997 eight-hour ozone NAAQS. The area did not monitor attainment by that date but at the end of the 2014 ozone season, the eight-hour design value was 81 ppb, based on 2012, 2013, and 2014 air monitoring data, which is in attainment of the 1997 eight-hour ozone standard. On February 24, 2015, the TCEQ submitted early certification of 2014 ozone air monitoring data to the EPA, along with a request for a determination of attainment for the 1997 eight-hour ozone standard for the DFW area. On September 1, 2015, the EPA published a determination of attainment for the DFW 1997 eight-hour ozone nonattainment area (80 FR 52630).

On August 18, 2015, the TCEQ submitted a Redesignation Substitute Report for the DFW 1997 Eight-Hour Ozone Standard Nonattainment Area, which fulfilled the EPA’s redesignation substitute requirements in its 2008 eight-hour ozone standard SIP requirements rule to lift anti-backsliding obligations for the revoked 1997 eight-hour ozone NAAQS by ensuring that specific redesignation requirements are met for the DFW area under the revoked standard. The redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. On November 8, 2016, the EPA approved the 1997 eight-hour ozone DFW redesignation substitute demonstration effective December 8, 2016 (81 FR 78688).

1.1.2.2 HGB 1997 Eight-Hour Ozone NAAQS History

Effective June 15, 2004, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties were designated nonattainment in the first phase of the EPA's implementation rule for the 1997 eight-hour ozone NAAQS (69 FR 23951). The HGB area was classified moderate nonattainment for the standard, with an attainment deadline of June 15, 2010. The TCEQ was required to submit an RFP SIP revision for the 1997 eight-hour ozone NAAQS to the EPA by June 15, 2007. The commission adopted the 2007 HGB 1997 Eight-Hour Ozone Nonattainment Area RFP SIP revision on May 23, 2007, which demonstrated that a required 15% emissions reduction in ozone precursors (VOC and NO_x) would be met for the 2001 through 2008 RFP analysis period. On April 22, 2009, the EPA published approval of the RFP SIP revision, the associated MVEB, and the 2002 base year emissions inventory (EI) (74 FR 18298).

On June 15, 2007, the state requested that the HGB area be reclassified from a moderate to a severe nonattainment area for the 1997 eight-hour ozone NAAQS, with an attainment deadline of June 15, 2019. On December 31, 2007, the EPA published its proposal to grant the governor's request and took comments on a range of dates for the state to submit a revised SIP (72 FR 74252). The TCEQ provided comments to the EPA that supported the reclassification and justification for an April 2010 SIP submission date. On October 1, 2008, the EPA published approval of the governor's request to voluntarily reclassify the HGB ozone nonattainment area from a moderate to a severe nonattainment area for the 1997 eight-hour ozone NAAQS (73 FR 56983), effective October 31, 2008. The EPA set April 15, 2010 as the date for the state to submit a SIP revision addressing the severe-ozone nonattainment requirements and set a new attainment deadline of June 15, 2019.

The 2010 HGB 1997 Eight-Hour Ozone RFP SIP Revision, as required by the EPA, demonstrated an 18% emissions reduction occurred for the 2002 through 2008 RFP analysis period and that an average of 3% per year emissions reduction will occur between each of the analysis years 2008, 2011, 2014, 2017, and 2018. The RFP SIP revision established baseline emission levels, calculated reduction targets, identified control strategies to meet emission target levels, and tracked actual emission reductions against established emissions growth. This revision also included an MVEB for each analysis year and a contingency plan.

On January 25, 2011, the EPA published a notice of its determination that the MVEBs in the March 10, 2010 SIP revisions, which were developed using the on-road mobile source emissions inventories based on the EPA’s MOBILE 6.2 model, were adequate for transportation conformity purposes (76 FR 4342). On January 2, 2014, the EPA published approval of the RFP SIP revision (79 FR 51). On April 23, 2013, the commission adopted the 2013 HGB 1997 Eight-Hour Ozone MVEB SIP Revision. The SIP revision updated on-road mobile source emissions inventories and MVEBs for the HGB area using the MOVES2010a version of the EPA's mobile emissions estimation model. The 2013 MVEB SIP revision also met the primary obligation of the mid-course review commitment in the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision by demonstrating that the outstanding 3% contingency requirement was fulfilled. Updated on-road inventories and emissions analysis based on the EPA's August 30, 2012 vehicle miles traveled offset guidance and a modified version of the MOVES model demonstrated compliance with FCAA requirements for transportation control measures in severe nonattainment areas.

On January 2, 2014, the EPA published approval of this 2013 HGB 1997 Eight-Hour Ozone MVEB SIP Revision along with its approval of the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision (79 FR 57). On March 6, 2015, the EPA revoked the 1997 eight-hour ozone NAAQS effective April 6, 2015 (80 FR 12264).

The HGB area monitored attainment of the 1997 eight-hour ozone NAAQS based on 2012 through 2014 monitoring data. In February 2015, the TCEQ submitted certification of 2014 ozone data in support of the TCEQ's subsequent request for a determination of attainment, also known as a clean data determination, for the 1997 eight-hour ozone NAAQS for the HGB area. The EPA published a final determination of attainment for the 1997 eight-hour ozone NAAQS for the HGB area on December 30, 2015 (80 FR 81466).

On August 18, 2015, the TCEQ submitted a Redesignation Substitute Report for the HGB 1997 Eight-Hour Ozone Standard Nonattainment Area, which fulfilled the EPA's redesignation substitute requirements in its 2008 eight-hour ozone standard SIP requirements rule to lift anti-backsliding obligations for the revoked 1997 eight-hour ozone NAAQS by ensuring that specific redesignation requirements are met for the HGB area under the revoked standard. The redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. The EPA approved the 1997 eight-hour ozone HGB redesignation substitute demonstration on November 8, 2016 (81 FR 78691).

1.1.3 Redesignation Request and Maintenance Plan SIP Revisions for the One-Hour and 1997 Eight-Hour Ozone NAAQS

On February 16, 2018, the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit Court) issued an opinion in the case *South Coast Air Quality Management District v. EPA, 882 F.3d 1138 (D.C. Cir. 2018)*. The case was a challenge to the EPA's final 2008 eight-hour ozone standard SIP requirements rule, which revoked the 1997 eight-hour ozone NAAQS as part of the implementation of the more stringent 2008 eight-hour ozone NAAQS. The court's decision vacated parts of the EPA's final 2008 eight-hour ozone standard SIP requirements rule, including the redesignation substitute, removal of anti-backsliding requirements for areas designated nonattainment under the 1997 eight-hour ozone NAAQS, waiving requirements for transportation conformity for maintenance areas under the 1997 eight-hour ozone NAAQS, and elimination of the requirement to submit a second 10-year maintenance plan.

To address the court's ruling, the commission adopted a formal redesignation request and maintenance plan SIP revision for the one-hour and 1997 eight-hour ozone NAAQS for the HGB area on December 12, 2018 and for the DFW area on March 27, 2019. The SIP revisions include a request that the DFW and HGB area be redesignated to attainment for the revoked one-hour and 1997 eight-hour ozone NAAQS. The SIP revisions also include a maintenance plan that will ensure the areas remain in attainment of the standards through 2032. The maintenance plans use a 2014 base year inventory and include interim year inventories for 2020 and 2026, establish MVEBs for 2032, and include a contingency plan.

1.1.4 2008 Eight-Hour Ozone NAAQS

On March 12, 2008, the EPA lowered the primary and secondary eight-hour ozone NAAQS to 0.075 ppm or 75 ppb (73 FR 16436). Attainment of the standard (expressed as 0.075 parts per million) is achieved when an area's design value does not exceed 75 ppb. On May 21, 2012, the EPA published final designations for the 2008 eight-hour ozone standard with an effective date of July 20, 2012 (77 FR 30088). The EPA's implementation rule for the 2008 eight-hour ozone NAAQS, also published on May 21, 2012 (77 FR 30160), established December 31 of each relevant calendar year as the attainment date for all nonattainment area classification categories.

On June 6, 2013, the EPA published the proposed 2008 eight-hour ozone standard SIP requirements rule (78 FR 34178). The proposed rule addressed SIP requirements, the timing of SIP submissions, revocation of the 1997 eight-hour ozone NAAQS, and anti-backsliding requirements for previous ozone standards.

The D.C. Circuit Court published an opinion on December 23, 2014 agreeing with two challenges to the EPA's proposed rule implementing the 2008 eight-hour ozone NAAQS published on May 21, 2012 (77 FR 30160). The court vacated the provisions of the rule relating to attainment deadlines and revocation of the 1997 eight-hour ozone NAAQS for transportation conformity purposes. As part of the final 2008 eight-hour ozone standard SIP requirements rule, the EPA modified 40 CFR §51.1103 consistent with the D.C. Circuit Court decision to establish attainment dates that run from the effective date of designation, i.e., July 20, 2012, and revoked the 1997 eight-hour ozone NAAQS for all purposes.

1.1.4.1 DFW 2008 Eight-Hour Ozone NAAQS History

On May 21, 2012, the EPA designated a 10-county DFW area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties) as nonattainment for the 2008 eight-hour ozone NAAQS with a moderate classification, effective July 20, 2012. The attainment date for the DFW moderate nonattainment area was originally established in the EPA's implementation rule for the 2008 eight-hour ozone NAAQS published on May 21, 2012 and was set as December 31, 2018 (77 FR 30160). Due to the D.C. Circuit Court ruling, the attainment date changed from December 31, 2018 to July 20, 2018. In addition, because the attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment date, the attainment year for the DFW moderate nonattainment area changed from 2018 to 2017.

On July 2, 2014, the commission adopted a SIP revision to satisfy FCAA, §172(c)(3) and §182(a)(1) EI reporting requirements for the DFW nonattainment area under the 2008 eight-hour ozone standard. The EPA published direct final approval of this SIP revision on February 20, 2015 (80 FR 9204).

To meet FCAA requirements for a moderate ozone nonattainment area, the commission adopted the DFW RFP SIP revision for the 2008 Eight-Hour Ozone NAAQS on June 3, 2015. The SIP revision provided an RFP analysis for a 2017 attainment year, including a contingency plan and an MVEB, according to the following increments:

- a 15% emissions reduction in VOC for the six-year period from January 1, 2012 through December 31, 2017 for the newly designated one-county portion of the DFW 2008 eight-hour ozone nonattainment area consisting of Wise County;
- a 15% emissions reduction in VOC and/or NO_X for the six-year period from January 1, 2012 through December 31, 2017 for the previously designated nine-county portion of the DFW 2008 eight-hour ozone nonattainment area consisting of Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties; and
- a 3% emissions reduction in VOC and/or NO_X for the one-year period from January 1, 2018 through December 31, 2018 as attainment year RFP contingency for all counties of the DFW 2008 eight-hour ozone nonattainment area.

The 2017 Wise County RFP demonstration in the adopted DFW RFP SIP revision used a transfer of excess VOC reductions from the nine-county area previously designated as nonattainment to the newly designated Wise County. Upon notification that the option to transfer creditable VOC reductions between county groups was no longer available per the EPA's final 2008 eight-hour ozone SIP requirements rule (80 FR 12264), the TCEQ corrected the adopted DFW RFP analyses to remove the VOC reduction transfer and credit emission reductions from drilling rig controls that were available but had not been credited. The corrections were submitted to the EPA in an April 22, 2016 technical supplement.

On December 7, 2016, the EPA published final approval of the DFW RFP SIP revision for the 2008 eight-hour ozone NAAQS (81 FR 88124).

1.1.4.2 HGB 2008 Eight-Hour Ozone NAAQS History

On May 21, 2012, the EPA designated an eight-county HGB area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) as nonattainment for the 2008 eight-hour ozone NAAQS with a marginal classification, effective July 20, 2012. The attainment date for the HGB marginal nonattainment area was originally established in the EPA’s implementation rule for the 2008 eight-hour ozone NAAQS published on May 21, 2012 and was set as December 31, 2015 (77 FR 30160). Due to the D.C. Circuit Court ruling, the attainment date changed from December 31, 2015 to July 20, 2015. In addition, because the attainment year ozone season is the ozone season immediately preceding a nonattainment area’s attainment date, the attainment year for the HGB marginal nonattainment area changed from 2015 to 2014.

On July 2, 2014, the commission adopted a SIP revision to satisfy FCAA, §172(c)(3) and §182(a)(1) EI reporting requirements for the HGB nonattainment area under the 2008 eight-hour ozone standard. The EPA published direct final approval of this SIP revision on February 20, 2015 (80 FR 9204).

Reclassification to Moderate for the 2008 Eight-Hour Ozone NAAQS

The HGB area did not attain the 2008 eight-hour ozone standard in 2014 but qualified for a one-year attainment date extension in accordance with FCAA, §181(a)(5). On May

4, 2016, the EPA granted a one-year attainment deadline extension for the HGB 2008 eight-hour ozone marginal nonattainment area to July 20, 2016 (81 FR 26697).

Because the HGB area's 2015 design value of 80 ppb exceeded the 2008 eight-hour ozone NAAQS, the EPA published a proposed determination of nonattainment and reclassification of the HGB area from marginal to moderate nonattainment on September 27, 2016 (81 FR 66240). The EPA proposed a January 1, 2017 deadline for the state to submit an attainment demonstration that addresses the 2008 eight-hour ozone NAAQS moderate nonattainment area requirements, including RFP. As indicated in the EPA's 2008 eight-hour ozone standard SIP requirements rule, the attainment deadline for moderate classification was July 20, 2018 with an attainment year of 2017.

On December 15, 2016, the commission adopted the HGB 2008 Eight-Hour Ozone RFP SIP revision to satisfy the requirements of FCAA, §182(b)(1) for moderate ozone nonattainment areas. The SIP revision demonstrated a 15% emissions reduction in ozone precursors from the 2011 base year through the 2017 attainment year, a 3% reduction for contingency in 2018, and set NO_X and VOC MVEBs for the 2017 attainment year. The EPA published final approval of this SIP revision on February 13, 2019 (84 FR 3708).

1.1.4.3 Reclassification to Serious for the 2008 Eight-Hour Ozone NAAQS

With a moderate classification, the DFW and HGB areas had to attain the 2008 eight-hour ozone NAAQS of 0.075 ppm by a July 20, 2018 attainment date. Based on 2017 monitoring data, both the DFW and HGB areas did not attain the 2008 eight-hour ozone NAAQS in 2017[4] and did not qualify for a one-year attainment date extension in accordance with FCAA, §181(a)(5)[5]. On November 14, 2018, the EPA proposed to reclassify the DFW and HGB areas to serious nonattainment for the 2008 eight-hour ozone NAAQS (83 FR 56781). On August 7, 2019, the EPA signed the final reclassification notice.

Since the DFW and HGB areas have been reclassified by the EPA, they are subject to the serious nonattainment area requirements in FCAA, §182(c), and the TCEQ is required to submit serious area RFP SIP revisions to the EPA. As indicated in the EPA's 2008 eight-hour ozone standard SIP requirements rule published on March 6, 2015 (80 FR 12264), the attainment deadline for a serious classification is July 20, 2021 with an attainment year of 2020.

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[4] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment deadline.

[5] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 ppb). The DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor (C63/C679). The DFW area's design value for 2017 was 79 ppb. The HGB area's fourth highest daily maximum eight-hour average for 2017 was 79 ppb as measured at the Conroe Relocated monitor (C78/A321). The HGB area's design value for 2017 was 81 ppb.

1.2 RFP REQUIREMENTS

The 1990 FCAA amendments, 42 United States Code §7410, require states to submit SIP revisions that contain enforceable measures to achieve the NAAQS. The FCAA also requires states with ozone nonattainment areas classified as moderate or above to submit plans showing reasonable further progress toward attainment. Section 182(b)(1)(A) of the FCAA requires states with ozone nonattainment areas classified as moderate or higher to submit plans providing for a 15% reduction in VOC emissions in those areas. Section 182(c)(2) of the FCAA requires states with ozone nonattainment areas classified as serious or higher to submit plans providing for additional 3% annual combined reductions of NO_X and/or VOC averaged over three-year increments, until the area's attainment deadline.

For the 2008 eight-hour ozone NAAQS, the TCEQ previously adopted RFP SIP revisions for the DFW and HGB moderate nonattainment areas. The DFW RFP SIP revision adopted on June 3, 2015, demonstrated a 15% emissions reduction in VOC from the 2011 base year through the 2017 attainment year for the newly designated one-county portion of the DFW moderate nonattainment area (Wise County) and a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the previously designated nine-county portion of the DFW moderate nonattainment area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties). The HGB RFP SIP Revision adopted on December 15, 2016 demonstrated a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the eight-county HGB moderate nonattainment area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties).

While emissions and emissions reductions were calculated from 2011 through 2017 for this proposed DFW and HGB serious classification RFP SIP revision, 2017 is not considered an analysis year because the EPA approved the RFP demonstration for the 2017 analysis year for the DFW area on December 7, 2016 (81 FR 88124) and approved the RFP demonstration for the 2017 analysis year for the HGB area on February 13, 2019 (84 FR 3708). This RFP SIP revision demonstrates that the DFW and HGB nonattainment areas will achieve emissions reductions in ozone precursors (NO_X and/or VOC) consistent with the serious ozone nonattainment area requirements of FCAA, §182(c)(2)(B) and the 2008 eight-hour ozone standard SIP requirements rule according to the following increments:

- a 9% emissions reduction in NO_X and/or VOC for all counties for the three-year period from January 1, 2018 through December 31, 2020; and
- a 3% emissions reduction in NO_X and/or VOC for the one-year period from January 1, 2021 through December 31, 2021 for all counties as an attainment year RFP contingency.

In addition to demonstrating the required emissions reductions, the proposed SIP revision also provides MVEBs for the 2020 attainment year.

This proposed SIP revision demonstrates RFP for the DFW and HGB serious nonattainment areas for the 2020 attainment year as well as the 2021 contingency year. A summary of the DFW and HGB areas' progress toward meeting RFP requirements can be found in Appendix 1*: DFW Reasonable Further Progress*

Demonstration Spreadsheet and Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet*.

1.3 PUBLIC HEARING AND COMMENT INFORMATION

The commission will hold public hearings for this proposed SIP revision at the following times and locations:

Table 1-1: Public Hearing Information

City	Date	Time	Location
Houston	October 14, 2019	2:00 p.m.	Texas Department of Transportation District Office Auditorium 7600 Washington Avenue Houston, TX 77007
Arlington	October 17, 2019	2:00 p.m.	Arlington City Council Chambers 101 W. Abram St. Arlington, TX 76010

The public comment period will open on September 13, 2019, 2019 and close on October 28, 2019. Written comments will be accepted via mail, fax, or through the eComments (https://www6.tceq.texas.gov/rules/ecomments/) system. All comments should reference the "DFW and HGB 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision" and should reference Project Number 2019-079-SIP-NR. Comments may be submitted to Denine Calvin, MC 206, State Implementation Plan Team, Air Quality Division, Texas Commission on Environmental Quality, P.O. Box 13087, Austin, Texas 78711-3087 or faxed to (512) 239-6188. If you choose to submit electronic comments, they must be submitted through the eComments system. File size restrictions may apply to comments being submitted via the eComments system. Comments must be received by October 28, 2019.

An electronic version of the DFW and HGB Serious Classification RFP SIP Revision for the 2008 Eight-Hour Ozone Standard and appendices can be found at the TCEQ's DFW: Latest Ozone Planning Activities webpage (https://www.tceq.texas.gov/airquality/sip/dfw/dfw-latest-ozone) and HGB: Latest Ozone Planning Activities webpage (https://www.tceq.texas.gov/airquality/sip/hgb/hgb-latest-ozone).

1.4 SOCIAL AND ECONOMIC CONSIDERATIONS

No new control strategies have been incorporated into this proposed DFW and HGB RFP SIP revision. Therefore, there are no additional social or economic costs associated with this revision.

1.5 FISCAL AND MANPOWER RESOURCES

The state has determined that its fiscal and manpower resources are adequate and will not be adversely affected through the implementation of this plan.

CHAPTER 2: EMISSIONS INVENTORIES

2.1 INTRODUCTION

The Federal Clean Air Act (FCAA) Amendments of 1990 require that reasonable further progress (RFP) emissions inventories be prepared for ozone nonattainment areas. Ground-level (tropospheric) ozone is produced when ozone precursor emissions, volatile organic compounds (VOC) and nitrogen oxides (NO_X), undergo photochemical reactions in the presence of sunlight.

The Texas Commission on Environmental Quality (TCEQ) maintains an inventory of current information for sources of NO_X and VOC that identifies the types of emissions sources present in an area, the amount of each pollutant emitted, and the types of processes and control devices employed at each source or source category. The total inventory of NO_X and VOC emissions for an area is derived from estimates developed for four general categories of emissions sources: point, area, mobile (both non-road and on-road), and biogenic. The emissions inventory (EI) also provides data for a variety of air quality planning tasks, including establishing baseline emissions levels, calculating reduction targets, developing control strategies to achieve emissions reductions, developing emissions inputs for air quality models, and tracking actual emissions reductions against established emissions growth and control budgets.

This proposed Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) Reasonable Further Progress (RFP) State Implementation Plan (SIP) revision demonstrates RFP for a 2020 attainment year per the guidance in the Environmental Protection Agency's (EPA) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule), published in the *Federal Register* (FR) on March 6, 2015 (80 FR 12264). Specifically, this DFW and HGB RFP SIP revision demonstrates a 9% emissions reduction from calendar years 2018 through 2020 for the counties designated as nonattainment for ozone by combining NO_X and VOC emissions reductions.

To complete the RFP calculations, a set of inventories and control measures reduction estimates is required. In accordance with the requirement for these inventories and estimates, this DFW and HGB RFP SIP revision includes documentation of emissions inventories for the 2011 base year, for the 2020 attainment year, and for the attainment year RFP contingency requirement (2021). Those emissions inventories provide the basis for demonstrating how the required RFP emissions reductions will be met.

To develop an RFP SIP revision for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS), states must: (1) determine the base year emissions for NO_X and VOC; (2) calculate RFP target emissions reductions levels based on the RFP percent reduction requirements; (3) determine the attainment year inventories according to RFP requirements; and (4) account for creditable emissions reductions in the attainment year EI in accordance with applicable requirements. When the RFP controlled emissions reductions meet or exceed the calculated target emissions reductions, then RFP is demonstrated.

The requirement to calculate and account for the non-creditable emissions reductions due to pre-1990 Federal Motor Vehicle Control Program (FMVCP) reductions in RFP analyses was removed under the 2008 eight-hour ozone standard SIP requirements rule. This rule change eliminates the requirements to: calculate the adjusted base year (ABY) EI that estimates the effects of the non-creditable pre-1990 FCAA controls, use the ABY EI to calculate the percent reductions, and include the non-creditable reductions in the RFP target calculations. Accordingly, the RFP analyses presented in this proposed DFW and HGB RFP SIP revision do not include any of the RFP elements or non-creditable effects related to the pre-1990 FMVCP, including ABY emissions inventories and related summaries and documentation.

This proposed DFW and HGB RFP SIP revision includes:

- a 2011 base year EI;

  The base year EI is the starting point for calculating the target levels of emissions. A base year of 2011 was selected in accordance with the EPA's 2008 eight-hour ozone standard SIP requirements rule.

- 2020 uncontrolled EI;

  The RFP analysis requires an uncontrolled EI with growth between the base year and the attainment year. The uncontrolled EI serves as the basis for determining the amount of emissions reductions required to meet the RFP target for the attainment year.

- quantification of control measure reductions for the 2020 attainment year;

  The RFP analysis requires the calculations of emissions reductions for control strategies, which are then subtracted from the uncontrolled or existing controlled emissions to determine the controlled RFP EI. The RFP emissions reductions are individually quantified for each control strategy that pertains to particular source categories. A discussion of RFP control strategies is provided in Chapter 4: *Control Measures to Achieve Target Levels*.

- 2020 controlled EI; and

  The controlled EI represents the projected (forecasted) EI with all controls implemented. The controlled projected RFP EI is the result of subtracting the emissions reductions for controls that are used to demonstrate RFP from the uncontrolled or existing controlled projected EI.

- 2020 attainment year RFP contingency control reductions.

  The RFP analysis requires the calculation of the emissions reductions for control strategies for the year following the attainment year. These control reductions must be implemented if an RFP requirement is not met. A discussion of the RFP contingency control strategies for this DFW and HGB RFP SIP revision is provided in Chapter 4.

2.1.1 Updated Uncontrolled 2020 Attainment Year Inventories for Mobile Sources

Uncontrolled attainment year emissions inventories for mobile sources represent what each attainment year's emissions would be if the post-1990 mobile control strategies were never implemented. First, emissions inventories are calculated for each mobile source category using EPA-approved methodologies. The inventories are then combined to derive the total uncontrolled attainment year EI for NO_x and VOC. The uncontrolled attainment year EI includes 1990 or prior FCAA and/or state controls as well as growth in activity from 2011 to the attainment year, but the inventory does not include post-1990 FCAA and/or state controls.

2.1.2 Updated Controlled 2020 Attainment Year Inventory for Mobile Sources

The controlled attainment year EI represents projected emissions for 2020, accounting for emissions growth from either 2011 or the projection base year as detailed below and specified applicable controls. Emissions inventories are calculated for each source category using EPA-approved methodologies. Then, the inventories are combined to obtain the total controlled attainment year EI for NO_x and VOC. The controlled attainment year EI includes: specified FCAA and/or state controls implemented prior to the base year or analysis year, growth in activity from the base year or the projection base year to the attainment year, and specified FCAA and/or state controls used to meet the RFP target emissions levels.

2.1.3 Updated Uncontrolled and Controlled 2020 Attainment Year Inventory for Stationary Sources

For stationary sources, the uncontrolled attainment year emissions inventories represent the estimated attainment year emissions if no further action to control emissions growth were taken beyond the controls already accounted for in the EI. More recent stationary source data than the 2011 base year data is available; this newer data reflects growth that has occurred since the base year. This newer data also reflects more recent operations and applied controls since the 2011 base year. Therefore, the most recent annual EI was selected as the year from which to forecast emissions and is referred to as the *projection base year*.

Stationary source emissions inventories are calculated for each source category using methods as detailed in the appropriate sections below. The inventories are then combined to derive the total attainment year EI for NO_x and VOC. This attainment year EI reflects specified FCAA and/or state controls implemented by the end of the projection base year. The attainment year EI also reflects growth in activity from the projection base year to the attainment year. The uncontrolled 2011 EI for stationary sources includes all controls and associated reductions implemented by the end of the 2011 base year.

No stationary source controls beyond the controls previously described in this section are quantified for this proposed DFW and HGB RFP SIP revision; therefore, for the attainment year, the uncontrolled stationary source EI is equivalent to the controlled stationary source EI.

2.1.4 Updated Adjusted Base Year Inventories

The on-road ABY emissions inventories are not required for this DFW and HGB RFP SIP revision. See Section 2.1: *Introduction* for additional information.

2.2 POINT SOURCES

2.2.1 Emissions Inventory Development

Stationary point source emissions data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) § 101.10. This rule, referred to as the TCEQ EI reporting rule, establishes point source EI reporting thresholds in ozone nonattainment areas that are currently at or less than major source thresholds in the DFW and HGB ozone nonattainment areas. Therefore, some minor sources in the DFW and HGB ozone nonattainment areas report to the point source EI.

To collect the data, the TCEQ sends notices to all sites identified as potentially meeting the reporting requirements. Companies are required to report emissions data and to provide sample calculations used to determine the emissions. Information characterizing the process equipment, the abatement units, and the emission points is also required. Per FCAA §182(a)(3)(B), company representatives certify that reported emissions are true, accurate, and fully represent emissions that occurred during the calendar year to the best of the representative's knowledge.

All data submitted in the EI are reviewed for quality-assurance purposes and then stored in the State of Texas Air Reporting System (STARS) database. Emissions Inventory guidance documents and historical point source emissions of criteria pollutants are available on the TCEQ's Point Source Emissions Inventory webpage (https://www.tceq.texas.gov/airquality/point-source-ei/psei.html). Additional information is available upon request from the TCEQ's Air Quality Division.

2.2.2 Updated 2011 Base Year Inventory

The TCEQ extracted the 2011 point source inventory data from STARS on March 1, 2019. The extracted data includes reported annual and ozone season daily emissions of NO_x and VOC for each site in the DFW or HGB area that submitted a 2011 EI and reflects revisions made on or before the extract date.

2.2.3 Updated 2020 Attainment Year Inventories

Updated attainment year inventories were developed according to the general requirements described in Section 2.2.1: *Emissions Inventory Development*. The TCEQ designated the 2016 EI as the starting point for EI projections. The year 2016 was chosen as the projection base year for point sources because it was more representative of typical point source operations than 2017, when Hurricane Harvey occurred. The TCEQ extracted the 2016 point source EI data from STARS on March 1, 2019. The extracted data includes reported annual and ozone season daily emissions of NO_x and VOC for each site in the DFW or HGB area that submitted a 2016 EI and reflects revisions made on or before the extract date.

2.2.3.1 DFW 2020 Attainment Year Inventory

The TCEQ reviewed major and minor sources separately. For major sources, the TCEQ reviewed cement kilns separately from other major sources. Cement kiln NO_x emissions were projected by adding either 30 TAC Chapter 117 limits or site- or source-specific directly enforceable limits as appropriate. Other major source emissions were projected by adding emissions growth allowed under the nonattainment New Source Review (NSR) major modification thresholds. Minor source emissions were projected using growth factors. Unused emissions reductions credits were then added to the projections. For further details, please reference Appendix 3: *Development of Reasonable Further Progress Point Source Emissions Inventories for the DFW and HGB Nonattainment Areas.*

A summary of the point source RFP inventories is presented in:

- Table 2-5: *Nine-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*,
- Table 2-6: *One-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*
- Table 2-7: *10-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*, and
- Table 2-9: *10-County DFW RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*

2.2.3.2 HGB 2020 Attainment Year Inventory

For both major and minor sources, NO_X emissions from sites with equipment applicable to the Mass Emissions Cap and Trade (MECT) Program were projected using the MECT cap. Major source VOC emissions were projected by adding emissions growth allowed under the nonattainment NSR major modification thresholds. NO_X emissions from sites not listed in the MECT Program and VOC emissions from sources not identified as major for VOC were assumed to be minor source emissions and were projected using growth factors. Unused emissions reductions credits were then added to the projections. For further details, please reference Appendix 3: *Development of Reasonable Further Progress Point Source Emissions Inventories for the DFW and HGB Nonattainment Areas.*

A summary of the point source RFP inventories is presented in:

- Table 2-8: *HGB RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day);* and
- Table 2-10: *HGB RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day).*

2.3 AREA SOURCES

2.3.1 Emissions Inventory Development

Stationary emissions sources that do not meet the reporting requirements for point sources are classified as area sources. Area sources are small-scale stationary industrial, commercial, and residential sources that use materials or perform processes that generate emissions. Examples of typical VOC emissions sources include: oil and gas production sources, printing operations, industrial coatings, degreasing solvents, house paints, gasoline service station underground tank filling, and vehicle refueling operations. Examples of typical fuel combustion sources that emit NO_X include: oil and gas production sources, stationary source fossil fuel combustion at residences and businesses, outdoor refuse burning, and structure fires.

Area source emissions are calculated as county-wide totals rather than as individual sources. Area source emissions are typically calculated by multiplying an established emissions factor (emissions per unit of activity) by the appropriate activity or activity surrogate responsible for generating emissions. Population is one of the more commonly used activity surrogates for area source calculations. Other activity data commonly used include the amount of gasoline sold in an area, employment by industry type, and crude oil and natural gas production.

2.3.2 Updated 2011 Base Year Inventory

The 2011 area source inventory was developed in accordance with the requirements of the Air Emissions Reporting Requirements (AERR) rule. The 2011 inventory was developed using EPA-generated emissions inventories; TCEQ-contracted projects to develop emission inventories; TCEQ staff projects to develop emission inventories; and projecting historical emissions inventories by applying growth factors derived from Eastern Research Group (ERG) study data, the Economy and Consumer Credit Analytics website (http://www.economy.com/default.asp), and the United States Energy Information Administration's (EIA) *Annual Energy Outlook* publication. The documentation for the development of the ERG study projection factors can be found in Appendix 4: *Growth Factors for Point and Area Sources.*

The EPA developed emissions inventories for states to use for many area source categories as part of the National Emissions Inventory (NEI). The states access these individual inventories through the EPA's NEI website (ftp://ftp.epa.gov/EmisInventory/2011nei/doc/). These source categories include but are not limited to: industrial coatings; degreasing; residential, commercial/institutional, and industrial fuel use; commercial cooking; aviation fuel use; and consumer products. For some source categories, the TCEQ developed state-specific emissions estimates by acquiring current state-specific activity data and applying appropriate emissions factors. These source categories include but are not limited to: gasoline storage tanks; structure fires; dry cleaners; and automobile fires.

Additionally, the TCEQ committed significant resources to improve the oil and gas area source inventory categories for the 2011 base year inventory. The improvements included the development and refinement of a state-specific oil and gas area source emissions calculator. This oil and gas area source emissions calculator uses county-level production and local equipment activity data with local emissions requirements to estimate emissions from individual production categories including compressor engines, condensate and oil storage tanks, loading operations, heaters, and dehydrators. The documentation for the development of the oil and gas emissions calculator can be found in Appendix 5: *Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions and Specified Oil and Gas Well Activities Emissions Inventory Update.* A significant improvement made to the oil and gas calculator for the 2011 base year inventory was the development of refined emission factors for VOC emissions from condensate storage tanks. The documentation for the refined emission factors can be found in Appendix 6: *Condensate Tank Oil and Gas Activities.* Additionally, a recently completed study developed refined emissions factors for oil and gas well mud degassing as well as hydraulic pump engines. The documentation for these refined emission factors can be found in Appendix 7*: Specified Oil and Gas Well Activities Emissions Inventory Update.*

For those area source categories affected by TCEQ rules, rule effectiveness factors are applied to the baseline emissions to estimate controlled emissions. These factors address the efficiency of the controls and the percentage of the category's population affected by the rule. Quality assurance of area source emissions involves ensuring that the activity data used for each category is current and valid. Data such as current population figures, fuel usage, and material usage were updated and the EPA guidance on emissions factors was used. Other routine efforts such as checking calculations for errors and conducting reasonableness and completeness checks were implemented.

2.3.3 Updated Attainment Year Inventories

Updated attainment year inventories were developed according to the general requirements described in Section 2.3.1: *Emissions Inventory Development*. The TCEQ designated the 2017 EI as the starting point for EI projections of area source categories for the attainment year because it is the most recently available periodic inventory year.

The 2017 area source inventory was developed in accordance with the requirements of the AERR rule. The 2017 inventory was developed using EPA-generated emissions inventories, TCEQ-contracted projects to develop emission inventories, and TCEQ staff projects to develop emission inventories.

The area source oil and gas inventory production categories have been updated using 2017 production data from the Railroad Commission of Texas (RRC).

The updated 2020 attainment year inventory for the area source categories were developed using projection factors derived from Appendix 4. The study in this appendix contains individual projection factors for each source category and for each forecasting year. This projection method is the EPA standard and accepted methodology for developing future year emissions inventories.

The 2020 area source EI was developed by applying the selected emissions projection factor to the 2017 emissions for each area source category. Rules controlling emissions from industrial coatings, portable fuel containers, 30 TAC Chapter 117 Subchapter D controls on minor sources in ozone nonattainment areas, and gasoline station underground tank filling (Stage I) and vehicle refueling (Stage II) were applied in the base year inventory. Federal New Source Performance Standards Subpart OOOO emissions reductions were applied to the 2017 projection base year inventory but not the 2011 base year inventory due to applicable compliance deadlines. No additional controls were incorporated into the attainment year inventories; see Chapter 4 for additional details.

A summary of the area source RFP inventories is presented in Tables 2-5 through 2-10.

2.4 NON-ROAD MOBILE SOURCES

Non-road vehicles do not normally operate on roads or highways and are often referred to as off-road or off-highway vehicles. Non-road emissions sources include: agricultural equipment, commercial and industrial equipment, construction and mining equipment, lawn and garden equipment, aircraft and airport equipment, locomotives, drilling rigs, and commercial marine vessels (CMV). For this proposed DFW and HGB RFP SIP revision, emissions inventories for non-road sources were developed for the following subcategories: NONROAD model categories, airports, locomotives, CMVs, and drilling rigs used in upstream oil and gas exploration activities. The airport subcategory includes estimates for emissions from the aircraft, auxiliary power units (APU), and ground support equipment (GSE) subcategories added together and presented as a total. The sections below describe the emissions estimates methodologies used for the non-road mobile source subcategories.

2.4.1 NONROAD Model Categories Emissions Estimation Methodology

A Texas-specific version of the EPA's NONROAD 2008a model, called the Texas NONROAD (TexN) model, was used to calculate emissions from all non-road mobile source equipment and recreational vehicles, with the exception of airports, locomotives, commercial marine vessels, and drilling rigs used in upstream oil and gas exploration activities. Because emissions for airports, commercial marine vessels, and locomotives are not included in either the NONROAD model or the TexN model, the emissions for these categories are estimated using other EPA-approved methods and guidance as described in the sections below. Although emissions for drilling rigs are included in the NONROAD model, alternate emissions estimates were developed for that source category to develop more accurate county-level inventories as described in Section 2.4.2: *Drilling Rig Diesel Engines Emissions Estimation Methodology*. The equipment populations for drilling rigs were set to zero in the TexN model to avoid double counting emissions from these sources.

The TexN model is a software tool for estimating emissions for non-road mobile source categories that are included in the EPA NONROAD model, with the exception of drilling rigs, as discussed above. The model allows air quality planners to replace the EPA's default emissions data used in the NONROAD model with more specific local activity data, a practice encouraged by the EPA. Local, county-level input data are incorporated into the TexN model as it becomes available to the TCEQ. Several equipment survey studies have been conducted in Texas to improve upon the default data available in the EPA NONROAD model. Those studies focused on various equipment categories operating in different areas of the state, including: diesel construction equipment, liquid propane gas powered forklifts, transportation refrigeration units, commercial lawn and garden equipment, agricultural equipment, and recreational marine vessels. Using this county-level input data produces a more accurate representation of non-road emissions for the DFW and HGB nonattainment areas. The NONROAD model category emissions included in this proposed DFW and HGB RFP SIP revision were developed using version 1.7.2 of the TexN emissions model.

2.4.2 Drilling Rig Diesel Engines Emissions Estimation Methodology

Drilling rig diesel engines used in upstream oil and gas exploration activities are included in the EPA NONROAD model. However, due to significant growth in the oil and gas exploration and production industry, a 2015 survey of oil and gas exploration and production companies was used to develop updated drilling rig emissions characterization profiles. The uncontrolled and controlled drilling rig emissions characterization profiles from this study were combined with county-level drilling activity data obtained from the RRC to develop the drilling rigs EI. The documentation of procedures used in developing the drilling rigs EI can be found in Appendix 8: *2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories.*

2.4.3 Commercial Marine Vessel and Locomotive Emissions Estimation Methodology

The CMV EI was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The CMV EI includes at-port and underway emissions activity data from Category I, II, and III CMVs by county for applicable counties in the HGB nonattainment area. Documentation of the methods and procedures used to develop the CMV EI can be found in Appendix 9: *2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories.*

The locomotive EI was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The locomotive EI includes line haul and rail yard emissions activity data from all Class I, II, and III locomotive activity and emissions by rail segment. Documentation of methods and procedures used to develop the locomotive EI can be found in Appendix 10: *2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories.*

2.4.4 Airport Emissions Estimation Methodology

The airport EI was developed from a TCEQ-commissioned study using the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT). AEDT is the most recent FAA model for estimating airport emissions and has replaced the FAA's Emissions and Dispersion Modeling System.

The airport emissions categories used for this DFW and HGB RFP SIP revision included aircraft (commercial air carriers, air taxis, general aviation, and military), APU, and GSE operations. Documentation of methodology and procedures used to develop the DFW and HGB airport emissions inventories can be found in Appendix 11: *Development of the Statewide Aircraft Inventory for 2011* and Appendix 12: *Development of the Statewide Aircraft Inventory for 2020.*

2.4.5 Updated 2011 Base Year Inventory

For certain non-road mobile source categories detailed below, the updated 2011 base year EI was developed from the 2014 periodic EI to provide consistency between emissions estimation approaches used for this proposed DFW and HGB RFP SIP revision. Exceptions and specific details about non-road source category inventory development are included in the relevant section below.

2.4.5.1 Updated 2011 Base Year NONROAD Model Category Inventory

The 2011 base year inventory used for all non-road mobile model-specific source categories was developed using the latest version of the TexN model with updated county-specific input data. More detailed information on the TexN emissions model, guidance document, and updates to the model can be found in the TexN directory (ftp://amdaftp.tceq.texas.gov/pub/EI/nonroad/TexN/) on the TCEQ's Air Modeling and Data Analysis file transfer protocol (FTP) site.

2.4.5.2 Updated 2011 Base Year Drilling Rig Diesel Engines Inventory

The 2011 base year EI for drilling rig diesel engines used in upstream oil and gas exploration activities was developed using the results of a 2015 statewide EI improvement study combined with 2011 drilling activity data from the RRC. The documentation of procedures used in developing the 2011 drilling rigs EI can be found in Appendix 8.

2.4.5.3 Updated 2011 Base Year Commercial Marine Vessel and Locomotive Inventory

The 2011 base year CMV inventory was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The CMV EI includes Category I, II, and III CMV activity and emissions for all coastal counties within Texas. The CMV EI was developed using Automatic Identification System activity data for CMVs from PortVision, which provided vessel location, speed, and other identifying information. In addition to activity data, vessel-specific data from the Information Handling Services Vessel Database were used to determine which subsets of emissions factors were applicable for each vessel. Documentation of the methods and procedures used to develop the CMV EIs can be found in Appendix 9.

The 2011 base year Texas locomotive inventory was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The locomotive inventory was developed by ERG under contract with the TCEQ and includes Class I, II, and III locomotive activity and emissions by rail segment for all counties within Texas. The locomotive line haul and rail yard activity data were reported by companies operating in Texas to create a county-level Class I line haul inventory. Activity and emissions profiles were used for Class II and Class III railroads; these data were developed by the Eastern Regional Technical Advisory Committee in collaboration with the Federal Railroad Administration, the American Short Line and Regional Railroad Association (ASLRRA), and members of the Class II and III railroad communities. The annual gallons of fuel used by railroads were estimated from data compiled by ASLRRA from the Class II and III railroads, including total industry fuel use in 2008 for locomotives and total Class II/III route miles. Based on the EIA's *Annual Energy Outlook*, 2008 fuel usage values were projected to estimate 2011 emissions. Documentation of methods and procedures used to develop the locomotive emissions inventories can be found in Appendix 10.

2.4.5.4 Updated 2011 Base Year Airport Inventory

The 2011 base year airport emissions inventories were developed by ERG under contract with the TCEQ using the FAA's AEDT along with applicable 2011 aircraft activity, fleet mix, and other AEDT model input parameters for airports within the DFW and HGB areas. Documentation of methodology and procedures used to develop the DFW and HGB airport emissions inventories can be found in Appendix 11.

2.4.6 Updated Uncontrolled Analysis Year Inventories

The NONROAD model category uncontrolled emissions for each analysis year (2011 base year, 2020 attainment year, and 2021 contingency year) were calculated by removing all federal and state controls from the model runs.

The TCEQ calculated updated, uncontrolled emissions from airports based on the information and growth factors from the ERG reports found in Appendix 11 and Appendix 12.

The updated uncontrolled analysis year emissions for the locomotive sources were developed by applying activity adjustment factors by source classification code (SCC) per the ERG report in Appendix 10. The activity adjustment factors used were based on the EIA's Transportation Sector Key Indicators and Delivered Energy Consumption data (http://www.eia.gov/forecasts/aeo/tables_ref.cfm).

Uncontrolled emissions for CMVs were based on emission factors developed by ERG with guidance from the EPA that excluded adjustments for fleet turnover and the implementation of state and federal regulatory programs; see Appendix 9 for more information.

The uncontrolled 2011 EI for drilling rigs was developed using 2011 drilling activity data and the 2011 year-specific uncontrolled factors from the ERG report found in Appendix 8. A 2020 EI for drilling rigs was developed using 2017 drilling activity data and the 2020 year-specific uncontrolled factors from the ERG report found in Appendix 8. Because future drilling activity is difficult to predict, the 2017 drilling activity data was held constant to the 2020 attainment year, since 2017 was the most current data available.

2.4.7 Updated Controlled Analysis Year Inventories

For the NONROAD model category sources, the TCEQ developed county-level controlled inventories for the 2020 attainment and 2021 contingency year using the latest version of the TexN model. The model runs were performed accounting for all state and federal control measures.

The updated controlled attainment year emissions for the airports were calculated based on the information from the ERG report found in Appendix 12. Control strategies for airport emissions included emission reductions from the GSE and APU electric conversions.

Controlled emissions for locomotive sources were determined by applying activity adjustment factors by SCC, and emission rate adjustment factors. The emission rate adjustment factors were obtained from the EPA's Emission Factors for Locomotives Fact Sheet (https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100500B.TXT). The activity adjustment factors used were based on the EIA's Transportation Sector Key Indicators and Delivered Energy Consumption (http://www.eia.gov/forecasts/aeo/tables_ref.cfm) data.

Controlled emissions for CMVs were based on emissions factors developed by ERG with guidance from the EPA, which took into account fleet turnover and the implementation of state and federal regulatory programs; see Appendix 9 for more information.

Controlled 2020 emissions for diesel drilling rigs were based on 2017 drilling activity data combined with the 2020 year-specific controlled emission factors from the ERG report found in Appendix 8.

A summary of the non-road mobile source RFP inventories is presented in Tables 2-5 through 2-10.

2.5 ON-ROAD MOBILE SOURCES

The 2011, 2020, and 2021 on-road mobile source emissions inventories for this proposed DFW and HGB RFP SIP revision were developed under contract by the North Central Texas Council of Governments (NCTCOG) and the Texas A&M Transportation Institute (TTI) for the DFW and HGB nonattainment areas, respectively. The data, methods, activity inputs, emissions factors, and results are documented in the

NCTCOG and TTI reports provided in Appendix 13: *Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021* and Appendix 14: *Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories.* The inventories include the 10 DFW and eight HGB area counties designated as nonattainment for the 2008 eight-hour ozone NAAQS. As required by the RFP implementation rules, the on-road inventories are based on vehicle miles traveled (VMT) estimates and emission rates for an average summer work weekday. The latest major revision of the EPA's mobile source emission model, the Motor Vehicle Emission Simulator (MOVES) model, MOVES2014a[6], was used to estimate the summer weekday emission rates in units of grams per mile for NO_X and VOC. The roadway link-level VMT estimates were obtained from travel demand modeling for the 10-county DFW and eight-county HGB nonattainment areas for each analysis year.

2.5.1 On-Road Emissions Inventory Development

On-road mobile emissions sources consist of automobiles, trucks, motorcycles, and other motor vehicles traveling on public roadways. On-road mobile source ozone precursor emissions are usually categorized as combustion-related emissions or evaporative hydrocarbon emissions. Combustion-related emissions are estimated for vehicle engine exhaust. Evaporative hydrocarbon emissions are estimated for the fuel tank and other evaporative leak sources on the vehicle. To calculate emissions, both the rate of emissions per unit of activity (emission factors) and the number of units of activity must be determined.

Emission factors for this proposed DFW and HGB RFP SIP revision were developed using the EPA's mobile emissions factor model, MOVES2014a. The MOVES2014a model may be run using national default information or the default information may be modified to simulate data specific to an area, such as the control programs, driving behavior, meteorological conditions, and vehicle characteristics. Because modifications to the national default values influence the emission factors calculated by the MOVES2014a model, to the extent that local values are available, parameters that are used reflect local conditions. The localized inputs used for the on-road mobile EI development include vehicle speeds for each roadway link, vehicle populations, vehicle hours idling, temperature, humidity, vehicle age distributions for each vehicle type, percentage of miles traveled for each vehicle type, type of inspection and maintenance (I/M) program, fuel control programs, and gasoline Reid vapor pressure controls.

To estimate on-road mobile source emissions, emission factors calculated by the MOVES2014a model must be multiplied by the level of vehicle activity. On-road mobile source emissions factors are expressed in units of grams per mile, grams per vehicle (evaporative), and grams per hour (extended idle); therefore, the activity data required to complete the inventory calculation are VMT in units of miles per day, vehicle populations, truck hoteling activity, and source hours idling. The level of vehicle travel activity is developed using travel demand models (TDM) run by the Texas Department of Transportation or by the local metropolitan planning organizations. The TDMs are

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[6] For on-road EI development, MOVES2014a is technically the most recent on-road release. The more recent MOVES2014b update only impacts non-road model components and does not change the on-road portion of the model.

validated against a large number of ground counts, i.e., traffic passing over counters placed in various locations throughout a county or area. For SIP inventories, VMT estimates are calibrated against outputs from the federal Highway Performance Monitoring System, a model built from a different set of traffic counters. Vehicle populations by source type are derived from the Texas Department of Motor Vehicles' registration database and, as needed, national estimates for vehicle source type population.

In addition to the number of miles traveled on each roadway link, the speed on each roadway type or segment is also needed to complete an on-road EI. Roadway speeds, required inputs for the MOVES2014a model, are calculated by using the activity volumes from the TDM and a post-processor speed model.

A summary of the on-road mobile source VMT used to develop the various NO_X and VOC emissions estimates for the DFW area are presented in Table 2-1: *DFW RFP Ozone Season Weekday On-Road Mobile Source VMT (miles per day).*

A summary of the on-road mobile source VMT used to develop the various NO_X and VOC emissions estimates for the HGB area are presented in Table 2-2*: HGB RFP Ozone Season Weekday On-Road Mobile Source VMT (miles per day).*

The controlled and uncontrolled on-road mobile source emissions inventories are summarized in Table 2-3 for the DFW area and Table 2-4 for the HGB area.

For complete documentation of the development of the on-road mobile source emissions inventories for the DFW RFP demonstration, refer to Appendix 13, for the HGB demonstration, refer to Appendix 14. The complete set of input and output files are available upon request from the TCEQ's Air Quality Division.

Table 2-1: DFW RFP Ozone Season Weekday On-Road Mobile Source VMT[1] (miles per day)

RFP Analysis Year	VMT
2011 Base Year	191,251,636
2020 Attainment Year	231,949,231

Note 1: For this RFP SIP revision, the same VMT is used for the uncontrolled and controlled scenarios.

Table 2-2: HGB RFP Ozone Season Weekday On-Road Mobile Source VMT[1] (miles per day)

RFP Analysis Year	VMT
2011 Base Year	145,136,623
2020 Attainment Year	193,683,005

Note 1: For this RFP SIP revision, the same VMT is used for the uncontrolled and controlled scenarios.

2.5.2 On-Road Mobile Updated 2011 Base Year Inventory

The 2011 base year EI for on-road mobile sources was updated using emission factors calculated using the MOVES2014a model. Additional updates were made to incorporate the latest activity estimates from the DFW and HGB TDM 2011 networks. Only control strategies implemented prior to 2011 were included in the input to the EI development for the 2011 on-road mobile source base year emissions inventories. Those controls include: the pre-1990 FMVCP, the 1990 to 2011 FMVCP, reformulated gasoline (RFG), the East Texas Regional Low RVP Gasoline Program, federal ultra-low sulfur diesel, the vehicle I/M program, and on-road Texas Low Emission Diesel (TxLED), where applicable. The activity levels used to calculate the EI reflect the 2011 roadway networks with 2011 VMT and speeds. A summary of the EI is presented in Table 2-3 for the DFW area and Table 2-4 for the HGB area. For complete documentation of the development of the EI and details on MOVES2014a model inputs, refer to Appendix 13 for the DFW area and Appendix 14 for the HGB area.

2.5.3 On-Road Mobile Updated 2011 Adjusted Base Year Inventories for the Base and Attainment Years

The on-road adjusted base year emissions inventories are not required for this proposed DFW and HGB RFP SIP revision. See Section 2.1 for additional information.

2.5.4 On-Road Mobile Updated Uncontrolled Attainment Year Inventories

The uncontrolled on-road mobile emissions inventories for each RFP attainment year were developed using emission factors that reflect only control strategies implemented prior to 1990. Those controls include pre-1990 FMVCP and the 1992 RVP control. MOVES2014a was used to develop the emissions inventories for this DFW and HGB RFP SIP revision. The activity levels were updated to include the latest output from the DFW and HGB TDMs. The activity levels used to calculate the EI reflect the attainment roadway network, with attainment year VMT and speeds. A summary of the emissions inventories is presented in Tables 2-3 and 2-4. For complete documentation of the development of the EI and details on MOVES2014a model inputs, refer to Appendix 13 for the DFW area and Appendix 14 for the HGB area.

2.5.5 On-Road Mobile Updated Controlled Attainment Year Inventories

The controlled on-road mobile emissions inventories for the attainment year were developed using emission factors that include: the effects of pre-1990 control strategies, the effects of all control strategies between 1990 and 2011, and the effects of all control strategies from 1990 through the attainment year. The effects of the post-1990 control strategies between 2011 and the attainment year are creditable reductions used to demonstrate compliance with RFP requirements. The pre- and post-1990 controls include pre-1990 FMVCP, post-1990 FMVCP, RFG, the East Texas Regional Low RVP Gasoline Program, federal ultra-low sulfur diesel, the vehicle I/M program, and TxLED, where applicable. All control strategies used to demonstrate RFP for DFW and HGB are documented in Chapter 4. The on-road control strategies are documented in Section 4.5: *On-Road Mobile Source Controls.*

The activity levels used to calculate the attainment year emissions inventories reflect the 2020 roadway network, with 2020 VMT and speeds. A summary of the uncontrolled on-road mobile EI, the on-road mobile control reductions, and the resulting controlled on-road mobile EI for the attainment year are summarized in Table 2-3: *2020 DFW RFP Ozone Season Weekday On-Road Mobile Source* NO_X *and VOC Emissions and Control Strategy Reductions* for the DFW area and in Table 2-4: *2020 HGB RFP Ozone Season Weekday On-Road Mobile Source* NO_X *and VOC Emissions and Control Strategy Reductions* for the HGB area. For complete documentation of the development of the DFW and HGB emissions inventories and details on MOVES2014a model inputs, refer to Appendix 13 and Appendix 14, respectively.

Table 2-3: 2020 DFW RFP Ozone Season Weekday On-Road Mobile Source NO_x and VOC Emissions and Control Strategy Reductions

Emissions Inventory and Control Strategy Description	NO_x (tons per day)	VOC (tons per day)
2020 Uncontrolled Inventory	957.90	370.27
Post-1990 FMVCP	796.66	290.23
On-road RFG/East Texas Regional Low RVP/Low Sulfur/federal ultra-low sulfur diesel	54.23	15.17
Inspection and Maintenance Program	6.87	8.14
On-road TxLED	2.65	0.00
2020 Controlled Inventory	97.49	56.73

Table 2-4: 2020 HGB RFP Ozone Season Weekday On-Road Mobile Source NO_x and VOC Emissions and Control Strategy Reductions

Emissions Inventory and Control Strategy Description	NO_x (tons per day)	VOC (tons per day)
2020 Uncontrolled Inventory	750.39	322.18
Post-1990 FMVCP	561.84	245.62
On-road RFG with Tier 3 sulfur, and federal ultra-low sulfur diesel	101.55	16.96
Inspection and Maintenance Program	5.13	7.39
On-road TxLED	2.39	0.00
2020 Controlled Inventory	79.48	52.21

Quantification of specific control reductions are documented in Chapter 4: *Control Measures to Achieve Target Levels.* Motor vehicle emissions budget (MVEB) calculations for the attainment year are documented in Chapter 5: *Motor Vehicle Emissions Budgets*.

2.6 BIOGENIC SOURCES

Biogenic sources include VOC emissions from crops, lawn grass, and trees as well as small amounts of NO_x from soils and other sources. Previously, under the Consolidated Emissions Reporting Rule (June 2002) and earlier emissions reporting rules, biogenic sources were required to be reported along with point, nonpoint, on-road mobile, and non-road mobile sources. Beginning with the AERR rule (December 2008), the emissions required to be reported to the EPA no longer include emissions from biogenic sources. Therefore, as of the 2011 reporting year, the TCEQ's comprehensive triennial EI no longer includes emissions from biogenic sources. Biogenic inventories may still be developed for air quality modeling purposes as necessary.

The RFP demonstrations are based upon the emissions from anthropogenic sources only. The guidance for RFP calculations shows the first step is to subtract the emissions from biogenic sources from the total base year emissions to obtain the total anthropogenic emission inventory. As of 2011, under the AERR rule, the base year emissions do not include biogenic sources and already represent the total anthropogenic emissions. In this case, step one of the RFP process is not needed, and the inclusion of emissions from biogenic sources is unnecessary. Therefore, this proposed DFW and HGB RFP SIP revision does not include quantification of emissions from biogenic sources.

2.7 EMISSIONS SUMMARY

Uncontrolled and controlled base year NO_X and VOC emissions for each RFP source category are summarized in the following tables[7]:

- Table 2-5: *Nine-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*;
- Table 2-6: *One-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*;
- Table 2-7: *10-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day);* and
- Table 2-8: *HGB RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day).*

For the 2020 attainment year, the uncontrolled and controlled NO_X and VOC emissions for each RFP source category and analysis year are summarized in the following tables:

- Table 2-9: *10-County DFW RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*; and,
- Table 2-10: *HGB RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day).*

Between 1990 and 2011, substantial emissions reductions have occurred in all EI source categories (stationary sources as well as mobile sources) due to regulations implemented at the federal, state, and local levels and innovative programs implemented by the TCEQ. As noted in Section 2.1, the uncontrolled 2011 EI for stationary sources includes all controls and associated reductions implemented by the end of the 2011 base year. No additional stationary source controls are quantified for this proposed DFW and HGB RFP SIP revision; therefore, the 2011 controlled stationary source EI is equivalent to the 2011 uncontrolled stationary source EI.

Similarly, the 2020 attainment year inventory reflects: 1) all controls and associated reductions implemented by the end of the projection base EI year and 2) growth from the projection base EI. Where there is no difference between the uncontrolled and controlled emissions for the base year or the attainment year, there were no controls quantified for the projected source inventories.

Table 2-5: Nine-County[1] DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	231.95	86.08	141.05	40.28
On-Road Mobile Sources	749.37	231.83	296.35	100.19
Area Sources	37.69	37.69	262.35	262.35
Point Sources	31.34	31.34	27.54	27.54

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[7] Wise County is the only county in the DFW 10-county area designated as nonattainment under the 2008 eight-hour ozone NAAQS but not previously designated as nonattainment under a prior ozone NAAQS (i.e., one-hour or 1997). The timing of Wise County's designation impacts certain RFP requirements and therefore Wise County is grouped separately when appropriate.

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Total of All Sources	1,050.35	386.94	727.29	430.36

Note 1: The nine-county DFW Area includes the nine DFW counties previously designated nonattainment under the one-hour and/or the 1997 eight-hour ozone NAAQS: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties.

Table 2-6: One-County[1] DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	13.74	5.96	4.35	1.21
On-Road Mobile Sources	18.39	7.24	4.80	2.05
Area Sources	13.29	13.29	28.95	28.95
Point Sources	8.61	8.61	2.35	2.35
Total of All Sources	54.03	35.10	40.45	34.56

Note 1: The one-county DFW Area includes the one DFW county newly designated nonattainment under the 2008 eight-hour ozone NAAQS: Wise County.

Table 2-7: 10-County[1] DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	245.69	92.04	145.40	41.49
On-Road Mobile Sources	767.76	239.07	301.15	102.24
Area Sources	50.98	50.98	291.30	291.30
Point Sources	39.95	39.95	29.89	29.89
Total of All Sources	1,104.38	422.04	767.74	464.92

Note 1: The 10-county DFW Area includes all 10 counties designated nonattainment under the 2008 NAAQS: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties.

Table 2-8: HGB RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	242.73	144.84	116.94	50.11
On-Road Mobile Sources	536.68	168.60	239.63	80.45
Area Sources	21.15	21.15	308.53	308.53
Point Sources	108.33	108.33	95.97	95.97
Total of All Sources	908.89	442.92	761.07	535.06

Table 2-9: 10-County DFW RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	264.51	70.03	162.12	36.58
On-Road Mobile Sources	957.90	97.49	370.27	56.73
Area Sources	38.69	38.69	299.22	299.22
Point Sources	46.83	46.83	24.35	24.35

Emissions Inventory Source	Uncontrolled NO_x	Controlled NO_x	Uncontrolled VOC	Controlled VOC
Total of All Sources	1307.93	253.04	855.96	416.88

Table 2-10: HGB RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_x and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_x	Controlled NO_x	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	254.17	77.44	136.26	31.49
On-Road Mobile Sources	750.39	79.48	322.18	52.21
Area Sources	30.04	30.04	310.98	310.98
Point Sources	131.06	131.06	85.23	85.23
Total of All Sources	1165.66	318.02	854.65	479.91

CHAPTER 3: PROGRESS TOWARD MEETING TARGET EMISSIONS LEVELS

3.1 INTRODUCTION

3.1.1 General RFP Requirements

This chapter describes how the Dallas-Fort Worth (DFW) and the Houston-Galveston-Brazoria (HGB) reasonable further progress (RFP) demonstrations are calculated, documents the RFP calculations, and provides a summary of the DFW and HGB RFP demonstrations for all RFP analysis years. Based upon the United States Environmental Protection Agency's (EPA) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard state implementation plan (SIP) requirements rule), published in the *Federal Register* (FR) on March 6, 2015 (80 FR 12264), the attainment date for serious nonattainment areas is July 20, 2021, with an attainment year of 2020.

For this proposed DFW and HGB RFP SIP revision, a base year of 2011 was used to harmonize the RFP base year with the triennial reporting requirement of the Air Emissions Reporting Requirements (AERR) rule and for consistency with previous DFW and HGB 2008 eight-hour ozone National Ambient Air Quality Standards (NAAQS) SIP revisions. The required emissions reductions for RFP as detailed below are calculated as a percentage of the base year (2011) emissions inventory (EI) and must occur no later than the required timeframe.

The RFP requirements for this proposed DFW and HGB RFP SIP revision are to demonstrate:

- a 9% emissions reduction for the three-year period from January 1, 2018 through December 31, 2020 for the 10-county DFW nonattainment area;
- a 3% emissions reduction for the one-year period between January 1, 2021 through December 31, 2021 as attainment year RFP contingency for the 10-county DFW nonattainment area;
- a 9% emissions reduction for the three-year period from January 1, 2018 through December 31, 2020 for the eight-county HGB nonattainment area; and
- a 3% emissions reduction for the one-year period between January 1, 2021 through December 31, 2021as attainment year RFP contingency for the eight-county HGB nonattainment area.

For RFP and contingency analyses, the requirement to calculate and account for the non-creditable emissions reductions due to pre-1990 Federal Motor Vehicle Control Program (FMVCP) reductions was removed under the 2008 eight-hour ozone standard SIP requirements rule. The RFP analyses presented in this proposed DFW and HGB RFP SIP revision does not include any of the RFP elements or non-creditable effects related to the pre-1990 FMVCP.

3.1.2 Fifteen Percent Emissions Reduction Requirement

The 2008 eight-hour ozone standard SIP requirements rule requires states with serious nonattainment areas to submit an RFP plan with a 15% emissions reduction from the RFP base year to the first RFP analysis year, and an average 3% reduction per year from the first RFP analysis year to an area's attainment year. In accordance with the 2008 eight-hour ozone standard SIP requirements rule, if a state chooses 2011 as a base year for a serious area designated nonattainment in 2012, the 15% reduction requirement covers the period from January 1, 2012 through December 31, 2017.

The first 15% RFP reduction achieved by an area must be from volatile organic compounds (VOC) emissions. In subsequent RFP demonstrations, this reduction requirement can be fulfilled with a combination of nitrogen oxides (NO_X) and VOC emissions. The EPA has previously approved demonstrations of the 15% VOC-only reduction requirements for all counties within the HGB and DFW 2008 ozone nonattainment areas as noted in Table 3-1: *EPA Approval of 15% VOC-Only RFP SIP Revision for HGB and DFW Ozone Nonattainment Areas.*

Table 3-1: EPA Approval of 15% VOC-Only RFP SIP Revision for HGB and DFW Ozone Nonattainment Areas

Area	County or Counties	Ozone NAAQS	Date of EPA Approval	Federal Register Notice Citation
HGB	Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller	One-hour	November 14, 2001	66 FR 57160
DFW	Collin, Dallas, Denton, and Tarrant	One-hour	April 12, 2005	70 FR 18993
DFW	Ellis, Johnson, Kaufman, Parker, and Rockwall	1997 eight-hour	October 7, 2008	73 FR 58475
DFW	Wise	2008 eight-hour	December 7, 2016	81 FR 88124

For the 2008 eight-hour ozone NAAQS, the TCEQ previously adopted moderate classification RFP SIP revisions for the DFW and HGB to address the 15% emissions reduction requirement in VOC only (if not already satisfied) or in NO_X and/or VOC for the six-year period from January 1, 2012 through December 31, 2017. The DFW RFP SIP revision adopted on June 3, 2015, demonstrated a 15% emissions reduction in VOC only from the 2011 base year through the 2017 attainment year for the newly designated one-county portion of the DFW moderate nonattainment area (Wise County) and a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the previously designated nine-county portion of the DFW moderate nonattainment area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties). The HGB RFP SIP Revision adopted on December 15, 2016 demonstrated a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the eight-county HGB moderate nonattainment area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties). The EPA approved the DFW RFP SIP revision on December 7, 2016 (81 FR 88124) and approved the HGB RFP SIP revision on February 13, 2019 (84 FR 3708).

3.1.3 Additional Emissions Reduction Requirements

To demonstrate RFP for the DFW and HGB serious ozone nonattainment areas for the 2008 eight-hour ozone NAAQS, an additional 9% emissions reduction is required for the three-year period from January 1, 2018 to December 31, 2020. A combination of VOC and NO_X[8] emissions reductions may be used to achieve the 9% reduction requirements.

For certain source categories, 2017 was used as the projection base year to forecast 2020 attainment year emissions. However, 2017 is not an analysis year for this SIP revision because the RFP requirement to demonstrate a 15% emissions reduction from January 1, 2012 through December 31, 2017 has been previously submitted to EPA and approved as noted in Section 3.1.2: *Fifteen Percent Emissions Reduction Requirement*.

3.1.4 Contingency Demonstration

The RFP requirements also include a 3% contingency demonstration for the one-year period after each RFP analysis year and the attainment year. A combination of VOC and NO_X emissions reductions may be used to achieve the 3% contingency reduction requirements.

With a 2020 attainment year under the serious classification, this proposed DFW and HGB RFP SIP revision includes a 3% post-attainment year contingency for DFW and HGB for the one-year period from January 1, 2021 through December 31, 2021. Under the former moderate classification, a 2017 attainment year contingency requirement for the one-year period from January 1, 2018 through December 31, 2018 was demonstrated and approved in previous DFW and HGB RFP SIP revisions. The emissions reductions required to account for the 2018 RFP contingency year continue to be reserved out of the creditable reductions used between 2011 and 2020 to assure reductions are not double counted.

3.1.5 RFP Demonstration Method

Required serious nonattainment area RFP demonstration elements for the 10-county DFW and the eight-county HGB ozone nonattainment areas include:

- the 2011 base year emissions;
- 2020 target levels;
- 2020 projected emissions, with growth; and
- individually quantified emissions reductions from control measures for 2020.

Progress toward the 2020 attainment year emissions reductions requirements is demonstrated using EPA methodologies to calculate the elements of the RFP demonstration and complete the RFP analyses. First, the emissions inventories and control reductions are developed for each analysis year. Second, the target level of emissions is calculated for each analysis year. Third, the RFP control measure reductions for each analysis year are subtracted from the uncontrolled or existing controlled EI for the corresponding analysis year. The difference includes growth from

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[8] NO_X may be substituted for VOC under conditions defined in the EPA's December 1993 NO_X Substitution Guidance (https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2_old/19931201_oaqps_nox_substitution_guidance.pdf).

the base year to the selected analysis year. When the combined uncontrolled and existing controlled projected inventory for each analysis year minus the RFP controls is less than or equal to the target level of emissions for VOC and/or NO_X, the RFP requirement has been met.

3.2 TARGET LEVEL METHODOLOGY

EPA guidance specifies the method that should be used to calculate the maximum amount of emissions a nonattainment area can emit for each RFP analysis year. Those RFP target levels of emissions are calculated using a three-step process, which is used for this proposed DFW and HGB RFP SIP revision. The two steps previously required to account for pre-1990 non-creditable reductions are no longer required and are not included. The three steps used to calculate the RFP targets are:

1. Determine the 2011 RFP base year EI.
2. Calculate the required 15% and 9% emissions reduction amounts between 2011 and 2020.
3. Calculate the 2020 emissions target levels for NO_X and VOC.

Each of these steps is explained in more detail in Section 3.3: *Calculation of Target Emissions Levels*.

3.3 CALCULATION OF TARGET EMISSIONS LEVELS

A summary of the three-step process described above for target calculations for 2020 is presented in:

- Table 3-2: *Summary of the Calculation Process for 2020 DFW RFP Target Levels;* and
- Table 3-3: *Summary of the Calculation Process for 2020 HGB RFP Target Levels*.

The 2020 DFW and HGB attainment year VOC and NO_X target levels are found in Line 11 of Table 3-2: *Summary of the Calculation Process for 2020 DFW RFP Target Levels*, and, Line 7 of Table 3-3: *Summary of the Calculation Process for 2020 HGB RFP Target Levels*. In these tables, VOC and NO_X target levels are expressed in tons per day (tpd) unless a percent reduction (%) is specified.

Table 3-2: Summary of the Calculation Process for 2020 DFW RFP Target Levels

Line	Description	NO_X (tpd or %)	VOC (tpd or %)
Line 1	Step 1A: 2011 base year (BY) EI for one DFW newly designated county (See Table 2-6)	35.10	34.56
Line 2	15% VOC reduction requirement for one DFW newly designated county	N/A	15%
Line 3	Step 1B: 2011 BY EI for nine DFW previously designated counties (See Table 2-5)	386.94	430.36
Line 4	Percent of NO_X (PN) and VOC (PV) to meet 15% reduction requirement for nine DFW previously designated counties, PN plus PV = 15	14%	1%
Line 5	Step 1C: 2011 BY EI for 10 DFW counties (Equals Line 1 plus Line 3, See Table 2-7)	422.04	464.92
Line 6	PN and PV to meet 9% reduction requirement, PN plus PV = 9	8%	1%

Line	Description	NO_X (tpd or %)	VOC (tpd or %)
Line 7	Step 2A: Calculate the 2011-to-2017 15% VOC reduction requirement for one DFW newly designated county (set to zero for NO_X, and Line 1 multiplied by Line 2 for VOC)	0.00	5.18
Line 8	Step 2B: Calculate the 2011-to-2017 15% NO_X and VOC reduction requirement for nine DFW previously designated counties (Line 3 multiplied by Line 4)	54.17	4.30
Line 9	Step 2C: Calculate the 2017-to-2020 9% reduction requirement for 10 DFW counties (Line 5 multiplied by Line 6)	33.77	4.65
Line 10	Step 2D: Calculate the total 2011-to-2020 percent reduction requirement (Line 7 plus Line 8 plus Line 9)	87.94	14.13
Line 11	Step 3: Calculate the 2020 target level of emissions for 10 DFW counties (Line 5 minus 10)	334.10	450.79

Table 3-3: Summary of the Calculation Process for 2020 HGB RFP Target Levels

Line	Description	NO_X (tpd or %)	VOC (tpd of %)
Line 1	Step 1: 2011 BY EI for HGB (see Table 2-8)	442.92	535.06
Line 2	PN and PV to meet 15% reduction requirement (PN plus PV = 15)	10%	5%
Line 3	PN and PV to meet 9% reduction requirement (PN plus PV = 9)	6.2%	2.8%
Line 4	Step 2A: Calculate the 15% NO_X and VOC reduction requirement between 2011 and 2017 (Line 1 multiplied by Line 2)	44.29	26.75
Line 5	Step 2B: Calculate the 9% NO_X and VOC reduction requirement between 2017 and 2020 (Line 1 multiplied by Line 3)	27.46	14.98
Line 6	Step 2C: Calculate the total NO_X and VOC reduction requirement between 2011 and 2020 (Line 4 plus Line 5)	71.75	41.73
Line 7	Step 3: Calculate the 2020 target level of emissions for the HGB counties (Line 1 minus Line 6)	371.17	493.33

Step one of the RFP target calculation process involves the development of the 2011 base year EI, which represents the total anthropogenic emissions for the area. EPA guidance specifies the methodology that must be used to develop the base year EI and all other SIP emissions inventories.[9] Details of the development of the 2011 DFW and HGB base year emissions inventories are discussed in Chapter 2: *Emissions Inventories*. Summaries for the 2011 DFW and HGB base year NO_X and VOC emissions inventories are presented in Table 2-5: *Nine-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day),* Table 2-6: *One-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)* , Table 2-7: *Ten-County DFW RFP Summary of the 2011*

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[9] References for guidance documents used for EI development in this SIP revision are listed in the *References for Guidance Documents* section at the end of this document.

Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day) , and Table 2-8: *HGB RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day).*

Step two of the RFP target calculation process, calculating the emissions reduction amount required for each analysis year, is accomplished by multiplying the RFP base year EI values by the percent reduction needed to meet RFP requirements. For the DFW and HGB nonattainment areas, the first requirement is to reduce emissions by 15% between 2011 and 2017. The post-2017 requirement is to reduce emissions by 3% per year from January 1, 2018 to the end of the attainment year. Since the attainment year for DFW and HGB is 2020, a 9% reduction in emissions is required from the end of 2017 through 2020.

The EPA's final 2008 eight-hour ozone standard SIP requirements rule allow ozone nonattainment areas to substitute NO_X reductions for VOC reductions, but the use of NO_X emissions reductions must meet the criteria in §182(c)(2)(C) in the Federal Clean Air Act (FCAA). The eight-county HGB area, which was previously designated nonattainment under the one-hour ozone NAAQS and the 1997 eight-hour ozone NAAQS, has already satisfied the 15% VOC emissions reduction requirement; therefore, all eight HGB nonattainment counties may substitute NO_X reductions for VOC under the conditions detailed in the EPA's NO_X substitution guidance.[10] Nine of the 10 DFW counties were originally designated nonattainment under the one-hour ozone standard and the 1997 eight-hour ozone NAAQS and have already satisfied the 15% VOC-only requirement prior to designation under the 2008 eight-hour ozone NAAQS; therefore, an equivalent percentage of NO_X reductions may be substituted for VOC reductions requirements in those counties between 2011 and 2017. For the one county (Wise) added to the DFW nonattainment area under the 2008 eight-hour ozone NAAQS, the 15% reduction requirement from 2011 through 2017 must be all VOC.

For the DFW area, the 2011 through 2017 reduction requirement was met for the one DFW nonattainment county (Wise) added under the 2008 eight-hour ozone standard through a 15% VOC emissions reduction. The 2011 through 2017 reduction requirement was met for the nine previously designated nonattainment counties through a 14% NO_X reduction and 1% VOC reduction. After 2017, all 10 DFW nonattainment counties may substitute NO_X reductions for VOC under the conditions of the EPA's NO_X substitution guidance.[11] For the 10 DFW counties for the 2020 attainment year, the 9% reduction requirement between the end of 2017 and 2020 for this proposed RFP SIP revision is satisfied by taking an 8% reduction from NO_X emissions and a 1% reduction from VOC for the 10 DFW nonattainment counties. Equation 3-1 describes the method to calculate the percentage of NO_X emissions substituted for VOC emissions for the previous 2017 RFP analysis year. Equation 3-2 describes the method to calculate the percentage of NO_X emissions substituted for VOC emissions for the 2020 RFP attainment year.

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[10] NO_X may be substituted for VOC under conditions defined in the EPA's December 1993 NO_X Substitution Guidance (https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2_old/19931201_oaqps_nox_substitution_guidance.pdf).

[11] See footnote 10.

Equation 3-1: $N_{AY} = 15 - V_{AY}$

where:

AY = First RFP analysis year

N_{AY} = percentage NO_X reductions for year AY

V_{AY} = percentage VOC reductions for year AY

Equation 3-2: $N_{AY} = [3 \times (CY_{AY} - CY_{AY-1})] - V_{AY}$

where:

AY = RFP analysis year

$AY - 1$ = previous RFP analysis year

N_{AY} = percentage NO_X reductions for year AY

CY = calendar year

V_{AY} = percentage VOC reductions for year AY

For the HGB area, the 15% reduction requirement for 2011 through 2017 was met for the eight HGB counties through a 10% NO_X reduction and 5% VOC reduction. For the eight HGB counties for the 2020 attainment year, the 9% reduction requirement between the end of 2017 and 2020 for this proposed RFP SIP revision is satisfied by taking a 6.2% reduction from NO_X emissions and a 2.8% reduction from VOC. As with DFW, Equations 3-1 and 3-2 describe the method to calculate the percentage of NO_X emissions substituted for VOC emissions for the previous 2017 RFP analysis years and the 2020 RFP attainment year.

Emissions reductions percentages are multiplied by their corresponding NO_X and VOC base year emissions inventories to calculate the required NO_X and VOC emissions reductions for each RFP analysis year. Tables 3-2: *Summary of the Calculation Process for 2020 DFW RFP Target Levels* and 3-3*: Summary of the Calculation Process for 2020 HGB RFP Target Levels* provide a summary of the NO_X and VOC reductions needed to satisfy the initial 15% and the subsequent 3% per year requirement for all RFP analysis years. The equations for calculating the 9% required reductions for NO_X and VOC are shown in Equations 3-3A and 3-3B. Summaries of the NO_X and VOC reductions needed to satisfy the 15% and post-2017 3% per year requirements for the RFP attainment year are provided for DFW in Lines 7, 8 and 9 of Table 3-2, and, for HGB Lines 4 and 5 of Table 3-3.

Equation 3-3A: $RPR_{AY, VOC} = [\ BY_{2011, VOC}\ ] \times PV_{AY}$

and

Equation 3-3B: $RPR_{AY, NOx} = [\ BY_{2011, NOx}\ ] \times PN_{AY}$

where:

AY = RFP analysis year

$RPR_{AY, VOC}$ = required VOC emission reductions between 2011 and AY

$RPR_{AY, NOx}$ = required NO_X emission reductions between 2011 and AY

$BY_{2011, VOC}$ = 2011 base year EI for VOC

$BY_{2011, NOx}$ = 2011 base year EI for NO_X

PV_{AY} = percentage VOC reductions for year AY

PN_{AY} = percentage NO_X reductions for year AY

Step three of the RFP target calculation process, calculating RFP target levels of emissions, is accomplished by subtracting the required emissions reductions (step two) from the 2011 base year EI. The target level represents the level of emissions for each RFP analysis year, for each county group, for the HGB and DFW nonattainment areas to meet their 2008 eight-hour ozone standard RFP requirements. The method for calculating the target levels of emissions for the DFW and HGB RFP analysis years is shown in Equation 3-4.

Equation 3-4: $TL_{AY, X} = TL_{(AY-1), X} - RPR_{AY, X}$

where:

AY = RFP analysis year

$AY - 1$ = previous RFP analysis year

$TL_{AY, X}$ = target level of emissions for AY

$TL_{(AY-1), X}$ = target level of emissions for the previous RFP analysis year (Note: For 2017, the target level of emissions for the previous RFP analysis year is equal to the 2011 base year EI.)

$RPR_{AY, X}$ = emission reduction requirement for AY for pollutant X

X = either VOC or NO_X

The calculation of the target values for the RFP attainment year for DFW and HGB are documented in Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet* and Appendix 2: *HGB Reasonable Further Progress Demonstration*

Spreadsheet. Table 3-2 and Table 3-3 provide a step-by-step summary of the calculation of the 2020 DFW and HGB RFP target levels of VOC and NO_X emissions.

In Section 3.5: *RFP Demonstration*, the target levels are integrated into the RFP demonstration.

3.4 GROWTH

This proposed DFW and HGB RFP SIP revision must account for any growth in emissions between the RFP base year (2011) and the attainment year (2020). For future analysis years, the uncontrolled (for mobile sources) or existing controlled (for stationary sources) NO_X and VOC emissions inventories are developed by applying the appropriate projection methodologies to the most recent EI estimates, emissions factors, and/or to activity-level estimates. The resulting emissions inventories include any growth between 2011 and 2020.

The projection methodology for the uncontrolled or existing controlled RFP EI excludes changes in the emissions factor due to control strategies so that the projections represent the total growth in emissions. When the creditable RFP control reductions are subtracted from uncontrolled or existing controlled projected emissions inventories that include growth, the result will be the forecasted controlled RFP emissions.

The controlled RFP emissions are compared to the target emissions levels to determine if a nonattainment area successfully demonstrates RFP, thereby meeting RFP requirements. The method for accounting for growth is based on EPA guidance for performing RFP calculations.[12] The development of the uncontrolled or existing controlled projected EI is documented in Chapter 2: *Emissions Inventories*. The development of the projected control reductions is documented in Chapter 4: *Control Measures to Achieve Target Levels*.

3.5 RFP DEMONSTRATION

The EPA's final 2008 eight-hour ozone standard SIP requirements rule requires the RFP control strategy plan to show ozone precursor (NO_X and VOC) emissions reductions that will reduce controlled RFP analysis year emissions to values equal to or less than the emissions target values. To demonstrate RFP, the creditable RFP control reductions are subtracted from the uncontrolled or existing controlled forecast EI for each RFP analysis year. The contingency reductions for the one-year period from January 1, 2018 through December 31, 2018 set aside under the previous moderate nonattainment SIP revisions for the 2008 eight-hour ozone NAAQS are reserved to avoid double-counting these reductions. The RFP requirement is met for each analysis year if the resulting controlled RFP EI forecast is less than the target level of emissions. The following two sections provide the DFW and HGB RFP demonstrations for this RFP SIP revision.

3.5.1 DFW RFP Demonstration

The RFP demonstration calculations were completed for the 2020 DFW attainment year. A summary of the 2020 DFW RFP demonstration is provided in Table 3-4*:*

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[12] United States Environmental Protection Agency, "Final Rule to Implement the 8-Hour Ozone National Ambient Air Quality Standard; Final Rule," *Federal Register* (70 FR 71631), November 29, 2005.

Summary of the 2020 DFW RFP Demonstration (tons per day). As concluded in the final row of the table, the 10-county DFW area demonstrates the required RFP emission reductions for 2020. All RFP calculations, including the required reductions and the target emissions levels, are calculated and shown in Appendix 1. Details of the emissions reductions used to calculate the creditable RFP control reductions for 2020 are documented in Chapter 4 and summarized in Table 4-1: *Summary of DFW RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day).*

Table 3-4: Summary of the 2020 DFW RFP Demonstration (tons per day)

Line	Description	NO_X	VOC
Line 1	Uncontrolled or existing controlled 10-county DFW 2020 emissions forecast with growth	1307.94	855.96
Line 2	Creditable 10-county DFW RFP control reductions between 2011 and 2020	1023.27	432.82
Line 3	Controlled 10-county DFW 2020 RFP emissions forecast (Line 1 minus Line 2)	284.67	423.14
Line 4	Amount of creditable reductions reserved for 2017 to 2018 RFP milestone contingency	8.44	4.65
Line 5	Controlled 10-county DFW 2020 RFP emission forecast with 2018 contingency (Line 3 plus Line 4)	293.11	427.79
Line 6	Amount of NO_X reduction substitution (see Sheet 9)	0.00	0.00
Line 7	Controlled 10-county DFW 2020 RFP forecast without reductions reserved for contingency and accounting for NO_X substitution (Line 5 plus Line 6)	293.11	427.79
Line 8	10-county DFW 2020 RFP target level of emissions	334.10	450.79
Line 9	Excess (+) / Shortfall (-) (Line 8 minus Line 7)	+ 40.99	+ 23.00
Line 10	Is controlled RFP EI less than target level of emissions?	Yes	Yes

3.5.2 HGB RFP Demonstration

The RFP demonstration calculations were completed for the 2020 HGB attainment year. A summary of the 2020 HGB RFP demonstration is provided in Table 3-5*: Summary of the 2020 HGB RFP Demonstration (tons per day)*. As concluded in the final row of the table, the eight-county HGB area demonstrates the required RFP emission reductions for 2020. All RFP calculations, including the required reductions and the target emissions levels, are calculated and shown in Appendix 2. Details of the emissions reductions used to calculate the creditable RFP control reductions for 2020 are documented in Chapter 4 and summarized in Table 4-2: *Summary of HGB NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day).*

Table 3-5: Summary of the 2020 HGB RFP Demonstration (tons per day)

Line	Description	NO_X	VOC
Line 1	Uncontrolled or existing controlled eight-county HGB 2020 emissions forecast with growth	1165.66	854.65
Line 2	Creditable RFP control reductions between 2011 and 2020	821.70	370.04
Line 3	Controlled eight-county HGB 2020 RFP emissions forecast (Line 1 minus Line 2)	343.96	484.61
Line 4	Amount of creditable reductions reserved for 2017-to-2018 RFP milestone contingency	13.29	0.00
Line 5	Controlled eight-county HGB 2020 RFP emission forecast accounting for 2018 contingency (Line 3 plus Line 4)	357.25	484.61
Line 6	Amount of NO_X reduction substitution	0.00	0.00
Line 7	Controlled 2020 RFP forecast without reductions reserved for contingency and accounting for NO_X substitution (Line 5 plus Line 6)	357.25	484.61
Line 8	2020 RFP target level of emissions	371.17	493.33
Line 9	Excess (+) / Shortfall (-) (Line 8 minus Line 7)	+13.92	+8.72
Line 10	Is controlled RFP EI less than target level of emissions?	Yes	Yes

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CHAPTER 4: CONTROL MEASURES TO ACHIEVE TARGET LEVELS

4.1 OVERVIEW OF CONTROL MEASURES

This chapter describes the methods used to achieve the emissions reductions in volatile organic compounds (VOC) and nitrogen oxides (NO_X) required to demonstrate reasonable further progress (RFP) for both the Dallas-Fort Worth (DFW) 2008 eight-hour ozone nonattainment area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties) and the Houston-Galveston-Brazoria (HGB) 2008 eight-hour ozone nonattainment area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties).

The projected emissions reductions reflect the identified federal and state emissions controls. All state control measures are codified in regulations for the State of Texas. Control measures used for RFP do not include all emissions reduction programs and requirements for the DFW and HGB areas. Only the controls used to meet the DFW and HGB RFP requirements for the 2020 attainment year are presented in Table 4-1: *Summary of DFW RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day)* and Table 4-2: *Summary of HGB RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day).*

Individual and total values shown in the summary tables have been extracted from the spreadsheets in Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet* and Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet.*

Table 4-1: Summary of DFW RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day)

Control Strategy Description	NO_X Reduction	VOC Reduction
Chapter 117 NO_X controls[1]	0.00	0.00
Chapter 115 storage tank rules	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers[1]	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	796.66	290.23
Reformulated Gasoline (RFG)[2]/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra-Low Sulfur Diesel	54.23	15.17
Inspection and Maintenance (I/M)	6.87	8.14
On-road Texas Low Emissions Diesel (TxLED)	2.65	0.00
Tier I and II locomotive NO_X standards	19.15	0.74
Small non-road spark ignition (SI) engines (Phase I)[3]	-3.88	33.19
Heavy duty non-road engines	37.44	14.79
Tiers 2 and 3 non-road diesel engines	38.06	3.15
Small non-road SI engines (Phase II)	2.71	32.19
Large non-road SI and recreational marine	36.77	16.48
Non-road TxLED	3.89	0.00
Non-road RFG	0.01	0.49
Tier 4 non-road diesel engines	25.93	1.14
Diesel recreational marine	0.00	0.00

Control Strategy Description	NO_X Reduction	VOC Reduction
Small SI (Phase III)	2.47	16.99
Chapter 117 NO_X area source engine controls[1]	0.00	0.00
Drilling rigs: federal engine standards and TxLED	0.31	0.11
Sum of reductions from projected uncontrolled or existing controlled emissions	1,023.27	432.82

Note 1: These rules had compliance deadlines before 2011 in the DFW area. The 2011 base year emissions inventory (EI) includes the effect of the control. No additional emissions reductions beyond 2011 are claimed.
Note 2: The 10-county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with federal RFG are: Collin, Dallas Denton and Tarrant. The six counties with Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise.
Note 3: The small SI Phase 1 rule is shown to provide a substantial reduction in VOC emissions. A slight increase in NO_X emissions is due to the engine modifications required to meet the VOC and CO standards of the Small SI Phase 1.

Table 4-2: Summary of HGB RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day)

Control Strategy Description	NO_X Reduction	VOC Reduction
Chapter 117 NO_X controls	0.00	0.00
Chapter 115 Storage Tank Rule	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers	0.00	0.00
FMVCP	561.84	245.62
RFG/Low Sulfur Gasoline/Ultra-Low Sulfur Diesel	101.55	16.96
I/M	5.13	7.39
On-road TxLED	2.39	0.00
Tier I and II locomotive NO_X standards	21.02	0.81
Small non-road SI engines (Phase I)[1]	-3.17	25.60
Heavy duty non-road engines	26.71	13.71
Tiers 2 and 3 non-road diesel engines	30.22	2.62
Small non-road SI engines (Phase II)	2.22	23.67
Large non-road SI and recreational marine	37.37	16.51
Non-road TxLED	1.36	0.00
Non-road RFG	0.01	0.73
Tier 4 non-road diesel engines	17.70	0.78
Diesel recreational marine	0.00	0.00
Small SI (Phase III)	2.16	15.43
Chapter 117 NO_X area source engine controls	0.00	0.00
Drilling rigs: federal engine standards and TxLED	0.43	0.09
Commercial marine vessel engine certification standards and fuel programs	14.76	0.12
Sum of reductions from projected uncontrolled or existing controlled emissions	821.70	370.04

Note 1: The small SI Phase 1 rule is shown to provide a substantial reduction in VOC emissions. A slight increase in NO_X emissions is due to the engine modifications required to meet the VOC and CO standards of the Small SI Phase 1.

4.2 POINT SOURCE CONTROLS

Specific point source controls required by state rules and the associated emissions reductions were incorporated into the 2011 base year inventory and the 2020 attainment year inventory as appropriate according to compliance deadlines. These controls include Title 30 Texas Administrative Code (TAC) Chapter 117 reductions of NO_X emissions from cement plants, electric generating units, internal combustion engines, and heaters and 30 TAC Chapter 115 reductions of VOC emissions, which had compliance deadlines before 2011. Point source emissions for attainment year 2020 are summarized in Table 4-3: *DFW RFP 2020 Point Source Emissions and Reductions for NO_X and VOC (tons per day)* and Table 4-4: *HGB RFP 2020 Point Source Emissions and Reductions for NO_X and VOC (tons per day).*

Table 4-3: DFW RFP 2020 Point Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011)	46.83	24.35
RFP point source reduction	0.00	0.00
RFP post-2011 controlled emissions	46.83	24.35

Table 4-4: HGB RFP 2020 Point Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011	131.06	85.23
RFP point source reduction	0.00	0.00
RFP post-2011 controlled emissions	131.06	85.23

4.3 AREA SOURCE CONTROLS

Area source controls required by state and federal rules and the associated emissions reductions were incorporated into the 2011 base year inventory and the 2020 attainment year inventory as appropriate according to compliance deadlines. These controls include 30 TAC Chapter 117 reductions of NO_X emissions from internal combustion engines in the HGB and DFW area, which had compliance deadlines before 2011; and the federal portable fuel containers rule, which also had compliance deadlines prior to 2011. Other reductions, including Federal New Source Performance Standards Subpart OOOO emissions reductions, are included in the projection base year EI (2017) for this state implementation plan (SIP) revision and are included in the 2020 attainment year EI.

Area source emissions for attainment year 2020 are summarized in Table 4-5: *DFW RFP 2020 Area Source Emissions and Reductions Summary for NO_X and VOC (tons per day) and* Table 4-6: *HGB RFP 2020 Area Source Emissions and Reductions Summary of NO_X and VOC (tons per day).*

Table 4-5: DFW RFP 2020 Area Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011)	38.69	299.22
RFP area source reduction	0.00	0.00
RFP post-2011 controlled emissions	38.69	299.22

Table 4-6: HGB RFP 2020 Area Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011)	30.04	310.98
RFP area source reduction	0.00	0.00
RFP post-2011 controlled emissions	30.04	310.98

4.4 NON-ROAD MOBILE SOURCE CONTROLS

Non-road mobile source controls required by state and federal rules and the associated emissions reductions were incorporated into the 2011 base year inventory and the 2020 attainment year inventory as appropriate according to compliance deadlines. Emissions reductions were calculated as detailed in the following sections. Summaries of all non-road mobile source RFP emissions inventories and control strategy reductions are presented in Table 4-7: *DFW RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)* and Table 4-8: *HGB RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day).*

Table 4-7: DFW RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Uncontrolled emissions	264.52	162.12
RFP non-road source reduction	162.86	119.28
RFP controlled (post-control) emissions	101.66	42.84

Table 4-8: HGB RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Uncontrolled emissions	254.17	136.26
RFP non-road source reduction	150.79	100.07
RFP controlled (post-control) emissions	103.38	36.19

4.4.1 NONROAD Model Categories

For this proposed DFW and HGB RFP SIP revision, the Texas NONROAD Model (TexN) 1.7.2 model was run using county-specific population and activity files, where available. To evaluate RFP requirements, a series of TexN model runs was performed for both controlled and uncontrolled scenarios for each federal and state control program and each analysis year. The applicable federal and state rules that were modeled are located in Section 4.1*: Overview of Control Measures*. The emissions inventories developed include county-level ozone season daily controlled and uncontrolled emissions estimates for the 2011 and 2020 analysis years for the DFW and HGB nonattainment areas.

Emissions reductions from individual federal and state controls for non-road equipment were calculated by subtracting the controlled (post-control) emissions estimates from the uncontrolled emissions estimates.

4.4.2 Non-Road Categories Not Included in the EPA NONROAD Model

Emissions from the non-road mobile sources that are not estimated using the TexN model include commercial marine vessels (CMV), locomotives, aircraft, auxiliary power units (APU), and ground support equipment (GSE), and drilling rigs used in upstream oil and gas exploration activities. Emissions for those source categories were calculated using alternate United States Environmental Protection Agency (EPA)-approved methods and guidance.

4.4.2.1 Drilling Rigs

The 2011 emissions were developed by using 2011 drilling activity data combined with the 2011 year-specific controlled and uncontrolled emission factors from Appendix 8: *2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories.* A 2020 EI for drilling rigs was developed using 2017 drilling activity data and the 2020 year-specific controlled and uncontrolled emission factors from Appendix 8. Because future drilling activity is difficult to predict, the 2017 drilling activity data was held constant to the attainment year since that was the most current data available. Emissions reductions from individual federal and state controls for these specific types of non-road equipment were calculated by subtracting the controlled (post-control) emissions estimates from the uncontrolled emissions estimates.

4.4.2.2 Commercial Marine Vessels and Locomotives

Controlled emissions for CMV were based on emissions factors developed by Eastern Research Group, Inc. (ERG) with guidance from the EPA which took into account fleet turnover and the implementation of state and federal regulatory programs. Uncontrolled emissions were based on a separate set of emissions factors that excluded adjustments for fleet turnover and the implementation of state and federal regulatory programs. Documentation of methods and procedures used in developing the CMV emissions inventories can be found in Appendix 9: *2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories.*

The locomotive EI was developed from a Texas Commission on Environmental Quality (TCEQ)-commissioned study using EPA-accepted EI development methods. The locomotive EI includes line haul and yard emissions activity data from all Class I, II, and III locomotive activity and emissions by rail segment. Controlled emissions for locomotive sources were determined by applying activity adjustment factors by source classification code and emissions rate adjustment factors. The emissions rate adjustment factors were obtained from the EPA's Emission Factors for Locomotives

Fact Sheet (https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100500B.TXT). Documentation of methods and procedures used by ERG in developing the locomotive emissions inventories can be found in Appendix 10: *2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories*. The emissions inventories developed include county-level ozone season day controlled and uncontrolled emissions estimates for 2011 and 2020.

4.4.2.3 Airports

Emissions for aircraft, APU and GSE were calculated using the Federal Aviation Administration's Aviation Environmental Design Tool (AEDT). The updated controlled analysis year emissions for the airports were calculated based on the information provided by ERG in Appendix 11: *Development of the Statewide Aircraft Inventory for 2011* and Appendix 12: *Development of the Statewide Aircraft Inventory for 2020*. Control strategies for airport emissions included emission reductions from GSE and APU electric conversions.

4.5 ON-ROAD MOBILE SOURCE CONTROLS

The on-road mobile source emissions inventories and the corresponding on-road mobile source control strategy reductions for this proposed DFW and HGB RFP SIP revision were developed using the Motor Vehicle Emissions Simulator (MOVES) 2014a model. The TCEQ recently completed development of 2011, 2020, and 2021 on-road emission inventories for the DFW and HGB areas. The inventories were completed under contract with the North Central Texas Council of Governments (NCTCOG) and the Texas A&M Transportation Institute for the DFW and HGB areas, respectively.

For RFP analyses, the requirement to calculate and account for non-creditable emissions reductions due to pre-1990 FMVCP reductions was removed under the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule.* The RFP analyses presented in this DFW and HGB RFP SIP revision do not include any of the RFP elements or non-creditable effects related to the pre-1990 FMVCP. The on-road mobile control strategy reduction summaries and documentation do not include quantification of the pre-1990 FMVCP as a separate reduction.

4.5.1 DFW RFP On-Road Mobile Source Control Strategies

The on-road mobile emissions inventories were developed using emissions factors that reflect creditable control strategies for each analysis year. The controls that were modeled include: pre-1990 FMVCP, post-1990 FMVCP, ultra-low sulfur diesel, summer RFG, the East Texas Regional Low RVP Gasoline Program, the vehicle I/M program, Tier 3 FMVCP, the lower sulfur gasoline associated with Tier 3 FMVCP, and TxLED. A summary of the DFW on-road mobile source control strategies used for the DFW RFP are presented in Table 4-9: *Summary of DFW On-Road Mobile Control Strategies*.

Table 4-9: Summary of DFW On-Road Mobile Control Strategies

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
Pre-1990 FMVCP	Pre-1990 control	Pre-1990	No
1992 Federal Controls on Gasoline Volatility	Pre-1990 control. Collin, Dallas, Denton and Tarrant Counties: Maximum Reid Vapor Pressure of 7.8 pounds per square inch Ellis, Johnson, Kaufman, Parker, Rockwall and Wise: Maximum Reid Vapor Pressure of 9.0 pounds per square inch	1992	No
Anti-Tampering Program (Dallas and Tarrant counties only)	According to Section 2.8.9.3 of the MOBILE6.2 User's Guide, "the mere presence of an I/M program is expected to act as a deterrent to tampering… All 1996 and newer model year vehicles are assumed to have negligible tampering effects. As a result, there is no tampering reduction benefit associated with the 1996 and newer vehicles." Section 5.2 of the MOBILE6.2 User's Guide elaborates further by stating that "with the introduction of the phase 2 of the onboard diagnostic (OBD) electronics in 1996, the explicit modeling of the effects of tampering on vehicle emissions will phase out because OBD vehicles are assumed to have negligible tampering rates." Year 1995-and-older vehicles are currently a very small portion of the fleet, and their total number will continue to decline with fleet turn-over.	1986	No
I/M Program (Dallas and Tarrant counties only)	None	1990	Yes
Tier 1, FMVCP	None	1994	Yes
Reformulated Gasoline	Collin, Dallas, Denton and Tarrant Counties only	1995 for phase one, 2000 for phase two	Yes

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
East Texas Regional Low RVP Gasoline Program	Ellis, Johnson, Kaufman, Parker, Rockwall and Wise Counties	2000	Yes
National Low Emission Vehicle Program	None	2001	Yes
Expanded I/M and ATP	Expanded to Collin, Denton counties	2002	Yes
Expanded I/M and ATP	Expanded to Ellis, Johnson, Kaufman, Parker, and Rockwall Counties	2003	Yes
Tier 2, FMVCP	Phase in from 2004 to 2009	2004	Yes
TxLED	15 parts per million maximum sulfur content. Low aromatic hydrocarbon and high cetane number to control NO_X	2006	Yes
Ultra-Low-Sulfur Diesel	15 parts per million maximum sulfur content	2006	Yes
2007 Heavy duty FMVCP	Phase in from 2007 to 2010	2007	Yes
Tier 3, FMVCP	Phase in from 2017 to 2025	2017	Yes
I/M Program (Dallas and Tarrant counties only)	None	1990	Yes

4.5.2 HGB RFP On-Road Mobile Source Control Strategies

The on-road mobile emissions inventories were developed using emission factors that reflect all creditable control strategies for each analysis year. The controls that were modeled include: pre-1990 FMVCP, post-1990 FMVCP, summer RFG, the HGB vehicle I/M program, the lower sulfur gasoline associated with Tier 3 FMVCP, ultra-low sulfur diesel, and TxLED. A summary of the HGB on-road mobile source control strategies used for this HGB RFP SIP revision are presented in Table 4-10: *Summary of HGB On-Road Mobile Control Strategies*.

Table 4-10: Summary of HGB On-Road Mobile Control Strategies

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
Pre-1990 FMVCP	Pre-1990 control	Pre-1990	No
1992 Federal Controls on Gasoline Volatility	Pre-1990 control. Maximum Reid Vapor Pressure of 7.8 pounds per square inch.	1992	No
I/M Program	Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties	1997	Yes
Tier 1, FMVCP	Included in MOVES post-1990 FMVCP	1994	Yes

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
RFG	Eight HGB counties	1995 for phase one, 2000 for phase two	Yes
National Low Emission Vehicle Program	Included in MOVES post-1990 FMVCP	2001	Yes
Tier 2, FMVCP	Phased in from 2004 to 2009. Included in MOVES post-1990 FMVCP.	2004	Yes
TxLED	15 parts per million (ppm) maximum sulfur content. Low aromatic hydrocarbon and high cetane number to control NO_X.	2006	Yes
Ultra-Low-Sulfur Diesel	15 ppm maximum sulfur content	2006	Yes
2007 Heavy Duty FMVCP	Phased in from 2007 to 2010. Included in MOVES post-1990 FMVCP.	2007	Yes
Tier 3, FMVCP	Phased in from 2017 to 2025. Included in MOVES post-1990 FMVCP.	2017	Yes
Tier 3, Low Sulfur Gasoline	A part of the Tier 3 FMVCP lowers the limit on gasoline sulfur content; also improves the performance of Tier 2 equipment	2017	Yes

4.5.3 On-Road Mobile Source Control Strategy Reductions

The projected mobile source emissions inventories documented in Appendix 13: *Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021* and Appendix 14: *Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories*, include quantification of emissions reductions for all federal and state on-road mobile source control rules for the attainment year for the DFW and HGB nonattainment areas. A summary of the on-road mobile control scenarios included in the 2011, 2020, and 2021 RFP emissions inventories is presented in Table 4-11: *DFW Control Programs Modeled for each RFP Control Scenario* and Table 4-12: *HGB Control Programs Modeled for each RFP Control Scenario*. The summary of 2020 uncontrolled emissions, control program reductions, and controlled (post-control) emissions for on-road mobile sources in the DFW and HGB nonattainment areas may be found in Table 4-13: *DFW RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)* and Table 4-14: *HGB RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)* for the DFW and HGB areas, respectively.

Table 4-11: DFW Control Programs Modeled for each RFP Control Scenario

Control Scenario Description	Controls Modeled
Control Scenario 1 Pre-1990 Controls Only (for RFP purposes, this is the uncontrolled emissions inventory)	Pre-1990 FMVCP and 1992 federal controls on gasoline volatility
Control Scenario 2	Add: Post-1990 FMVCP (Tier 1 FMVCP, Tier 2 FMVCP, 2007 heavy duty diesel FMVCP, Tier 3 FMVCP)
Control Scenario 3	Add: Federal RFG with Tier 3 sulfur levels (Collin, Dallas, Denton and Tarrant Counties) and East Texas Regional Low RVP Gasoline Program with Tier 3 sulfur levels (Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise Counties) and ultra-low sulfur diesel (All DFW counties)
Control Scenario 4	Add: DFW I/M program: modeled for Dallas, Collin, Denton Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties
Control Scenario 5 RFP Post-Control Emissions	Add: TxLED program, 15 ppm maximum sulfur content, low aromatic hydrocarbons, and high cetane number to control NO_X

Table 4-12: HGB Control Programs Modeled for each RFP Control Scenario

Control Scenario Description	Controls Modeled
Control Scenario 1 Pre-1990 Controls Only (for RFP purposes, this is the uncontrolled emissions inventory)	Pre-1990 FMVCP and 1992 federal controls on gasoline volatility
Control Scenario 2	Add: Federal RFG with Tier 3 sulfur levels and ultra-low sulfur diesel
Control Scenario 3	Add: Post-1990 FMVCP (Tier 1 FMVCP, Tier 2 FMVCP, 2007 heavy duty diesel FMVCP, Tier 3 FMVCP)
Control Scenario 4	Add: HGB I/M program: modeled for Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties

Control Scenario Description	Controls Modeled
Control Scenario 5 RFP Post-Control Emissions	Add: TxLED program, 15 ppm maximum sulfur content, low aromatic hydrocarbons, and high cetane number to control NO_X

Table 4-13: DFW RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Inventory or Control Strategy Description	NO_X	VOC
2020 uncontrolled emissions	957.90	370.27
Post-1990 FMVCP	796.66	290.23
On-road RFG with Tier 3 sulfur and ultra-low sulfur diesel	54.23	15.17
DFW I/M program	6.87	8.14
On-road TxLED	2.65	0.00
2020 RFP controlled (post-control) emissions	97.49	56.73

Table 4-14: HGB RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Inventory or Control Strategy Description	NO_X	VOC
2020 uncontrolled emissions	750.39	322.18
Post-1990 FMVCP	561.84	245.62
On-road RFG with Tier 3 sulfur and ultra-low sulfur diesel	101.55	16.96
HGB I/M program	5.13	7.39
On-road TxLED	2.39	0.00
2020 RFP controlled (post-control) emissions	79.48	52.21

4.6 VEHICLE MILES TRAVELED DEMONSTRATION

Transportation control measures (TCM) are required to offset growth in vehicle miles traveled (VMT) that result in an increase in vehicle emissions for nonattainment areas classified as serious under the National Ambient Air Quality Standards (NAAQS). There is growth in VMT for the DFW and HGB ozone nonattainment areas for the years between the RFP base year of 2011 and the attainment year, 2020, as illustrated in Figure 4-1: *2011 and 2020 DFW and HGB RFP VMT Trends (miles per day)*. However, the growth in VMT for both areas is more than offset by control measures that reduce the per mile emission rates, resulting in a decrease in emissions of both VOC and NO_X for the same time period, as shown in Figure 4-2: *DFW 2011 and 2020 RFP NO_X and VOC Emissions (tons per day)* and Figure 4-3: *HGB 2011 and 2020 RFP NO_X and VOC Emissions (tons per day).* The increase in VMT and decrease in vehicle emissions for the RFP time period are summarized in Table 4-15: *DFW RFP On-Road Mobile Controlled NO_X Emissions, VOC Emissions, and Vehicle Miles Traveled* and Table 4-16: *HGB RFP On-Road Mobile Controlled NO_X Emissions, VOC Emissions, and Vehicle Miles Traveled.* A list of the DFW and HGB on-road mobile source control measures used to demonstrate RFP in this proposed SIP revision are provided in Tables 4-9: *Summary of DFW On-Road Mobile Control Strategies* and Table 4-10: *Summary of HGB On-Road Mobile Control*

Strategies. Since vehicle emissions are decreasing with the current list of controls, no additional controls from TCMs are required.

Table 4-15: DFW RFP On-Road Mobile Controlled NO_x Emissions, VOC Emissions, and Vehicle Miles Traveled

RFP Analysis Year	NO_x (tons per day)	VOC (tons per day)	VMT (miles per day)
2011 Base Year	239.07	102.24	191,251,636
2020 Attainment Year	97.49	56.73	231,949,231

Table 4-16: HGB RFP On-Road Mobile Controlled NO_x Emissions, VOC Emissions, and Vehicle Miles Traveled

RFP Analysis Year	NO_x (tons per day)	VOC (tons per day)	VMT (miles per day)
2011 Base Year	168.60	80.45	145,136,623
2020 Attainment Year	79.48	52.21	193,683,005

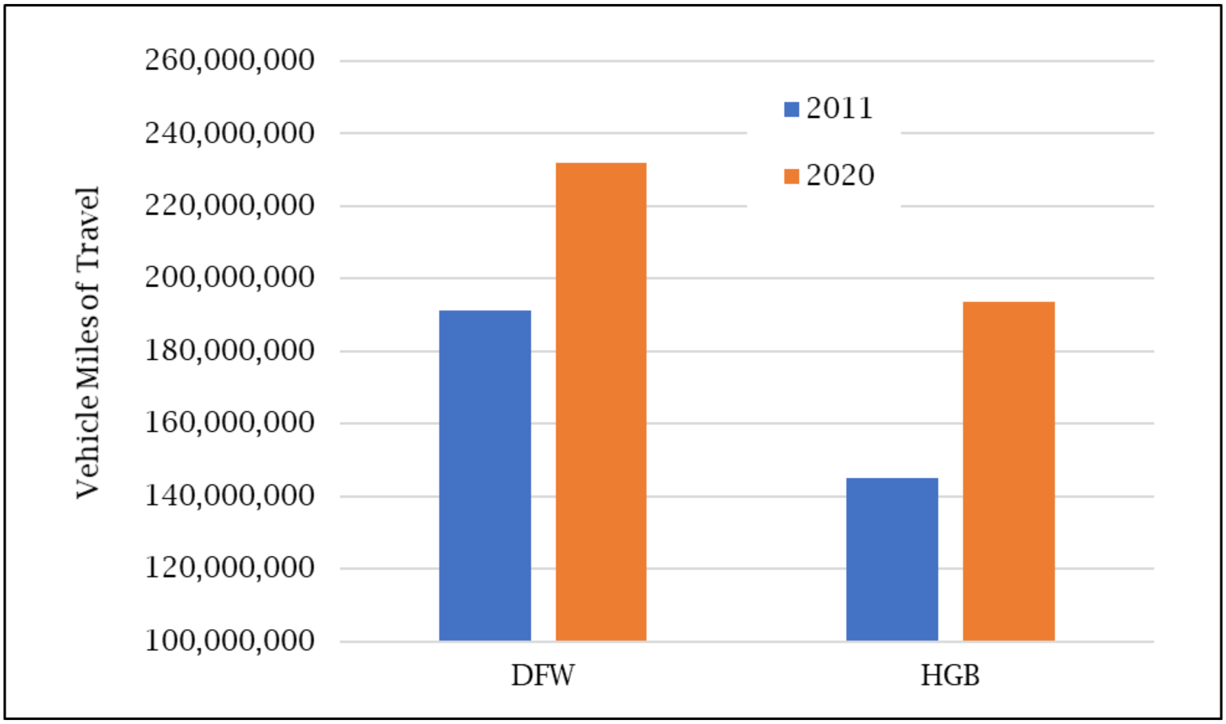

Figure 4-1: 2011 and 2020 DFW and HGB RFP VMT Trends (miles per day)

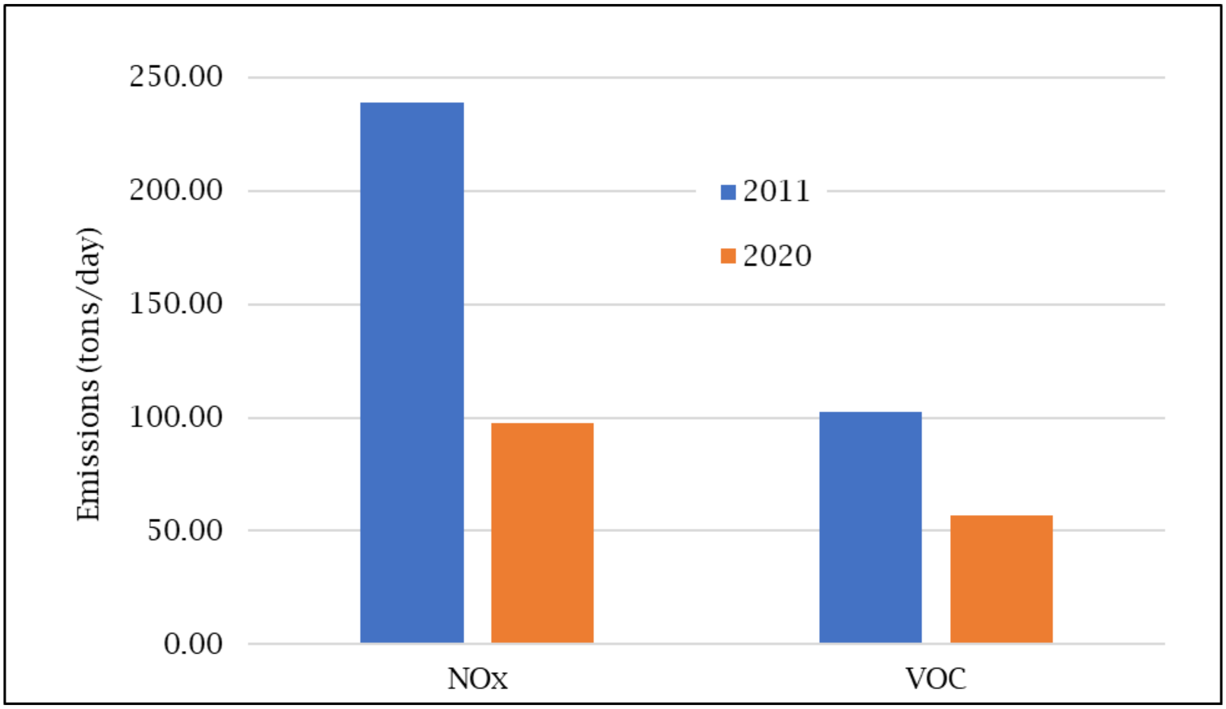

Figure 4-2: DFW 2011 and 2020 RFP NO_x and VOC Emissions (tons per day)

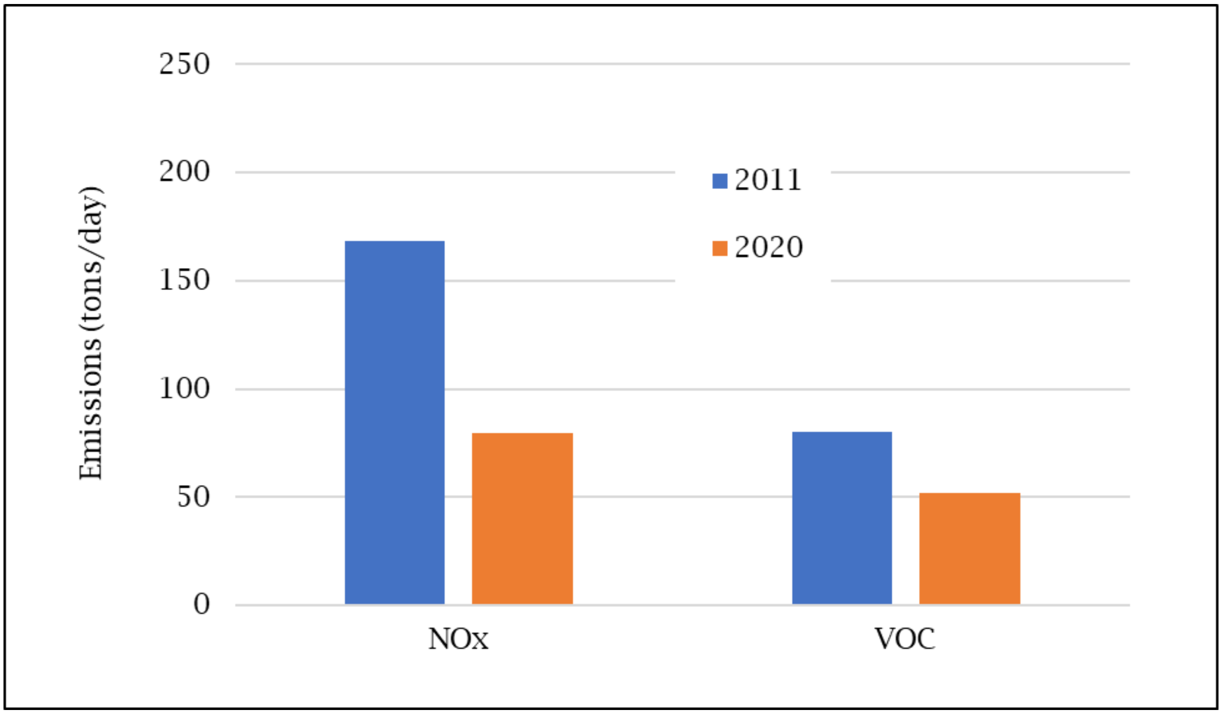

Figure 4-3: HGB 2011 and 2020 RFP NO_x and VOC Emissions (tons per day)

4.7 CONTINGENCY MEASURES

The RFP requirements include a 3% contingency demonstration for the one-year period after each RFP analysis year and the one-year period after the attainment year. In the event an RFP requirement is not met, the contingency control measures will provide the required emissions reduction. For this DFW and HGB RFP SIP revision, the only RFP analysis year is the attainment year. As with the 3% per year reduction requirement, the 3% contingency requirement is based on the RFP base year EI and may be met using VOC and/or NO_X reductions. This section contains an attainment year RFP contingency demonstration based on the 2020 attainment year.

The 3% attainment year RFP contingency analysis is based on a 2% reduction in NO_X, and a 1% reduction in VOC for the DFW area and a 3% reduction in NO_X only (no VOC reduction) for the HGB area to be achieved for the one-year period from January 1, 2021 through December 31, 2021. EI analyses were performed for fuel control programs and for the fleet turnover effects for the federal emissions certification programs for on-road and non-road vehicles. The emissions reductions for the year between 2020 and 2021 were estimated for those programs in both the DFW and HGB areas. Controlled (post-control) emissions reductions not previously used in the 2020 RFP demonstration may also be used to satisfy contingency requirements, so the excess emissions reductions from the 2020 RFP demonstration are included in the contingency analysis. This DFW and HGB RFP SIP revision provides for a motor vehicle emissions budget (MVEB) safety margin using some of the excess emissions reductions from the 2020 RFP demonstration; those emissions are subtracted from the amount available to demonstrate RFP contingency for the 2020 attainment year. The MVEB safety margin has been set to use 23.8% of the excess NO_X reductions and 24.7% of the excess VOC reductions in the DFW area, and 59% of the excess NO_X reductions and 63% of the excess VOC reductions in the HGB area and is reflected in the contingency calculation. Summaries of the 2020 attainment year RFP contingency analyses for DFW and HGB are provided in Table 4-17*: DFW RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted)* and Table 4-18: *HGB RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted).*

The analysis demonstrates that the attainment year RFP contingency reductions exceed the 3% reduction requirement; therefore, the RFP contingency requirement is fulfilled for the DFW and HGB areas.

Table 4-17: DFW RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted)

Line	Contingency Demonstration Description	NO_X	VOC
Line 1	2011 base year (BY) emissions inventory	422.04	464.92
Line 2	Percent for 2020 attainment year contingency calculation (total of 3%)	2.00	1.00
Line 3	Required contingency reductions between 2020 and 2021 (BY emissions inventory multiplied by contingency percent: Line 1 multiplied by Line 2)	8.44	4.65
	Control reductions to meet contingency requirements	**NO_X**	**VOC**
Line 4	Excess reductions from 2020 RFP demonstration (from Table 3-4: *Summary of the 2020 DFW RFP Demonstration [tons per day]*)	40.99	23.00

Line	Contingency Demonstration Description	NO_x	VOC
Line 5	Subtract 2020 RFP demonstration MVEB safety margin from excess reductions from 2020 RFP demonstration (see Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet*, Sheet 6)	-9.76	-5.68
Line 6	2020 to 2021 emission reductions due to FMVCP, (I/M, RFG/East Texas Regional Low RVP,2017 low sulfur gasoline standard on-road TxLED, and Ultra-Low Sulfur Diesel (ULSD) (Note: The 10-county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with RFG are: Collin, Dallas Denton and Tarrant. The six counties with Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall and Wise)	24.69	9.12
Line 7	2020 to 2021 emission reductions due to federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	2.75	2.48
Line 8	Total RFP demonstration contingency reductions (sum of Line 4, Line 5, Line 6, and Line 7)	58.67	28.92
Line 9	**Contingency Excess (+) or Shortfall (–) (Line 8 minus Line 3)**	+ 50.23	+ 24.27

Table 4-18: HGB RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted)

Line	Contingency Demonstration Description	NO_x	VOC
Line 1	2011 base year (BY) emissions inventory	442.92	535.06
Line 2	Percent for 2020 attainment year contingency calculation (total of 3%)	3.00	0.00
Line 3	Required contingency reductions between 2020 and 2021 (BY emissions inventory multiplied by contingency percent: Line 1 multiplied by Line 2)	13.29	0.00
	Control reductions to meet contingency requirements	**NO_x**	**VOC**
Line 4	Excess reductions from 2020 RFP demonstration (from Table 3-5: *Summary of the 2020 HGB RFP Demonstration [tons per day]*)	13.92	8.72
Line 5	Subtract 2020 RFP demonstration MVEB safety margin from excess reductions from 2020 RFP demonstration (see Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet*, Sheet 6)	-8.21	-5.49
Line 6	2020 to 2021 emission reductions due to FMVCP, (I/M, RFG, 2017 low sulfur gasoline standard on-road TxLED, and ULSD	24.19	13.05
Line 7	2020 to 2021 emission reductions due to federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	4.59	2.29
Line 8	Total RFP demonstration contingency reductions (sum of Line 4, Line 5, Line 6, and Line 7)	34.49	18.57
Line 9	**Contingency Excess (+) or Shortfall (–) (Line 8 minus Line 3)**	+21.20	+18.57

CHAPTER 5: MOTOR VEHICLE EMISSIONS BUDGET

5.1 INTRODUCTION

The proposed Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) reasonable further progress (RFP) state implementation plan (SIP) revision establishes motor vehicle emissions budgets (MVEBs), setting the allowable on-road mobile emissions an area can produce while continuing to demonstrate RFP. The DFW and HGB RFP MVEBs are calculated by subtracting the on-road mobile source control strategies emissions reductions necessary to demonstrate RFP from the uncontrolled, projected on-road mobile source emissions inventories. Local transportation planning organizations use applicable MVEBs to demonstrate that projected emissions from transportation plans, programs, and projects are equal to or less than the MVEBs, as required by the federal transportation conformity rule (40 Code of Federal Regulations (CFR) Part 93, Subpart A).

The on-road mobile source emissions inventories and the corresponding MVEBs for this DFW and HGB RFP SIP revision were developed using the latest major revision to the United States Environmental Protection Agency's (EPA) mobile source emission model, the Motor Vehicle Emission Simulator (MOVES) 2014 model, MOVES2014a[13]. The Texas Commission on Environmental Quality (TCEQ), working with the North Central Texas Council of Governments (NCTCOG), and the Texas A&M Transportation Institute (TTI), recently completed development of 2011, 2020, and 2021 on-road emission inventories using MOVES2014a for the DFW and HGB areas, respectively. The planning assumptions, fleet characteristics, and vehicle miles traveled estimates were updated to incorporate the latest available information at the time the inventories and MVEBs were developed.

5.2 OVERVIEW OF METHODOLOGIES AND ASSUMPTIONS

The TCEQ developed updated on-road mobile source emissions inventories and control strategy reductions estimates using the latest planning assumptions and the EPA's MOVES2014a emissions factor model. Updated emissions inventory (EI) development included development of a 2011 base year EI, uncontrolled emissions inventories for 2020 and 2021, controlled emissions inventories for 2020 and 2021, and control strategies reduction estimates for 2020 and 2021. The TCEQ contracted NCTCOG and TTI to develop the RFP emissions inventories and control strategies reductions for the DFW and HGB areas, respectively. Detailed documentation of the on-road mobile EI development is provided in the contractor reports:

- Appendix 13: *Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021* and
- Appendix 14: *Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories.*

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[13] For on-road EI development, MOVES2014a is technically the most recent on-road release. The more recent MOVES2014b update only impacts non-road model components and does not change the on-road portion of the model.

5.3 MOTOR VEHICLE EMISSIONS BUDGETS FOR RFP ANALYSIS YEARS

The RFP MVEBs use the on-road mobile source emissions inventories for RFP analysis years, the on-road mobile source reductions strategies used to demonstrate RFP, and a transportation conformity safety margin, if one is used. A transportation conformity safety margin is allowed when there is an excess of emissions reductions beyond those required to demonstrate RFP. However, the amount of the safety margin cannot exceed the nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions reductions required for the RFP demonstration. This ensures that even if the safety margin is used for a transportation conformity determination, the DFW and HGB 2008 eight-hour ozone nonattainment areas will meet the 2008 eight-hour ozone standard RFP requirements. Summaries of the MVEB calculations for 2020 are presented in:

- Table 5-1: *2020 RFP MVEBs for the DFW 10-County Ozone Nonattainment Area (tons per day).*
- Table 5-2: *2020 RFP MVEBs for the HGB Eight-County Ozone Nonattainment Area (tons per day).*

Details for MVEB calculations are documented in Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet* for the DFW area and in Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet* for the HGB area. The RFP control strategies produce more than the required emissions reductions for the 2020 attainment year in both the DFW and HGB nonattainment areas. Some of the excess in emissions reductions for the 2020 attainment years are used to provide MVEB safety margins. In the DFW area, these MVEB safety margins are 10.01% for NO_X and 10.01% for VOC. The DFW percentage safety margins represent 23.8% of the excess NO_X reductions and 24.7% of the excess VOC reductions. In the HGB area, these MVEB safety margins are 10.33% for NO_X and 10.52% for VOC. The HGB percentage safety margins represent 59% of the excess NO_X reductions and 63% of the excess VOC reductions. These safety margins are less than the total emissions reductions needed for the RFP demonstration in both the DFW and HGB areas. Therefore, even if this safety margin is used, the DFW and HGB areas will still demonstrate RFP for 2020.

Table 5-1: 2020 RFP MVEBs for the DFW 10-County Ozone Nonattainment Area (tons per day)

Control Strategy Description	NO_X	VOC
2020 on-road emissions projection without post-1990 Federal Clean Air Act (FCAA) controls	957.90	370.27
Federal Motor Vehicle Control Program (FMVCP), inspection and maintenance (I/M), reformulated gasoline (RFG), East Texas Regional Low Reid Vapor Pressure Gasoline Program, on-road Texas low emission diesel (TxLED), and ultra-low sulfur diesel (ULSD).	860.41	313.54
2020 on-road emissions projection with post-1990 FCAA controls (uncontrolled emissions inventory minus control reductions)	97.49	56.73
Add transportation conformity safety margin	9.76	5.68
2020 DFW RFP MVEBs with safety margin	**107.25**	**62.41**

Table 5-2: 2020 RFP MVEBs for the HGB Eight-County Ozone Nonattainment Area (tons per day)

Control Strategy Description	NO_x	VOC
2020 on-road emissions projection without post-1990 FCAA controls	750.39	322.18
FMVCP, I/M, RFG, on-road TxLED, and ULSD	670.91	269.97
2020 on-road emissions projection with post-1990 FCAA controls (uncontrolled emissions inventory minus control reductions)	79.48	52.21
Add transportation conformity safety margin	8.21	5.49
2020 HGB RFP MVEBs with safety margin	**87.69**	**57.70**

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Appendices Available Upon Request

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WRITTEN AND ORAL TESTIMONY

INDEX OF WRITTEN TESTIMONY

REFERENCE NUMBER	SUBMITTED BY
W-1	Isabel G. Segarra Treviño, Earthjustice, on behalf of Achieving Community Tasks Successfully; Air Alliance Houston; Earthjustice; Sierra Club; and Texas Environmental Justice Advocacy Services

W-1

Proposed Houston-Galveston-Brazoria (HGB) Serious Classification Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone National Ambien Air Quality Standard (NAAQS),

Rule Project No. 2019-077-SIP-NR

TCEQ Docket No. 2019-0692-SIP

Proposed Sept. 11, 2019

Comments of Environmental and Community Groups:

ACHIEVING COMMUNITY TASKS SUCCESSFULLY

AIR ALLIANCE HOUSTON

EARTHJUSTICE

SIERRA CLUB

TEXAS ENVIRONMENTAL JUSTICE ADVOCACY SERVICES

October 28, 2019

Submitted via eComments at https://www6.tceq.texas.gov/rules/ecomments/

Comments of Environmental and Community Groups

These comments are submitted on behalf of Achieving Community Tasks Successfully, Air Alliance Houston, Coalition of Community Organizations, Earthjustice, Sierra Club, and Texas Environmental Justice Advocacy Services (collectively, "Commenters").

Achieving Community Tasks Successfully ("ACTS") is a grassroots community group working for social and environmental justice in the Pleasantville community of east Houston.

Air Alliance Houston is a non-profit environmental group that seeks to reduce air pollution and other health threats in the Houston region, and to protect public health and environmental integrity through applied research, education, and advocacy which includes actions to assist our constituents in the area facing this air pollution in their daily lives.

Earthjustice is the nation's largest nonprofit environmental law organization. It fights for a future where children can breathe clean air, no matter where they live, and where all communities are safer, healthier places to live and work.

Sierra Club is one of the oldest and largest national nonprofit grassroots environmental organizations in the country, with approximately 782,000 members nationwide dedicated to exploring, enjoying, and protecting the wild places and resources of the earth; practicing and promoting the responsible use of the earth's ecosystems and resources; educating and enlisting humanity to protect and restore the quality of the natural and human environment; and using all lawful means to carry out these objectives.

Texas Environmental Justice Advocacy Services ("t.e.j.a.s.") is a non-profit group whose mission is to create sustainable, healthy communities in the Houston Ship Channel region by educating individuals on health impacts from environmental pollution and empowering them to promote the enforcement of environmental laws. In furtherance of this mission, t.e.j.a.s. engages in advocacy and organizing around environmental issues in Texas, including pollution created by refineries and petrochemical facilities along the Houston Ship Channel.

INTRODUCTION

The Texas Commission on Environmental Quality ("TCEQ") must not finalize this proposal. Instead of perpetuating weak ozone protections in one of the most polluted areas of Texas, if not the entire country, TCEQ should be strengthening those protections. The communities and people who have borne the disproportionate burden of toxic ozone precursor emissions of carcinogenic volatile organic compounds ("VOCs") and oxides of nitrogen ("NO_X"), as well as the resulting ozone air pollution have the right to a healthy environment. And in the Houston nonattainment area, it is low resource communities and communities of color who bear the resulting disproportionate health harm from this pollution. The proposed action is a step away from realizing their right to breathe healthy air. As explained below, TCEQ cannot lawfully or rationally finalize the proposed action. In particular, TCEQ fails to demonstrate attainment by the serious area attainment date and the Proposed Rule[1] fails to adequately assess or adopt readily available control technology that is highly cost-effective and could be quickly installed or activated, favoring existing controls that are actually far inferior to reasonably available control technology already in place at other Texas facilities and throughout the nation.

I. The Proposed Rule Perpetuates the Ozone Problem in the Houston Nonattainment Area.

A. Ground-Level Ozone is Harmful to Human Health.

Ozone, the main component of smog, is a corrosive air pollutant that inflames the lungs and constricts breathing, and likely kills people. *See Am. Trucking Ass'ns v. EPA*, 283 F.3d 355, 359 (D.C. Cir. 2002); 80 Fed. Reg. 65,292, 65,308/3-09/1 (Oct. 26, 2015); EPA, *Integrated Science Assessment for Ozone and Related Photochemical Oxidants* 2-20 to -24 tbl.2-1, EPA-HQ-OAR-2008-0699-0405 (Feb. 2013) ("ISA"). It causes and exacerbates asthma attacks, emergency room visits, hospitalizations, and other serious health harms. *E.g.*, EPA, *Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards* 3-18, 3-26 to -29, 3-32, EPA-HQ-OAR-2008-0699-0404 (Aug. 2014) ("PA"); ISA 2-16 to -18, 2-20 to -24 tbl.2-1. Ozone-induced health problems can force people to change their ordinary activities, requiring children to stay indoors and forcing people to take medication and miss work or school. *E.g.*, PA 4-12.

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[1] Proposed Houston-Galveston-Brazoria (HGB) Serious Classification Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone National Ambien Air Quality Standard (NAAQS) ("Proposed Rule"), TCEQ Rule Project No. 2019-077-SIP-NR, TCEQ Docket No. 2019-0692-SIP (proposed Sept. 11, 2019).

Ozone can harm healthy adults, but others are more vulnerable. *See* 80 Fed. Reg. 65,310/1-3. Because their respiratory tracts are not fully developed, children are especially vulnerable to ozone pollution, particularly when they have elevated respiratory rates, as when playing outdoors. *E.g.*, *id.* 65,310/3, 65,446/1; PA 3-81 to -82. People living with lung disease and the elderly also have heightened vulnerability. *See* 80 Fed. Reg. 65,310/3. People living with asthma suffer more severe impacts from ozone exposure than healthy individuals and are more vulnerable at lower levels of exposure. *Id.* 65,311/1 n.37, 65,322/3.

Ozone exposure has been linked to the development of asthma, as well as its exacerbation. For individuals already diagnosed with asthma, evidence shows that ozone exposure increases the likelihood of having an asthma attack.[2] Ozone exposure has been shown to have especially significant effects on asthma exacerbation among children. Children living in areas with higher ambient ozone concentrations have been shown to be more likely to either have asthma or to experience asthma attacks compared with children living in areas having lower ambient ozone concentrations.[3]

Additionally, certain "sensitive" groups and individuals are found to have significantly greater susceptibility to ozone-related health impacts. In a 14-year study of 95 U.S. cities, links were found between short-term increases in ozone and premature mortality, even when excluding days exceeding 60 ppb, finding that that "daily changes in ambient O3 exposure are linked to premature deaths, even at very low pollution levels."[4] Other health impacts linked to ozone exposure are related to newborns and the developing fetus.[5] Prenatal exposure to ozone has been linked to reduced birth weight, premature delivery, and birth defects.[6]

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[2] *See, e.g.*, Franze et al., Protein nitration by polluted air, Enviro Sci Technol. 39: 1673-1678 (2005), http://dx.doi.org/10.1021/es0488737; U.S. Environmental Protection Agency, Air quality criteria for ozone and related photochemical oxidants, (EPA/600/R-05/004AF) (2006), http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=149923.

[3] Akinbami, The association between childhood asthma prevalence and monitored air pollutants in metropolitan areas, United States 2001-2004 (Environ. Res. Apr. 2010), 110(3):294-301, http://dx.doi.org/10.1016/j.envres.2010.01.001.

[4] Bell et al., The Exposure-Response Curve for Ozone and Risk of Mortality and Adequacy of Current Ozone Regulations, Environ Health Perspect. 114:532-536 (2006), *available at* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1440776/.

[5] ISA (2013) at 2-20.

[6] Salam et al., Birth Outcomes and Prenatal Exposure to Ozone, Carbon Monoxide, and Particulate Matter: Results from the Children's Health Study, Environ Health Perspec.113: 1638-1644 (2005), http://dx.doi.org/10.1289/ehp.8111.

Ozone also damages vegetation and forested ecosystems, causing or contributing to widespread stunting of plant growth, tree deaths, visible leaf injury, reduced carbon storage, and reduced crop yields. PA 5-2 to -3; ISA 9-1. By harming vegetation, ozone can also damage entire ecosystems, leading to ecological and economic losses. 80 Fed. Reg. 65,370/1-2, 65,377/3.

Currently, approximately half of Texans—over 12 million people—live in areas with air that EPA classified as unsafe to breathe under the 2008 ozone standard.[7] Even more communities violate the more protective 2015 ozone standard.[8] Recent D.C. Circuit decisions regarding the Clean Air Act's Good Neighbor provision mean that Texas is likely to come under obligations to restrict its significant contributions of ozone pollution on downwind states in the near future.[9]

B. Ozone Pollution is a Serious Health Problem in Houston.

Residents of the Houston area are consistently exposed to some of the highest ozone levels in the Central United States. Indeed, air quality monitors in the area consistently exceed the ozone levels current scientific research dictates as necessary to protect human health—especially for sensitive populations such as children, asthmatics, the elderly, and outdoor workers. In fact, the Houston area consistently ranks as one of the most polluted cities in the country for ozone.[10]

For decades, the eight counties making up the Houston area have struggled to attain federal NAAQS for ozone pollution, which are designed to protect human health and welfare. For more than forty years—throughout the implementation of the most recent 2015 ozone standard to the first 8-hour standard in 1997, and further back to the 1-hour standard, and then further back still to photochemical oxidant standards in the

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[7] *Compare* EPA's Greenbook, available at http://www.epa.gov/oaqps001/greenbk/ancl.html (listing Texas counties in nonattainment for the 2008 ozone standards), with U.S. Census Bureau, American FactFinder, 2010 Demographic Profile (search population for each county in the nonattainment areas and Texas population), https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. We incorporate by reference all cited documents into these comments

[8] http://www.epa.gov/oaqps001/greenbk/ancl.html (listing Texas counties in nonattainment for the 2015 ozone standard)

[9] *See Wisconsin v. EPA*, Nos. 16-1406, slip op. (D.C. Cir. Sept. 13, 2019) (finding Clean Air Act's Good Neighbor Provision requires upwind states to eliminate their significant contributions to downwind states' nonattainment problems by respective attainment dates); *see also New York v. EPA*, 2019 WL 4804419 (D.C. Cir. Sept. 30, 2019) (vacating EPA rule partially addressing interstate ozone transport obligations under 2008 NAAQS).

[10] American Lung Association, 2019 State of the Air Report, Most Polluted Cities (ranking the Houston area as the 9th most polluted area in the nation), https://www.lung.org/our-initiatives/healthy-air/sota/city-rankings/most-polluted-cities.html.

early 1970's—the Houston area has consistently failed to meet ozone maximum air quality standards designed to protect human health and welfare. Indeed, the same eight counties in the Houston area—Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller—have been designated "nonattainment" under each of EPA's ozone NAAQS, meaning they have had, or have been contributing to, ozone pollution levels that violate health standards for ozone since the 1970s. 40 C.F.R. § 81.344. And air quality monitors throughout the Houston area regularly report exceedances of federal standards.

The Houston area has a long history of missing attainment dates and seeking extensions, even when the area's history and current data call for stronger ozone control measures. Under the 1-hour 1979 and the 1997 8-hour ozone standards, Houston was classified as "severe"—the second worst classification under the Act. 80 Fed. Reg. 12,264, 12,311 app.B (Mar. 6, 2015) ("Implementation Rule" for the 2008 ozone standard). At the time of the implementation of the 2008 ozone standard, the Houston area had still not complied with either the 1979 or the 1997 standards, though its attainment deadline under the 1979 standard passed in 2007. *Id.*; *see also* 42 U.S.C. § 7511(a)(1) tbl.1. At the time of initial classifications for the 2008 ozone standard, Houston was classified as "marginal" but due to persistent poor air quality, and after receiving a one-year extension and lodging a failing bid for a second one-year extension, EPA reclassified it to "moderate" with an attainment date of July 20, 2018. 80 Fed. Reg. 90,207 (Dec. 14, 2016) (reclassifying Houston area from marginal to moderate); *See also* 77 FR 30,160 (May 21, 2012) (setting moderate area attainment date); *see also* 80 FR 12,264, 12,267/3-68/2 (Mar. 6, 2015) (revising attainment deadlines in light of *NRDC v. EPA*, 777 F.3d 456 (D.C. Cir. Dec. 23, 2014)). Now, the Houston area misses yet another attainment date—the "moderate" area attainment date—and thus must be reclassified to "serious" for the 2008 ozone standard with a new attainment date of July 20, 2021. 84 Fed. Reg. 44,238, 44,244/2 (Aug. 23, 2019).

Texas's failing air quality has serious and well-documented health consequences for the nearly 6 million Texans that live in the Houston area. Scientific research continues to strengthen our understanding of the harm that ozone causes to public health. As discussed above, exposure to ozone is connected to a wide range of significant human health impacts including respiratory and cardiovascular harms, premature deaths, perinatal and reproductive impacts, and central nervous system and developmental harms. Serious health impacts have been demonstrated through controlled human exposure, epidemiologic, and toxicological studies.[11] The physiological impacts of ozone exposure are experienced even by healthy individuals

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[11] *See* ISA (2013).

and even at relatively low concentrations of ozone. Moreover, there is a growing body of scientific evidence showing that repeated exposure over time causes additional health impacts, which may be more severe and less likely to be reversible.

For residents of Harris County alone, the consequences of smog are not trivial. Considering the health impacts of smog pollution from oil and gas operations in Harris County between 2016 and 2017, the Clean Air Task force found that children missed 9,954 days of school—over 27 years of education lost—and suffered from 13,600 asthma attacks. Seniors restricted their activities on 25,724 days.[12] These are just quantified examples the many ways quality of life is diminished by poor air quality for the millions of residents of the Houston nonattainment area. And these adverse health consequences are not evenly felt in the population, as discussed below, historically disenfranchised communities suffer the brunt of the health effects from this pollution.

C. Ozone Pollution Disproportionately Harms Low Resource Communities and Communities of Color in the Houston Nonattainment Area.

The acute harms of ozone pollution in the Houston nonattainment area are not felt evenly, numerous studies and data demonstrate that low resource communities and communities of color bear a higher burden. For example, in the historic Harrisburg and Manchester neighborhoods in east Houston, 97% of residents are people of color, 90% are low income, and 37% live in poverty.[13] Overall, there is a concentration of major industrial sources of air pollution in such communities. *Id.* at 3-6, 13. As of 2016, 26 Risk Management Plan industrial facilities—facilities that handle extremely hazardous substances and must report their emissions to the EPA's Toxic Release Inventory—operate in Manchester. *Id.* at 19. Major industrial sources, like those, are among the types of sources that are subject to requirements for Clean Air Act controls in the Texas SIP.

Focusing on unauthorized emissions of VOCs, a recent study finds that these environmental justice communities concentrated around the Houston Ship Channel are disproportionately affected by unauthorized emissions: "unauthorized VOC emissions…are most prevalent in the area around the Ship Channel," and "vulnerable populations experience greater emissions densities (on average) than their more

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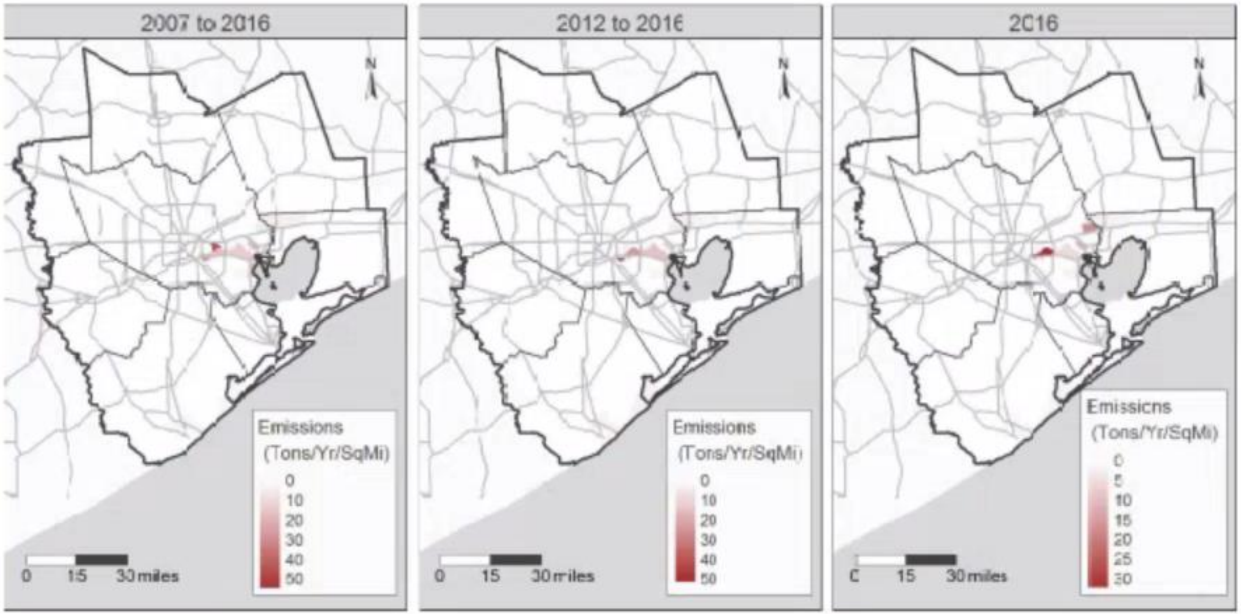
[12] The Oil and Gas Threat Map (search Harris County) (last visited October 28, 2019), https://oilandgasthreatmap.com/threat-map/.

[13] Center for Democracy at the Union of Concerned Scientists, *Double Jeopardy in Houston, Acute and Chronic Chemical Exposures Pose Disproportionate Risks for Marginalized Communities* 5-6 (Oct. 2016), https://www.ucsusa.org/sites/default/files/attach/2016/10/ucs-double-jeopardy-in-houston-full-report-2016.pdf (*Double Jeopardy*).

advantaged counterparts…due to the greater severity of emissions burdens that vulnerable populations bear when they live in tracts with emissions.”[14] The maps below illustrate the existing disparity:



Unauthorized VOC Emission in the Eight County Houston Region. *Id.* at 25 fig. 5.

These VOCs include chemicals that are extremely dangerous on their own, like the listed hazardous air pollutants benzene, toluene, and formaldehyde. *See* 40 C.F.R. § 51.100(s) (defining VOC as “any compound of carbon, excluding [certain compounds], which participates in atmospheric photochemical reactions”); EPA, Technical Overview of Volatile Organic Compounds, http://www.epa.gov/indoor-air-quality-iaq/technical-overview-volatile-organic-compounds (discussing benzene, formaldehyde, and toluene as examples of VOCs); 42 U.S.C. § 7412(b)(1) (listing all three compounds as hazardous air pollutants). VOCs are also stored in above-ground storage tanks, the same kind of tanks that recently caught on fire within the nonattainment area at the Deer Park Intercontinental Terminal Company facility and darkened the sky over Houston in a cloud of smoke laced with toxic chemicals like toluene, benzene, and butane.[15]

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[14] Sustainable Systems Research, LLC, *Evaluation of Vulnerability and Stationary Source Pollution in Houston* (“2019 Houston Vulnerability Study”) at 22 (Feb. 8, 2019), Attachment 1; *see also id.* at 23 tbl.5 (providing statistics).

[15] Letter, Toby Baker, Executive Director, TCEQ to Hon. Ron Reynolds, TX House of Representatives (Apr. 17, 2019), https://www.tceq.texas.gov/assets/public/response/smoke/correspondence/response-letter-to-Representative-Reynolds.pdf.

"The Houston Ship Channel is home to a number of environmental justice communities where long-term exposure to pollution already increases cancer risk by a factor of 1000. Levels of 1,3-butadiene and benzene, both carcinogenic VOCs and other precursor pollutants associated with formation of ground-level ozone, have been monitored for several years along the Houston Ship Channel. In the case of 1,3-Butadiene, a recent epidemiological investigation confirmed a trend of increased incidence of any type of leukemia in children living in parts of Harris County with higher average ambient air 1,3-butadiene concentrations compared to children living in areas of Harris County with lower concentrations of the pollutant. For children living near the Houston Ship Channel, there is a noted increase in the incidence rate of acute lymphocytic leukemia."[16]

And the disproportionate pollution harming Manchester and other Houston Ship Channel communities goes beyond ozone's toxic VOC precursors to particulate matter, and others. For example, spikes from so-called malfunctions of all types of air pollutants contribute to chronic health risks. 2019 Houston Vulnerability Study 22. In the Harrisburg and Manchester communities, "[l]ong-term daily exposures to air pollution can lead to health effects that go unaddressed due to residents' limited financial and health care resources." *Double Jeopardy* at 6. Today, Manchester experiences among the greatest vulnerability from air emissions by surrounding industrial polluters. 2019 Houston Vulnerability Study 25. Other communities of color, especially in eastern portions of Houston-Galveston-Brazoria ozone nonattainment area, bear a similar disproportionate emissions burden, including Pleasantville, Fifth Ward, Pasadena, Clinton Park, Galena Park, Deer Park, and Baytown. The map below illustrates high concentrations of people of color in eastern portions of the nonattainment area and their greater vulnerability to a variety of air pollutants discussed in the attached study.

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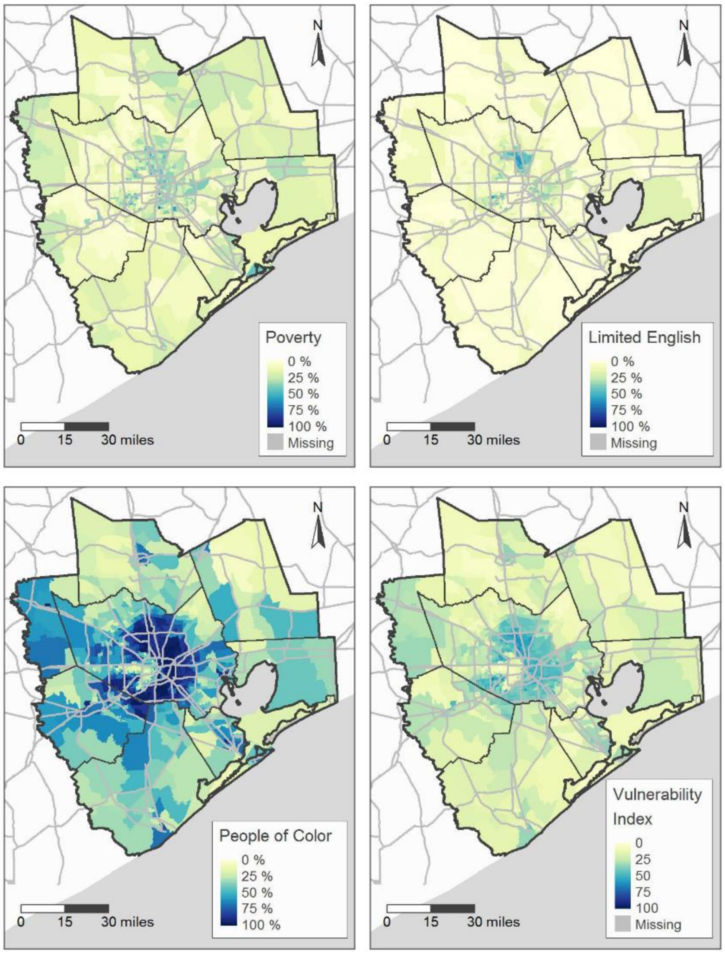
[16] Brief of Caring for Pasadena Communities as Amicus Curiae p. 14, *Sierra Club v. EPA*, Nos. 15-1465 & 19-1024 (D.C. Cir. filed Jul 22, 2019) (internal citation omitted) (Commenters adopt amici's disproportionality arguments and supporting materials cited), Attachment 2.



Vulnerability in the Eight County Houston Region. *Id.* at 19.

II. THE PROPOSED RULE IS ILLEGAL AND ARBITRARY.

A. The Plan Fails to Demonstrate Timely Attainment as Required by the Clean Air Act.

The attainment demonstration SIP fails to show timely attainment of the 2008 ozone health standard by 2020 as required by the Clean Air and EPA rules. TCEQ's own model shows a 2020 design value of 76 ppb which does not meet the 2008 standard of 75 ppb. TCEQ attempts to use a "weight of evidence" analysis to overcome this modeling result, but that analysis is deficient and simply not credible. The actual monitored design value for the Houston-Galveston-Brazoria (HGB) area as of 2018 was 78 ppb, and monitoring data for 2019 shows continued high ozone levels. According to TCEQ data[17], multiple monitoring locations have already recorded fourth-highest 8-

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[17] posted at https://www.tceq.texas.gov/cgi-bin/compliance/monops/8hr_exceed.pl.

hour ozone levels well in excess of 75 ppb this year, with the highest of these being 81 ppb.[18]

Trend data also refutes TCEQ's weight of evidence analysis. Design values show repeated violations of the 2008 NAAQS over recent years, with a value of 81 ppb as recently as the 2015-17 period. Contrary to TCEQ's assertions there is not a downward trend in the most recent years, but rather a repeated recurrence of levels in excess of the standard, alternating between higher and lower exceedances. Three of the past five design value periods have shown values of 80 ppb or higher. The following are design values reported for HGB for the periods 2007-09 through 2016-2018 respectively (in ppb):[19]

84 84 89 88 87 80 80 79 81 78

The data thus do not support a conclusion that the modeling is overpredicting ozone levels for 2020. If anything, the model is likely underpredicting ozone levels.
We also have concerns about TCEQ's use of outdated vehicle registration data to calculate mobile source emission inventories relied on in the model. The vehicle registration data used to calculate attainment and reasonable further progress in these SIPs are from the year 2014. Vehicle registration data is available to the public and is being updated daily by the Texas Department of Motor Vehicles. TCEQ must use the latest available data.

B. The Proposed Rule violates Title VI of the Civil Rights Act of 1964 and EPA's implementing civil rights regulations.

Finalizing a plan without stronger emission control measures where data demonstrate disproportionate harm and an area's air quality data models for NAAQS nonattainment by the attainment date is contrary to Title VI of the Civil Rights Act of 1964. Title VI of the Civil Rights Act of 1964 prohibits recipients of federal funds from discriminating against individuals on the basis of race, color, or national origin. 42 U.S.C. § 2000d. Title VI directs federal agencies granting federal assistance to issue regulations to achieve the statutory objectives. *Id*. § 2000d-1. EPA's implementing regulations state that "[n]o person shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving

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[18] *See* attached summary sheet, Attachment 3.

[19] Data from EPA, Ozone Design Values, 2018 (XLSX) (973 K, 7/23/2019); https://www.epa.gov/air-trends/air-quality-design-values#report.

EPA assistance on the basis of race, color, [or] national origin[.]" 40 C.F.R. § 7.30. The regulations also provide a non-exclusive list of specific, prohibited discriminatory acts:

> (b) A recipient shall not use criteria or methods of administering its program or activity which have the effect of subjecting individuals to discrimination because of their race, color, national origin, or sex, or have the effect of defeating or substantially impairing accomplishment of the objectives of the program or activity with respect to individuals of a particular race, color, national origin, or sex.

Id. § 7.35. Federal-funding recipients cannot "[r]estrict a person in any way in the enjoyment of any advantage or privilege enjoyed by others receiving any service, aid, or benefit provided by the program or activity." *Id.* § 7.35(a)(3).

The Proposed Rule violates Title VI of the Civil Rights Act of 1964 and EPA's implementing regulations. By TCEQ's own data, the Houston area is set to fail its serious area attainment deadline because its current design value exceeds the 2008 ozone NAAQS.[20] As discussed above, studies and data demonstrate that air pollution, and specifically ozone pollution and ozone precursor pollution, disproportionally harm people of color in the Houston nonattainment area. TCEQ's foot-dragging in implementing stronger emission controls in the face of this persistent smog problem prolongs the disproportionate pollution burden people of color in the Houston area suffer. This means that people of color in the Houston area enjoy the outdoors less and suffer more the health consequences of persistent air quality when compared to white Houston area residents.[21]

There are several measures TCEQ could take through this SIP revision to ameliorate the historic disproportionate harm to people of color. TCEQ should require implementation of available Reasonably Available Control Measures and Reasonably Available Control Measures, as required by the Act and discussed below. The agency could also revoke Texas's affirmative defense provision for startup, shut down, and malfunction events prior EPA's finalization of the proposed withdraw of finding of substantial inadequacy (84 Fed. Reg. 17,986 (Apr. 29, 2019))—a policy that, when in use, allowed polluters to claim the defense and avoid enforcement for approximately 97% of

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[20] Proposed Rule ES-1 ("The peak ozone design value for the HGB nonattainment area is projected to be 76 ppb in 2020…").

[21] *See Double Jeopardy* comparing Harrisburg/Manchester to predominantly white neighborhoods in Houston.

unauthorized releases.[22] This would help address some of the disproportionate VOC emissions burden borne by Houston Ship Channel communities, specifically discussed above.

Further, the Commission could extend the comment period, hold another public hearing, and provide *meaningful* opportunities for public participation for the most affected residents of the Houston nonattainment area. The Commission held a public hearing on Monday, October 14, 2019 at 2p.m. at the Houston Texas Department of Transportation office, and another in Arlington on October 17 under similar circumstances. This is hearing did not provide the public a meaningful opportunity to participate. For example, a government-issued identification card is required to enter this building and it is accessible only through very limited public transportation, creating unnecessary roadblocks for elderly residents, disabled persons, youth advocates who must attend school, and undocumented persons who may lack government-issued identification.[23] Using public transportation, it would take someone living in Manchester over an hour and a half to travel to this building. Further, by some measures, Houston has been named the most diverse city in the nation, with over 140 languages spoken by its residents[24], meaning, that TCEQ's English-only public hearing notice is wholly inept at garnering public participation in this part of Texas.[25]

Given the area's history of missing attainment dates and with modeled nonattainment for the serious area attainment deadline, TCEQ failure to implement enhanced emission control measures perpetuates the disproportionate harm borne by people of color in the Houston area in violation of Title VI and EPA's implementing regulations.

C. TCEQ's failure to implement Reasonably Available Control Measures in the Houston area is unlawful and arbitrary under Clean Air Act § 172(c)(1).

TCEQ's failure to implement all reasonably available control measures ("RACM") because it purportedly cannot implement measures by the next ozone

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[22] *See* 84 Fed. Reg. 17,986, Docket No. EPA-R06-OAR-2018-0770, Comments of Environmental and Community Group Coalition 1-2.

[23] One's status in this country is irrelevant to participation in SIP revisions or any other environmental permitting or rulemaking action before the TCEQ.

[24] Bryan Kirk, Houston Named the Most Diverse City in the U.S. in Recent Survey (Apr. 10, 2019), https://patch.com/texas/houston/houston-named-most-diverse-city-u-s-recent-survey.

[25] TCEQ, Notice of Public Hearing on Proposed Revisions to 30 Texas Administrative Code Chapters 115 and 117 and to the State Implementation Plan, https://www.tceq.texas.gov/assets/public/legal/rules/hearings/19075115_phn_HGB.pdf.

season plainly violates the Act. Under Act requirements, Texas must implement all available RACM and RACT controls through this SIP revision.[26]

RACM are an independent requirement on all nonattainment areas that that imposes a duty to adopt **all** reasonable available control measures as expeditiously as practicable. 42 U.S.C. § 7502(c)(1); *see also Ober v. Whitman*, 243 F.3d 1190 (9th Cir. 2001). The RACM requirement is an overarching requirement on states to implement reasonable measures as a means of meeting and maintaining standards. *See Sierra Club v. EPA*, 291 F.3d 155, 162 (D.C. Cir. 2002).

RACM determinations submitted to EPA for review must be supported by adequate analysis and data. *See Ober,* 243 F.3d at 1195 (*quoting American Lung Ass'n v. EPA,* 134 F.3d 388, 392–93 (D.C. Cir. 1998)). States must "consider all available control measures and [] adopt and implement such measures as are reasonably available for implementation in the areas as components of the area's attainment demonstration." General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990, 57 Fed. Reg. 13,498, 13,560/2 (Apr. 16, 1992). EPA has provided guidance to states on what constitutes RACM. *See* 74 Fed. Reg. 2945, 2951/3 (Jan. 16, 2009) (for the 1997 ozone NAAQS). Here, TCEQ has failed to conduct a thorough review of all available RACMs. It has rejected stronger RACMs without reasoned explanation. TCEQ has also failed to consider all ozone controls adopted in the South Coast Air Quality management District in California, or recommended by the Ozone Transport Commission in the Northeast, or identified in EPA guidance. Nor has TCEQ fully evaluated the transportation control measures identified in Clean Air Act section 108(f) and in EPA guidance elaborating on those measures.

TCEQ's failure to implement even a single new RACM in the Houston area, despite modeling nonattainment, is contrary to the Clean Air Act. Quite simply, TCEQ does not have discretion to delay additional RACM that are needed to timely attain. TCEQ claims that RACM measures "would have to be in place no later than the beginning of ozone season in the attainment year to be considered RACM, or January 1, 2020." Proposed Rule 4-10. But TCEQ has not even tried to show it cannot implement additional RACM in time to produce attainment in the 2020 ozone season. Nor has it demonstrated that timely implementation of sufficient measures is impossible. Even if it could, the claim that Texas cannot implement any new RACM in Houston because of

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[26] Dr. Ranajit Sahu, Comments on the Reasonably Available Control Technology (RACT) and Reasonably Available Control Measures (RACM) for the 2008 Ozone NAAQS Attainment SIP Modifications Proposed by the Texas Commission on Environmental Quality (TCEQ) for the Houston-Galveston-Brazoria (HGB) and Dallas-Fort Worth (DFW) Non-Attainment Areas (Oct. 28, 2019) ("Sahu Report"), Attachment 4.

TCEQ's "inability to implement control measures early enough to advance attainment of the 2008 eight-hour ozone NAAQS" impermissibly renders the RACM requirement void. *Id.* By this logic, TCEQ may perpetually short shrifts the Act's RACM requirement — even as the area stands to be reclassified to severe due to persistent smog pollution. Moreover, the claim is simply not credible. As documented in the Sahu Report filed herewith, there are numerous RACM and RACT measures that can be implemented in very short order to curb emissions of ozone precursors.

Texas must implement RACT and RACM as part of this reclassification because it is likely that Houston will fail to meet its serious area attainment date. The Houston area currently models nonattainment of the 2008 ozone NAAQS and there is a strong likelihood that it will fail to meet its serious area attainment deadline, as discussed above. Under this likely scenario, the Houston area is reclassified to severe, and its attainment date is extended by six years to July 20, 2027, 42 U.S.C. § 7511(a)(1) tbl.1, and the last set of air quality data that could be used to demonstrate attainment with this deadline is the ozone season ending on July 20, 2026. Within six months of the passage of the attainment date, or by January 20, 2022, EPA must determine whether the Houston area attained the 2008 ozone NAAQS by the serious area attainment date or reclassify the area to severe. *See* 42 U.S.C. § 7511(b)(2)(A), (B). But EPA is frequently tardy in carrying out this nondiscretionary duty. *See Center for Biological Diversity v. EPA*, 3:19-cv-2462-RS (N.D.C.A.) (case filed May 7, 2019) (lawsuit regarding EPA's failure to finalize attainment determinations by the Act's deadlines). At the time of Houston's serious area reclassification, the EPA Administrator used his discretion to set a SIP revision due date, including RACT measures, of August 3, 2020, approximately one year prior to the serious area attainment date of July 20, 2021 and one year after the effective date of the rule. 84 Fed. Reg. 44,245/3.[27] Without stronger RACM and RACT requirements in this SIP revision, the Houston area will fail to timely attain the serious area attainment deadline, and – under TCEQ's approach – may not see new control measures for the 2008 ozone NAAQS until 2024 or later—where any new measures would provide two-years' worth or less of emission reduction benefits to demonstrate severe area attainment. This outcome is absurd and runs contrary to the carefully designed framework for timely attainment prescribed by the Clean Air Act.

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[27] EPA's discretion-based SIP submittal date does not excuse Texas from adopting all RACM and RACT necessary to attain the 2008 standard by the 2020 ozone season. There, Texas cannot wait until August 2020 to adopt and implement all the measures needed to ensure timely attainment in 2020.

D. TCEQ arbitrarily disregards Reasonably Available Control Technology.

TCEQ claims that, based on its flawed framework, RACT measures are simply not available – TCEQ's contentions lack support in the record. The agency claims that existing Texas Administrative Code provisions regarding NOx and VOC controls "continue to fulfill [] RACT requirements for the HGB serious ozone nonattainment area under the 2008 eight-hour ozone NAAQS" and that additional controls for "certain major sources were determined to be either not economically feasible or not technologically feasible." Proposed Rule 4-7 to -8. Yet, based on independent research and TCEQ's own appendices to the Proposed Rule, Commenters' expert was able to identify numerous cost effective RACT measures for NOx and VOC sources that are easily implementable before the next ozone season.[28] TCEQ's reluctance to implement any new RACT measures through this SIP revision arbitrarily disregards this Clean Air Act requirement.

Moderate and higher ozone nonattainment areas must develop plans that implement "reasonably available control technology under [42 U.S.C. §] 7502(c)(1)" for "all…major stationary sources of [volatile organic compounds]" and NO_x. 42 U.S.C. § 7511a(b)(2), (f). Revisions to SIPs must include EPA-issued control technique guidelines ("CTGs") and alternative control techniques ("ACTs") for major sources of VOCs and NOx. RACT "defines the lowest limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility." Memorandum from R. Strelow, Asst. Adm'r, EPA, Office or Air and Waste Management, to Reg'l Adm'rs, EPA Regions I-X, re: *Guidance for Determining Acceptability of SIP Regulations in Non-Attainment Areas* 2 (Dec. 9, 1976) ("Strelow Memo"). RACT "means devices, systems, process modifications, or other apparatus or techniques that are reasonably available taking into account: (1) [t]he necessity of imposing such controls in order to attain and maintain a national air quality standard; (2) [t]he social, environmental, and economic impact of such controls; and (3) [a]lternative means of providing for attainment and maintenance of such standard [for requests for deadline extensions]." 40 C.F.R. § 51.100(o).

"RACT encompasses stringent, or even 'technology forcing,' requirement[s]." Strelow Memo 2; *See also Whitman v. Am. Trucking Ass'ns*, 531 U.S. 457, 492 (2001) (Breyer, J. concurring) (noting that technology forcing requirements "are still paramount in today's [Clean Air] Act"). "In every case RACT should represent the toughest controls considering technological and economic feasibility that can be applied to a specific situation. Anything less than this is by definition less than RACT and not

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[28] Sahu Report at 9-20.

acceptable for areas where it is not possible to demonstrate attainment[.]" Strelow Memo 3.

In support of timely attainment, RACT determinations must be made and implemented quickly. *See Miss. Comm'n on Envtl. Quality v. EPA*, 790 F.3d 138, 146 (D.C. Cir. 2015). In SIP revisions, States must submit supporting evidence with their RACT determinations. *NRDC v. EPA*, 571 F.3d 1245, 1254 (D.C. Cir. 2009); *see, e.g.*, 80 Fed. Reg. 12, 264, 12,278/2-80/2 (Mar. 6, 2015). States cannot rely on RACT determinations for previous ozone standards without explanation as to the continued adequacy of the RACT measures. *See* 81 Fed. Reg. 58,010, 58,037/3 (Aug. 24, 2016). The Act provides states with "discretion to require beyond-RACT reductions from any source" because "it may be necessary in some cases for states to achieve 'beyond RACT' reductions in order to demonstrate attainment as expeditiously as practicable." 80 Fed. Reg. 12,279/3.

"Past experience has shown that due to ongoing innovation, cost-effective control technologies and processes alternatives for many sectors continue to be developed…." *Id.* EPA guidance requires states to use information available at the time the RACT SIPs are developed. For example, ACTs, public comments, other relevant information. *See, e.g.,* 80 Fed. Reg. at 12,279/2. Even where ACTs and CTGs may be dated, EPA says that there is other information that is current from which states can provide adequate analysis. *Id.*; 78 Fed. Reg. 34,178, 34,192/2-3 (June 6, 2013). Thus, ACTs and CTGs may not themselves set firm RACT requirements.

Texas must require new RACT in Houston now because the Act so requires, because the area is on track to fail the serious area attainment date and there are stronger RACT measures available. Commenters' expert, Dr. Ranajit Sahu, outlines numerous RACT measures available for implementation that could reduce NOx and VOC emissions, and address the disproportionate burden on environmental justice communities within the nonattainment area. The single largest source of NOx emissions (by a factor of 10) in the Houston area is the W.A. Parish power plant. At this plant, gas-fired units actually emit more NOx than the coal units. Dr. Sahu identifies additional controls, such as "low-NOx burners, or ultra low NOx burners, SNCR, and SCR [selective catalytic reduction]"[29] for these highly polluting units. At the W.A. Parish coal units, new RACT measures appear even more readily accessible, including "properly maintaining and operating already in-place SCIRs for these units" along with other measures.[30]

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[29] Sahu Report at 15.

[30] *Id.*

TCEQ must implement new RACT and RACM measures for refineries because these are readily available. Refineries are large contributors to the ozone problem in Houston and a source of significant disproportionate impacts for environmental communities in the area. Typical reasonably available controls for refineries include "a combination of ultra low NOx burners/FGR/SNCR or ultra low NOx burners/SCR"[31] yet TCEQ does not propose these as RACM or RACT. Measures that do not require long lead times include "better maintenance or proactive replacement of equipment" to prevent and detect leaks of VOCs, also not proposed by TCEQ.[32] There are also readily available RACM and RACT measures for storage tanks at these refineries . Among other things, TCEQ must require all high vapor products "stored in internal floating roof or fixed roof tanks –[be] connected to a vapor recovery or vapor control system with a specified (and verifiable) capture and/or control efficiency of at least 99%."[33] Dr. Sahu demonstrates that there are storage tanks permitted for operation by TCEQ that achieve this level of efficiency; also available are "carbon adsorbers and concentrators (for vapor recovery), and/or catalytic oxidizers and regenerative thermal oxidizers (RTOs) (for destruction of vapors)."[34] TCEQ's RACT and RACM analysis fails to address available NOx and VOC emission reductions available from refinery and storage tank sources.

Additional details for these and other RACT and RACM measures are identified and explained in Dr. Sahu's discussion.

In sum, the Act does not allow TCEQ to disregard and refuse to adopt additional RACM and RACT. Such additional measures are required by the Act, and are necessary to ensure attainment as expeditiously as practicable.

Sincerely,

Isabel G. Segarra Treviño
David Baron
Earthjustice, Washington, D.C. Office
1625 Massachusetts Ave., NW, Ste. 702
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isegarra@earthjustice.org
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[31] *Id.* at 18.

[32] *Id.*

[33] *Id.* at 20.

[34] *Id.*

INDEX OF ORAL TESTIMONY

NO ORAL COMMENTS WERE RECEIVED PERTAINING TO THIS SIP REVISION.

Texas Commission on Environmental Quality
Public Hearing Registration

Date: October 14, 2019
Time: 2:00 p.m.

Project Nos.: 2019-075-115-AI, 2019-074-117-AI, 2019-077-SIP-NR, and 2019-079-SIP-NR

Short Title: VOC RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications, NO_x RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications, HGB 2008 Eight-Hour Ozone Serious Classification AD SIP Revision, and the DFW and HGB 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision

Location: Texas Department of Transportation Auditorium, 7600 Washington Avenue, Houston, TX

Concerning: Proposed revisions to 30 TAC Chapters 115 and 117 and proposed HGB area serious classification SIP revisions for the 2008 eight-hour ozone standard.

Name **(Please Print)**	Representing	Presenting Oral Testimony? **(Circle One)**
ISAAC DESOUZA	COH - HHD	Yes [✓ No]
Dave Ramold	BACT Resources	Yes [✓ No]
Andrew DeCardis	H - GAC	Yes [✓ No]
Sandra Holliday	H-GAC	Yes [✓ No]
Jeffrey English	TxDOT - HOU	Yes [✓ No]
Gilbert Washington	H-GAC	Yes [✓ No]
Charles Airiohuodion	TxDOT	Yes [✓ No]

Texas Commission on Environmental Quality

HEARING OFFICER REPORT

I am the hearing officer assigned to conduct the public hearing regarding the proposed Houston-Galveston Brazoria (HGB) 2008 Eight-Hour Ozone Serious Classification Attainment Demonstration State Implementation Plan (SIP) Revision (Project No. 2019-077-SIP-NR); Dallas-Fort Worth (DFW) and HGB 2008 Eight-Hour Ozone Serious Classification Reasonable Further Progress SIP Revision (Project No. 2019-079-SIP-NR); Nitrogen Oxides Reasonably Available Control Technology (RACT) Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications (Rule Project No. 2019-074-117-AI); and Volatile Organic Compounds RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications (Rule Project No. 2019-075-115-AI).

A public hearing was scheduled for October 14, 2019 at 2:00 p.m. in the Texas Department of Transportation auditorium at 7600 Washington Avenue, Houston, Texas, 77007.

At 1:30 p.m., the room was open and TCEQ staff members were available to discuss the proposals. At 2:00 p.m., TCEQ staff were present and ready to open the hearing for public comment. After waiting for 30 minutes, no one had arrived to make comments on the record. Therefore, the public hearing was not formally opened for comment and a transcript was not prepared.

Alison Stokes, Hearing Officer

10/16/2019

Date signed

Texas Commission on Environmental Quality

Public Hearing Registration

Date: October 17, 2019
Time: 2:00 p.m.

Project Nos.: 2019-075-115-AI, 2019-074-117-AI, 2019-078-SIP-NR, and 2019-079-SIP-NR

Short Title: VOC RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications, NO_x RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications, DFW 2008 Eight-Hour Ozone Serious Classification AD SIP Revision, and the DFW and HGB 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision

Location: Arlington City Council Chambers, 101 W. Abram St., Arlington, TX 76010

Concerning: Proposed revisions to 30 TAC Chapters 115 and 117 and proposed DFW serious classification SIP revisions for the 2008 eight-hour ozone standard.

Name **(Please Print)**	Representing	Presenting Oral Testimony? **(Circle One)**
Roja Haritha Gangupomu	TCEQ	**Yes [✓ No]**
Carl Young	EPA	**Yes [✓ No]**
Erik Snyder	EPA	**Yes [✓ No]**
Jenny Narvaez	NCTCOG	**Yes [✓ No]**
Vivek THIMMAVAJJHALA	NCTCOG	**Yes [✓ No]**
Mohammad Al Hweil	TxDOT-FTW	**Yes [✓ No]**
Brittany Wells	City of Dallas	**Yes [✓ No]**

Texas Commission on Environmental Quality

Public Hearing Registration

Date: October 17, 2019
Time: 2:00 p.m.

Project Nos.: 2019-075-115-AI, 2019-074-117-AI, 2019-078-SIP-NR, and 2019-079-SIP-NR

Short Title: VOC RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications, NO_x RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications, DFW 2008 Eight-Hour Ozone Serious Classification AD SIP Revision, and the DFW and HGB 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision

Location: Arlington City Council Chambers, 101 W. Abram St., Arlington, TX 76010

Concerning: Proposed revisions to 30 TAC Chapters 115 and 117 and proposed DFW serious classification SIP revisions for the 2008 eight-hour ozone standard.

Name **(Please Print)**	Representing	Presenting Oral Testimony? **(Circle One)**
Kevin Overton	City of Dallas	Yes [✓ No]
Robert Todd	EPA - R6	Yes [✓ No]
Zoe Bolack	DFW Airport	Yes [✓ No]
Esther Chitsinde	DFW Airport	Yes [✓ No]
Sarah Ziomek	DFW Airport	Yes [✓ No]
Mike Galizio	Tarrant County	Yes [✓ No]
		Yes No

Texas Commission on Environmental Quality

THE STATE OF TEXAS

HEARING OFFICER REPORT

I am the hearing officer assigned to conduct the public hearing regarding the proposed Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Serious Classification Attainment Demonstration State Implementation Plan (SIP) Revision (Project No. 2019-078-SIP-NR); DFW and Houston-Galveston-Brazoria (HGB) 2008 Eight-Hour Ozone Serious Classification Reasonable Further Progress SIP Revision (Project No. 2019-079-SIP-NR); Nitrogen Oxides Reasonably Available Control Technology (RACT) Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications (Rule Project No. 2019-074-117-AI); and Volatile Organic Compounds RACT Rules for the HGB and DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassifications (Rule Project No. 2019-075-115-AI).

A public hearing was scheduled for October 17, 2019 at 2:00 p.m. in the Arlington City Council Chambers at 101 W. Abram Street, Arlington, Texas, 76004.

At 1:30 p.m., the room was open and TCEQ staff members were available to discuss the proposals. At 2:00 p.m., TCEQ staff were present and ready to open the hearing for public comment. After waiting for 30 minutes, no one had arrived to make comments on the record. Therefore, the public hearing was not formally opened for comment and a transcript was not prepared.

Kristin Jacobsen, Hearing Officer

10/29/19

Date signed

EVALUATION OF TESTIMONY

Texas Commission on Environmental Quality
Interoffice Memorandum

To: Commissioners **Date:** February 14, 2020

Thru: Bridget C. Bohac, Chief Clerk
Toby Baker, Executive Director

From: Tonya Baer, Deputy Director
Office of Air

Docket No.: 2019-0660-SIP

Subject: Commission Adoption of the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) Serious Classification Reasonable Further Progress (RFP) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone Standard Nonattainment Area

DFW and HGB 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision
Non-Rule Project No. 2019-079-SIP-NR

Background and reason(s) for the SIP revision:
The DFW 2008 eight-hour ozone serious nonattainment area, consisting of Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties, along with the HGB 2008 eight-hour ozone serious nonattainment area, consisting of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties, were previously classified as moderate nonattainment for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) of 0.075 parts per million (ppm) with a July 20, 2018 attainment date. Based on monitoring data from 2015, 2016, and 2017, neither the DFW area nor the HGB area attained the 2008 eight-hour ozone NAAQS in 2017,[1] and neither qualified for a one-year attainment date extension in accordance with Federal Clean Air Act (FCAA), §181(a)(5).[2] On August 23, 2019, the United States Environmental Protection Agency (EPA) published the final notice reclassifying the DFW and HGB nonattainment area from moderate to serious for the 2008 eight-hour ozone NAAQS, effective on September 23, 2019 (84 *Federal Register* (FR) 44238).

Since the DFW and HGB areas have been reclassified by the EPA, they are now subject to the serious nonattainment area requirements in FCAA, §182(c), and the Texas Commission on Environmental Quality (TCEQ) is required to submit serious classification attainment demonstration (AD) and RFP SIP revisions to the EPA. As indicated in the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) published on March 6, 2015, the attainment date for a serious

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[1] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment deadline.

[2] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 parts per billion (ppb)). The DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor (C63/C679). The DFW area's design value for 2017 was 79 ppb. The HGB area's fourth highest daily maximum eight-hour average for 2017 was 79 ppb as measured at the Conroe Relocated monitor (C78/A321). The HGB area's design value for 2017 was 81 ppb.

classification is July 20, 2021 with a 2020 attainment year (80 FR 12264). The EPA set an August 3, 2020 deadline for states to submit AD and RFP SIP revisions to address the 2008 eight-hour ozone standard serious nonattainment area requirements.

Scope of the SIP revision:
This SIP revision addresses RFP consistent with FCAA requirements for areas classified as serious nonattainment for the 2008 eight-hour ozone NAAQS. The details of the AD SIP revisions, also required for each area, are covered in separate memos (Project No. 2019-078-SIP-NR and 2019-077-SIP-NR).

A.) Summary of what the SIP revision will do:
This RFP SIP revision demonstrates that the DFW and HGB 2008 eight-hour ozone nonattainment areas will achieve emissions reductions in ozone precursors (volatile organic compounds (VOC) and/or nitrogen oxides (NO_x) consistent with the serious ozone nonattainment area requirements of FCAA, §182(c)(2)(B) and the 2008 eight-hour ozone standard SIP requirements rule according to the following increments:

- a 9% emissions reduction in NO_x and/or VOC for all counties in each area for the three-year period from January 1, 2018 through December 31, 2020; and
- a 3% emissions reduction in NO_x and/or VOC for the one-year period from January 1, 2021 through December 31, 2021 for all counties in each area as an attainment year RFP contingency.

In addition to demonstrating the required emissions reductions, this SIP revision also provides motor vehicle emissions budgets (MVEB) for the 2020 attainment year.

This SIP revision demonstrates RFP for the DFW and HGB serious nonattainment areas for the 2020 attainment year as well as the 2021 contingency year.

B.) Scope required by federal regulations or state statutes:
This RFP SIP revision is required to demonstrate that the DFW and HGB serious nonattainment areas will achieve emissions reductions consistent with the requirements of FCAA, §182(c)(2) and the EPA's 2008 ozone standard SIP requirements rule.

The RFP calculations documented in this SIP revision rely on an RFP base year of 2011 and a 2020 attainment year. This SIP revision includes the required 3% per year emissions reductions for the three-year period from January 1, 2018 through December 31, 2020. This SIP revision also incorporates an additional 3% emissions reduction for the one-year period from January 1, 2021 through December 31, 2021 as contingency to be implemented if the area fails to achieve the targeted RFP emission reductions in 2020.

C.) Additional staff recommendations that are not required by federal rule or state statute:
None.

Statutory authority:
The authority to propose and adopt SIP revisions is derived from the following sections of Texas Health and Safety Code, Chapter 382, Texas Clean Air Act (TCAA), §382.002,

which provides that the policy and purpose of the TCAA is to safeguard the state's air resources from pollution; §382.011, which authorizes the commission to control the quality of the state's air; and §382.012, which authorizes the commission to prepare and develop a general, comprehensive plan for the control of the state's air. This RFP SIP revision is required by FCAA, §110(a)(1) and implementing rules in 40 Code of Federal Regulations Part 51.

Effect on the:
A.) Regulated community:
The DFW and HGB RFP SIP revision sets 2020 NO_X and VOC MVEBs for the 2020 attainment year for both nonattainment areas, which could, if found adequate or approved by the EPA, affect transportation planning conducted by local governments in both the DFW and HGB areas.

B.) Public:
The DFW and HGB RFP SIP revision does not require rulemaking for additional emissions reductions but does set MVEBs that could impact transportation planning and citizens in both the DFW and HGB areas. The general public in the DFW area may benefit from reduced ground-level ozone concentrations due to reduced emissions of ozone precursors documented in this RFP SIP revision.

C.) Agency programs:
The DFW and HGB RFP SIP revision has no new impact on agency programs.

Stakeholder meetings:
The proposed SIP revision went through a public review and comment period including two public hearings.

Public comment:
The public comment period opened on September 13, 2019 and closed on October 28, 2019. The commission offered two public hearings for the proposed SIP Revision. The first was held in Houston on October 14, 2019 and the second was held in Arlington on October 17, 2019. Notice of the public hearings was published in the *Texas Register* and the *Dallas Morning News*, and *Houston Chronicle* newspapers. TCEQ staff were present and ready to open both hearings for public comment; however, no attendees arrived to make comments on the record at either hearing. Therefore, the public hearings were not formally opened for comment and a transcript was not prepared.

During the comment period, staff received a comment from Earthjustice on behalf of Achieving Community Tasks Successfully, Air Alliance Houston, Earthjustice, Sierra Club, and Texas Environmental Justice Advocacy Services, concerning the use of 2014 vehicle registration data to develop the HGB area on-road emissions inventories. A summary of this comment and the TCEQ response is provided as part of this SIP revision in the Response to Comments.

Significant changes from proposal:
None.

Potential controversial concerns and legislative interest:
Although the EPA finalized its 2015 eight-hour ozone standard SIP requirements rule (83 FR 25776), the final rule did not revoke the 2008 eight-hour ozone standard. The EPA stated that revocation of the 2008 eight-hour ozone standard would be addressed in a separate future action. However, because of the February 16, 2018 United States Court of Appeals for the District of Columbia Circuit opinion in the case *South Coast Air Quality Management District v. EPA, 882 F.3d 1138 (D.C. Cir. 2018)*, the requirement for the EPA to reclassify the area and for the TCEQ to submit this RFP SIP revision is expected to remain even if the 2008 eight-hour ozone standard is revoked.

Does this SIP revision affect any current policies or require development of new policies?
No.

What are the consequences if this SIP revision does not go forward? Are there alternatives to this SIP revision?
The commission could choose to not comply with requirements to develop and submit this RFP SIP revision to the EPA. If the DFW and HGB RFP SIP revision is not submitted, the EPA could impose sanctions on the state and promulgate a federal implementation plan (FIP). Sanctions could include transportation funding restrictions, grant withholding, and 2-to-1 emissions offset requirements for new construction and major modifications of stationary sources in the DFW and HGB nonattainment areas. The EPA could impose such sanctions and implement a FIP until the state submitted, and the EPA approved, a replacement DFW and HGB 2008 eight-hour ozone RFP SIP revision for the area.

Key points in the SIP revision adoption schedule:
Anticipated adoption date: March 4, 2020
EPA due date: August 3, 2020

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Jamie Zech
Terry Salem

RESPONSE TO COMMENTS RECEIVED CONCERNING THE DALLAS-FORT WORTH (DFW) AND HOUSTON-GALVESTON-BRAZORIA (HGB) SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS (RFP) STATE IMPLEMENTATION PLAN (SIP) REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

The Texas Commission on Environmental Quality (commission or TCEQ) offered two public hearings; one in Houston on October 14, 2019, at 2:00 p.m. and the other in Arlington on October 17, 2019, at 2:00 p.m. TCEQ staff were present and ready to open both hearings for public comment; however, no attendees arrived to make comments on the record at either hearing. Therefore, the public hearings were not formally opened for comment. During the comment period, which closed on October 28, 2019, the commission received a comment from Earthjustice on behalf of Achieving Community Tasks Successfully, Air Alliance Houston, Earthjustice, Sierra Club, and Texas Environmental Justice Advocacy Services (Earthjustice).

In this response to comments, the commission uses "HGB area" to refer to the 2008 eight-hour ozone nonattainment area, consisting of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties, unless otherwise specified.

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GENERAL COMMENTS

Earthjustice commented that 2014 vehicle registration data were used to calculate RFP for the HGB area and that the vehicle registration data used to develop the HGB area on-road emissions inventories should be based on a more recent calendar year than 2014. Earthjustice noted that the vehicle registration database is updated on a daily basis.

The TCEQ agrees that, in most circumstances, using the most recent, Texas-specific, quality-assured vehicle registration data is the best approach when developing representative age distribution inputs for future year on-road emissions inventories. The on-road emissions inventories for this DFW and HGB RFP SIP revision were under development in late 2018 and early 2019. During the development of the RFP on-road inventories, the TCEQ evaluated the results of 2018 registration database queries. A quality assurance review of the data queried identified problems, including significant errors in vehicle counts, trailers identified as on-road vehicles, and potential data duplication that prevented the development of representative vehicle population and age distribution inputs. Since registration database queries are "snapshots" taken at a point in time, a retroactive 2018 mid-year query could not be performed. This left the 2014 Texas-specific registration data as the most recent, quality-assured data; therefore, the TCEQ elected to use the 2014 data for this DFW and HGB RFP SIP revision.

STAFF
RECOMMENDATION
(INCLUDING ORDER)

REVISIONS TO THE STATE OF TEXAS AIR QUALITY IMPLEMENTATION PLAN FOR THE CONTROL OF OZONE AIR POLLUTION

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA 2008 EIGHT-HOUR OZONE STANDARD NONATTAINMENT AREAS

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
P.O. BOX 13087
AUSTIN, TEXAS 78711-3087

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Adoption
March 4, 2020

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EXECUTIVE SUMMARY

The 1990 Federal Clean Air Act (FCAA) Amendments, §182, require ozone nonattainment areas designated with a classification of moderate or higher to submit plans showing reasonable further progress (RFP) toward attainment of the ozone National Ambient Air Quality Standard (NAAQS). On March 27, 2008, the United States Environmental Protection Agency (EPA) published a final rule revising the eight-hour ozone standard from 0.08 parts per million (ppm) to 0.075 ppm (73 *Federal Register* (FR) 16436). On May 21, 2012, the EPA published final designations for the 2008 eight-hour ozone standard with an effective date of July 20, 2012 (77 FR 30088). The EPA designated a 10-county Dallas-Fort Worth (DFW) area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties) as nonattainment with a moderate classification. The EPA designated an eight-county Houston-Galveston-Brazoria (HGB) area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) as nonattainment with a marginal classification. The HGB area was later reclassified from marginal to moderate nonattainment effective December 14, 2016 (published on December 14, 2016 (81 FR 90207)). The Texas Commission on Environmental Quality (TCEQ) adopted a moderate classification RFP SIP revision for the DFW area on June 3, 2015 and for the HGB area on December 15, 2016. The EPA published final approval of the DFW moderate classification RFP SIP revision on December 7, 2016 (81 FR 88124) and published final approval of the HGB moderate classification RFP SIP revision on February 13, 2019 (84 FR 3708).

As indicated in the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) published on March 6, 2015, the attainment date for the moderate classification was July 20, 2018 with a 2017 attainment year (80 FR 12264). Based on monitoring data from 2015, 2016, and 2017, neither the DFW area nor the HGB area attained the 2008 eight-hour ozone NAAQS in 2017,[1] and neither qualified for a one-year attainment date extension in accordance with FCAA, §181(a)(5).[2] On August 23, 2019, the EPA published the final notice reclassifying the DFW and HGB nonattainment areas from moderate to serious for the 2008 eight-hour ozone NAAQS, effective September 23, 2019 (84 FR 44238).

Since the DFW and HGB areas have been reclassified by the EPA, they are now subject to the serious ozone nonattainment area requirements in FCAA, §182(c), and the TCEQ is required to submit serious classification attainment demonstration (AD) and RFP SIP revisions to the EPA. According to the final 2008 eight-hour ozone standard SIP requirements rule, the attainment date for a serious classification is July 20, 2021 with a 2020 attainment year (80 FR 12264). The EPA set an August 3, 2020 deadline for

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[1] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment deadline.

[2] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 ppb). The DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor (C63/C679). The DFW area's design value for 2017 was 79 ppb. The HGB area's fourth highest daily maximum eight-hour average for 2017 was 79 ppb as measured at the Conroe Relocated monitor (C78/A321). The HGB area's design value for 2017 was 81 ppb.

states to submit AD and RFP SIP revisions to address the 2008 eight-hour ozone standard serious nonattainment area requirements.

This RFP SIP revision is not required to demonstrate attainment of the 2008 eight-hour ozone NAAQS but rather to demonstrate that the DFW and HGB nonattainment areas will meet the RFP requirements for serious ozone nonattainment areas. RFP requirements for serious ozone nonattainment areas, as specified in Section 182(c)(2) of the 1990 FCAA Amendments and in 40 CFR §51.910, involve reducing ozone precursor emissions (nitrogen oxides (NO_X) and volatile organic compounds (VOC)) at annual increments between the base year and the attainment year.

This RFP SIP revision demonstrates that the DFW and HGB nonattainment areas will achieve emissions reductions in NO_X and/or VOC consistent with the serious ozone nonattainment area requirements of FCAA, §182(c)(2)(B) and the 2008 eight-hour ozone standard SIP requirements rule according to the following increments:

- a 9% emissions reduction in NO_X and/or VOC for all counties in each area for the three-year period from January 1, 2018 through December 31, 2020; and
- a 3% emissions reduction in NO_X and/or VOC for the one-year period from January 1, 2021 through December 31, 2021 for all counties in each area as an attainment year RFP contingency.

The RFP methodology involves development of the base year, attainment year, and contingency year emissions inventories, and emissions reductions for each analysis year. The amount of emissions reductions is determined through the RFP methodology. Once calculated, the target levels and emissions inventories can be compared to determine if the forecasted controlled (post-control) emissions inventories are less than the target level, thus meeting FCAA RFP requirements. The results of the DFW RFP analysis-year comparisons are provided in Chapter 3: *Progress Toward Meeting Target Emissions Levels*.

In addition to demonstrating the required emissions reductions, this SIP revision also sets 2020 NO_X and VOC motor vehicle emissions budgets (MVEBs) for transportation conformity purposes, as detailed in Chapter 5: *Motor Vehicle Emissions Budget*. An MVEB is the on-road mobile source allocation of the total allowable emissions for each applicable criteria pollutant or precursor, as defined in the SIP. Transportation conformity determinations must be performed using the budget test once the EPA determines the budget adequate for transportation conformity purposes. To pass the budget test, areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the applicable MVEB for the established year.

This SIP revision demonstrates RFP for the DFW and HGB serious nonattainment areas for the 2020 attainment year as well as the 2021 contingency year.

SECTION V-A: LEGAL AUTHORITY

General

The Texas Commission on Environmental Quality (TCEQ) has the legal authority to implement, maintain, and enforce the National Ambient Air Quality Standards (NAAQS) and to control the quality of the state's air, including maintaining adequate visibility.

The first air pollution control act, known as the Clean Air Act of Texas, was passed by the Texas Legislature in 1965. In 1967, the Clean Air Act of Texas was superseded by a more comprehensive statute, the Texas Clean Air Act (TCAA), found in Article 4477-5, Vernon's Texas Civil Statutes. The legislature amended the TCAA in 1969, 1971, 1973, 1979, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015, and 2017. In 1989, the TCAA was codified as Chapter 382 of the Texas Health and Safety Code.

Originally, the TCAA stated that the Texas Air Control Board (TACB) was the state air pollution control agency and was the principal authority in the state on matters relating to the quality of air resources. In 1991, the legislature abolished the TACB effective September 1, 1993, and its powers, duties, responsibilities, and functions were transferred to the Texas Natural Resource Conservation Commission (TNRCC). In 2001, the 77th Texas Legislature continued the existence of the TNRCC until September 1, 2013 and changed the name of the TNRCC to the TCEQ. In 2009, the 81st Texas Legislature, during a special session, amended section 5.014 of the Texas Water Code, changing the expiration date of the TCEQ to September 1, 2011, unless continued in existence by the Texas Sunset Act. In 2011, the 82nd Texas Legislature continued the existence of the TCEQ until 2023. With the creation of the TNRCC, (and its successor the TCEQ), the authority over air quality is found in both the Texas Water Code and the TCAA. Specifically, the authority of the TCEQ is found in Chapters 5 and 7. Chapter 5, Subchapters A - F, H - J, and L, include the general provisions, organization, and general powers and duties of the TCEQ, and the responsibilities and authority of the executive director. Chapter 5 also authorizes the TCEQ to implement action when emergency conditions arise and to conduct hearings. Chapter 7 gives the TCEQ enforcement authority.

The TCAA specifically authorizes the TCEQ to establish the level of quality to be maintained in the state's air and to control the quality of the state's air by preparing and developing a general, comprehensive plan. The TCAA, Subchapters A - D, also authorizes the TCEQ to collect information to enable the commission to develop an inventory of emissions; to conduct research and investigations; to enter property and examine records; to prescribe monitoring requirements; to institute enforcement proceedings; to enter into contracts and execute instruments; to formulate rules; to issue orders taking into consideration factors bearing upon health, welfare, social and economic factors, and practicability and reasonableness; to conduct hearings; to establish air quality control regions; to encourage cooperation with citizens' groups and other agencies and political subdivisions of the state as well as with industries and the federal government; and to establish and operate a system of permits for construction or modification of facilities.

Local government authority is found in Subchapter E of the TCAA. Local governments have the same power as the TCEQ to enter property and make inspections. They also may make recommendations to the commission concerning any action of the TCEQ that affects their territorial jurisdiction, may bring enforcement actions, and may execute cooperative agreements with the TCEQ or other local governments. In addition, a city or town may enact and enforce ordinances for the control and abatement of air pollution not inconsistent with the provisions of the TCAA and the rules or orders of the commission.

Subchapters G and H of the TCAA authorize the TCEQ to establish vehicle inspection and maintenance programs in certain areas of the state consistent with the requirements of the Federal Clean Air Act; coordinate with federal, state, and local transportation planning agencies to develop and implement transportation programs and measures necessary to attain and maintain the NAAQS; establish gasoline volatility and low emission diesel standards; and fund and authorize participating counties to implement vehicle repair assistance, retrofit, and accelerated vehicle retirement programs.

Applicable Law

The following statutes and rules provide necessary authority to adopt and implement the state implementation plan (SIP). The rules listed below have previously been submitted as part of the SIP.

Statutes

All sections of each subchapter are included, unless otherwise noted.

TEXAS HEALTH & SAFETY CODE, Chapter 382	September 1, 2019
TEXAS WATER CODE	September 1, 2019

Chapter 5: Texas Natural Resource Conservation Commission
- Subchapter A: General Provisions
- Subchapter B: Organization of the Texas Natural Resource Conservation Commission
- Subchapter C: Texas Natural Resource Conservation Commission
- Subchapter D: General Powers and Duties of the Commission
- Subchapter E: Administrative Provisions for Commission
- Subchapter F: Executive Director (except §§5.225, 5.226, 5.227, 5.2275, 5.231, 5.232, and 5.236)
- Subchapter H: Delegation of Hearings
- Subchapter I: Judicial Review
- Subchapter J: Consolidated Permit Processing
- Subchapter L: Emergency and Temporary Orders (§§5.514, 5.5145, and 5.515 only)
- Subchapter M: Environmental Permitting Procedures (§5.558 only)

Chapter 7: Enforcement
- Subchapter A: General Provisions (§§7.001, 7.002, 7.0025, 7.004, and 7.005 only)
- Subchapter B: Corrective Action and Injunctive Relief (§7.032 only)
- Subchapter C: Administrative Penalties
- Subchapter D: Civil Penalties (except §7.109)
- Subchapter E: Criminal Offenses and Penalties: §§7.177, 7.179-7.183

Rules

All of the following rules are found in 30 Texas Administrative Code, as of the following latest effective dates:

Chapter 7: Memoranda of Understanding, §§7.110 and 7.119	December 13, 1996 and August 22, 2019
Chapter 19: Electronic Reporting	November 11, 2010
Chapter 35: Emergency and Temporary Orders and Permits; Temporary Suspension or Amendment of Permit Conditions	
Subchapter A: Purpose, Applicability, and Definitions	December 10, 1998
Subchapter B: Authority of Executive Director	December 10, 1998
Subchapter C: General Provisions	March 24, 2016
Subchapter K: Air Orders	July 20, 2006
Chapter 39: Public Notice	
Subchapter H: Applicability and General Provisions, §§39.402(a)(1) - (6), (8), and (10) - (12), 39.405(f)(3) and (g), (h)(1)(A) - (4), (6), (8) - (11), (i) and (j), 39.407, 39.409, 39.411(a), (e)(1) - (4)(A)(i) and (iii), (4)(B), (5)(A) and (B), and (6) - (10), (11)(A)(i) and (iii) and (iv), (11)(B) - (F), (13) and (15), and (f)(1) - (8), (g) and (h), 39.418(a), (b)(2)(A), (b)(3), and (c), 39.419(e), 39.420 (c)(1)(A) - (D)(i)(I) and (II), (D)(ii), (c)(2), (d) - (e), and (h), and Subchapter K: Public Notice of Air Quality Permit Applications, §§39.601 - 39.605	May 31, 2018
Chapter 55: Requests for Reconsideration and Contested Case Hearings; Public Comment, all of the chapter except §55.125(a)(5) and (6)	May 31, 2018
Chapter 101: General Air Quality Rules	October 12, 2017
Chapter 106: Permits by Rule, Subchapter A	July 19, 2018
Chapter 111: Control of Air Pollution from Visible Emissions and Particulate Matter	August 3, 2017
Chapter 112: Control of Air Pollution from Sulfur Compounds	July 16, 1997
Chapter 113: Standards of Performance for Hazardous Air Pollutants and for Designated Facilities and Pollutants	December 29, 2016
Chapter 114: Control of Air Pollution from Motor Vehicles	April 26, 2018
Chapter 115: Control of Air Pollution from Volatile Organic Compounds	January 5, 2017
Chapter 116: Control of Air Pollution by Permits for New Construction or Modification	November 22, 2018

Chapter 117: Control of Air Pollution from Nitrogen Compounds	June 25, 2015
Chapter 118: Control of Air Pollution Episodes	May 26, 1989
Chapter 122: §122.122: Potential to Emit	February 23, 2017
Chapter 122: §122.215: Minor Permit Revisions	June 3, 2001
Chapter 122: §122.216: Applications for Minor Permit Revisions	June 3, 2001
Chapter 122: §122.217: Procedures for Minor Permit Revisions	December 11, 2002
Chapter 122: §122.218: Minor Permit Revision Procedures for Permit Revisions Involving the Use of Economic Incentives, Marketable Permits, and Emissions Trading	June 3, 2001

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  2. Houston-Galveston-Brazoria (Revised)
  3. Beaumont-Port Arthur (No change)
  4. El Paso (No change)
  5. Regional Strategies (No change)
  6. Northeast Texas (No change)
  7. Austin Area (No change)
  8. San Antonio Area (No change)
  9. Victoria Area (No change)
C. Particulate Matter (No change)
D. Carbon Monoxide (No change)
E. Lead (No change)
F. Oxides of Nitrogen (No change)
G. Sulfur Dioxide (No change)
H. Conformity with the National Ambient Air Quality Standards (No change)
I. Site Specific (No change)
J. Mobile Sources Strategies (No change)
K. Clean Air Interstate Rule (No change)
L. Transport (No change)
M. Regional Haze (No change)

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ABY	adjusted base year
AD	attainment demonstration
AERR	Air Emissions Reporting Requirements
APU	auxiliary power unit
ASLRRA	American Short Line and Regional Railroad Association
BY	Base Year
CFR	Code of Federal Regulations
CMV	commercial marine vessel
DFW	Dallas-Fort Worth
EDMS	Emission and Dispersion Modeling System
EI	emissions inventory
EIA	United States Energy Information Administration
EPA	United States Environmental Protection Agency
ERG	Eastern Research Group
FAA	Federal Aviation Administration
FCAA	Federal Clean Air Act
FMVCP	Federal Motor Vehicle Control Program
FR	*Federal Register*
GSE	ground support equipment
HGB	Houston-Galveston-Brazoria
I/M	inspection and maintenance
MOVES	Motor Vehicle Emissions Simulator
MVEB	motor vehicle emissions budget
NAAQS	National Ambient Air Quality Standard
NCTCOG	North Central Texas Council of Governments
NEI	National Emissions Inventory
NO_x	nitrogen oxides
ppb	parts per billion
ppm	parts per million
PN	percent of NO_x
PV	percent of VOC
RFG	reformulated gasoline

RFP	reasonable further progress
ROP	rate of progress
RRC	Railroad Commission of Texas
SCC	source classification code
SI	spark ignition
SIP	state implementation plan
STARS	State of Texas Air Reporting System
TAC	Texas Administrative Code
TACB	Texas Air Control Board
TCAA	Texas Clean Air Act
TCEQ	Texas Commission on Environmental Quality (commission)
TDM	travel demand model
TexN	Texas NONROAD Model
TNRCC	Texas Natural Resource Conservation Commission
tpd	tons per day
TTI	Texas A&M Transportation Institute
TxLED	Texas Low Emission Diesel
VMT	vehicle miles traveled
VOC	volatile organic compounds

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Appendix 14	Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories

CHAPTER 1: GENERAL

1.1 REASONABLE FURTHER PROGRESS (RFP) BACKGROUND

Information on the Texas State Implementation Plan (SIP) and a list of SIP revisions and other air quality plans adopted by the commission can be found on the Texas State Implementation Plan webpage (http://www.tceq.texas.gov/airquality/sip) on the Texas Commission on Environmental Quality's (TCEQ) website (http://www.tceq.texas.gov/).

1.1.1 One-Hour Ozone National Ambient Air Quality Standard (NAAQS)

On February 8, 1979, the United States Environmental Protection Agency (EPA) set the one-hour ozone standard at 0.12 parts per million (ppm) (44 *Federal Register* (FR) 8202). A design value of 0.124 ppm, or 124 parts per billion (ppb), would round down and meet the NAAQS while a design value of 0.125 ppm, or 125 ppb, would round up and exceed the NAAQS. Because of these rounding conventions, the one-hour ozone NAAQS of 0.12 ppm is commonly referenced as 124 ppb. Violation of the one-hour ozone NAAQS is based on the maximum number of expected exceedances over all the monitors in an area with a threshold of 1.0 expected exceedances per year averaged over a three-year period. The one-hour ozone NAAQS was revoked on June 15, 2005 (69 FR 23951).

1.1.1.1 Dallas-Fort Worth (DFW) One-Hour Ozone NAAQS History

Under the one-hour ozone NAAQS of 0.12 ppm, the EPA designated a four-county DFW area (Collin, Dallas, Denton, and Tarrant Counties) as moderate nonattainment in 1991 with an attainment date of November 15, 1996. The Texas Natural Resources Conservation Commission (TNRCC), a predecessor to the TCEQ, adopted a rate-of-progress (ROP) SIP revision on July 24, 1996, which demonstrated a 15% reduction in volatile organic compounds (VOC) emissions between 1990 and 1996 for the DFW one-hour ozone moderate nonattainment area. The EPA fully approved the ROP SIP revision on April 12, 2005 (70 FR 18993).

On February 18, 1998, the EPA published a final determination that the DFW one-hour ozone moderate nonattainment area failed to attain the standard by the November 15, 1996 attainment date (63 FR 8128). The EPA reclassified the four-county DFW nonattainment area from moderate to serious, effective March 20, 1998, and established a new attainment date of November 15, 1999. On October 15, 1999, the TNRCC adopted a 9% ROP SIP revision for the DFW serious nonattainment area that included emissions reductions necessary to complete the ROP requirements for the years between 1996 and 1999. The EPA approved the 9% ROP SIP revision on January 12, 2000 (65 FR 1862).

In June 2005, the one-hour ozone standard was revoked after being replaced by the more stringent 1997 eight-hour ozone standard. By 2006, certified ambient monitoring data reflected attainment of the one-hour ozone standard. On October 16, 2008, the EPA published a final determination that the DFW one-hour ozone nonattainment area (Collin, Dallas, Denton, and Tarrant Counties) had attained the one-hour ozone standard with a design value of 124 ppb, based on certified 2004 through 2006 ambient monitoring data (73 FR 61357).

On August 18, 2015, the TCEQ submitted a Redesignation Substitute Report for the DFW area for the one-hour ozone standard. This report fulfilled the EPA's redesignation substitute requirements in its *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) to lift anti-backsliding obligations under a revoked ozone NAAQS by ensuring that specific redesignation requirements are met for the DFW area under the revoked standard (78 FR 34178). This redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. On November 8, 2016, the EPA published its final approval of the DFW area redesignation substitute for the one-hour ozone and 1997 eight-hour ozone NAAQS, effective December 8, 2016 (81 FR 78688).

1.1.1.2 Houston-Galveston-Brazoria (HGB) One-Hour Ozone NAAQS History

Under the one-hour ozone NAAQS of 0.12 ppm, the EPA designated an eight-county HGB area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) as a severe-17 nonattainment area in 1991 with an attainment date of November 15, 2007.

The TNRCC adopted an ROP SIP revision on December 6, 2000. The ROP SIP revision provided emissions inventories; ROP analyses for 2002, 2005, and 2007; and motor vehicle emissions budgets (MVEB) for nitrogen oxides (NO_X) and VOC. On September 26, 2001, the Follow-Up One-Hour Ozone Attainment Demonstration and ROP SIP Revision was adopted. This revision incorporated changes to several control strategies and described how the state would fulfill the commitment to obtain the additional emission reductions necessary to address the remainder of the emission reductions shortfall and demonstrate attainment of the one-hour ozone standard in the HGB area. On November 14, 2001, the EPA approved both the December 2000 and September 2001 SIP revisions (66 FR 57159).

On October 27, 2004, the commission adopted the HGB One-Hour Ozone Post-1999 ROP SIP Revision. This revision provided updated emissions inventories and ROP analyses for 2002, 2005, and 2007 and revised MVEBs for the HGB area based on new models for estimating on-road and non-road mobile emissions sources. The SIP revision replaced the previous versions of the Post-1999 ROP that the EPA approved in November 2001. On February 14, 2005, the EPA approved the HGB One-Hour Ozone Post-1999 ROP SIP revision (70 FR 7407).

In June 2005, the one-hour ozone standard was revoked after being replaced by the more stringent 1997 eight-hour ozone standard. Although the EPA revoked the one-hour ozone NAAQS, former one-hour ozone NAAQS nonattainment areas remain subject to certain anti-backsliding requirements. The HGB area failed to attain the one-hour ozone standard by the November 15, 2007 attainment deadline, as required in 1991. On June 19, 2012, the EPA published a failure-to-attain determination effective July 19, 2012 (77 FR 36400).

As part of the transition to the 1997 eight-hour ozone standard, the EPA created a submittal termed a termination determination to address anti-backsliding requirements for the one-hour ozone standard. In May 2010, the TCEQ requested a determination regarding termination of the one-hour ozone anti-backsliding obligations associated with the transition from the one-hour ozone standard to the 1997 eight-hour ozone standard. As a result of court action, the EPA was unable to propose approval of the request.

The HGB area demonstrated attainment of the one-hour ozone NAAQS based on 2011 through 2013 monitoring data. On May 30, 2014, the EPA concurred that the data met all the quality requirements, and that the HGB area met the one-hour ozone standard.[3] On July 22, 2014, the TCEQ submitted a Redesignation Substitute Report for the HGB One-Hour Ozone Standard Nonattainment Area. This report fulfilled the EPA's redesignation substitute requirements in its 2008 eight-hour ozone standard SIP requirements rule to lift anti-backsliding obligations for the revoked one-hour ozone NAAQS by ensuring that specific redesignation requirements are met for the HGB area under the revoked standard (78 FR 34178). The redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. On October 20, 2015, the EPA approved the one-hour ozone HGB redesignation substitute demonstration effective November 19, 2015 (80 FR 63429).

1.1.2 1997 Eight-Hour Ozone NAAQS

On July 18, 1997, the EPA revised the NAAQS for ground-level ozone effective September 16, 1997 (62 FR 38856). The EPA phased out and replaced the previous one-hour ozone NAAQS with an eight-hour NAAQS set at 0.08 ppm based on the three-year average of the annual fourth-highest daily maximum eight-hour average ozone concentrations measured at each monitor within an area. A design value of 0.084 ppm, or 84 ppb, would round down and meet the NAAQS while a design value of 0.085 ppm, or 85 ppb, would round up and exceed the NAAQS. Because of these rounding conventions, the 1997 eight-hour ozone NAAQS is commonly referenced as 84 ppb. The EPA revoked the 1997 eight-hour ozone standard in its 2008 eight-hour ozone standard SIP requirements rule, effective April 6, 2015 (80 FR 12264).

1.1.2.1 DFW 1997 Eight-Hour Ozone NAAQS History

On April 30, 2004, nonattainment area designations were published as part of the first phase of the EPA's implementation rule for the 1997 eight-hour ozone standard, effective June 15, 2004 (69 FR 23936). The DFW nonattainment area was redefined as Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties. The DFW 1997 eight-hour ozone nonattainment area was classified as a moderate, with an attainment date of June 15, 2010. The TCEQ was required to submit an RFP SIP revision to the EPA for the DFW eight-hour ozone nonattainment area by June 15, 2007.

The second phase of EPA's implementation rule for the 1997 eight-hour ozone standard established RFP submittal guidelines that required nonattainment areas partially composed of one-hour ozone standard nonattainment areas with approved 15% ROP SIP revisions, like the DFW area, to choose between two options (70 FR 71612). The first option was to submit a 1997 eight-hour ozone standard RFP SIP revision demonstrating 15% VOC emissions reductions for the entire eight-hour

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[3] Mark Hansen, Acting Associate Director for Air Programs, EPA. Letter to Richard A. Hyde, Executive Director, TCEQ. May 30, 2014

nonattainment area. The second option was to submit a 1997 eight-hour ozone standard RFP SIP revision demonstrating 15% VOC emissions reductions for the newly designated portion of the eight-hour nonattainment area and VOC and/or NO_X emissions reductions for the portion of the nonattainment area containing an approved one-hour ozone standard 15% ROP SIP revision. On May 23, 2007, the commission adopted the 2007 Dallas-Fort Worth Eight-Hour Ozone Nonattainment Area Reasonable Further Progress State Implementation Plan Revision (Project No. 2006-031-SIP-NR) based on the second option. Since Collin, Dallas, Denton, and Tarrant Counties already had an approved plan containing the 15% VOC-only emissions reduction, only the five newly designated counties were required to demonstrate a 15% VOC reduction, while the one-hour ozone nonattainment counties were permitted to substitute NO_X for VOC. The EPA approved the 1997 eight-hour ozone RFP SIP revision for the DFW nonattainment area on October 7, 2008 (73 FR 58475), including the 15% VOC-only emissions reduction for the newly designated counties.

The DFW area failed to meet the June 15, 2010 attainment deadline under its moderate classification. Effective January 19, 2011, the EPA published a final determination of failure to attain and reclassification of the DFW area from a moderate to a serious nonattainment area for the 1997 eight-hour ozone standard (75 FR 79302). The EPA set January 19, 2012 as the deadline for Texas to submit attainment demonstration and RFP SIP revisions addressing the serious ozone nonattainment area requirements of the Federal Clean Air Act (FCAA).

On December 7, 2011, the TCEQ adopted the 2011 DFW 1997 Eight-Hour Ozone RFP SIP Revision (Project No. 2010-023-SIP-NR). The 2011 RFP SIP revision demonstrated a 9% emissions reduction between 2008 and 2011 and a 3% emissions reduction between 2011 and 2012 and also included MVEBs for each milestone year and a contingency plan. The 2011 RFP SIP revision used the EPA's Motor Vehicle Emission Simulator (MOVES) model to develop the base year and milestone year on-road mobile emissions inventories and the milestone year MVEBs. The EPA published final approval of the 2011 DFW RFP SIP revision on November 12, 2014 (79 FR 67068).

Under the serious classification, the DFW nonattainment area was given until June 15, 2013 to attain the 1997 eight-hour ozone NAAQS. The area did not monitor attainment by that date but at the end of the 2014 ozone season, the eight-hour design value was 81 ppb, based on 2012, 2013, and 2014 air monitoring data, which is in attainment of the 1997 eight-hour ozone standard. On February 24, 2015, the TCEQ submitted early certification of 2014 ozone air monitoring data to the EPA along with a request for a determination of attainment for the 1997 eight-hour ozone standard for the DFW area. On September 1, 2015, the EPA published a determination of attainment for the DFW 1997 eight-hour ozone nonattainment area (80 FR 52630).

On August 18, 2015, the TCEQ submitted a Redesignation Substitute Report for the DFW 1997 Eight-Hour Ozone Standard Nonattainment Area, which fulfilled the EPA's redesignation substitute requirements in its 2008 eight-hour ozone standard SIP requirements rule to lift anti-backsliding obligations for the revoked 1997 eight-hour ozone NAAQS by ensuring that specific redesignation requirements are met for the DFW area under the revoked standard. The redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. On November 8, 2016, the EPA approved the 1997 eight-hour ozone DFW redesignation substitute demonstration effective December 8, 2016 (81 FR 78688).

1.1.2.2 HGB 1997 Eight-Hour Ozone NAAQS History

Effective June 15, 2004, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties were designated nonattainment in the first phase of the EPA's implementation rule for the 1997 eight-hour ozone NAAQS (69 FR 23951). The HGB area was classified moderate nonattainment for the standard, with an attainment deadline of June 15, 2010. The TCEQ was required to submit an RFP SIP revision for the 1997 eight-hour ozone NAAQS to the EPA by June 15, 2007. The commission adopted the 2007 HGB 1997 Eight-Hour Ozone Nonattainment Area RFP SIP revision on May 23, 2007, which demonstrated that a required 15% emissions reduction in ozone precursors (NO_x and VOC) would be met for the 2001 through 2008 RFP analysis period. On April 22, 2009, the EPA published approval of the RFP SIP revision, the associated MVEBs, and the 2002 base year emissions inventory (EI) (74 FR 18298).

On June 15, 2007, the state requested that the HGB area be reclassified from a moderate to a severe nonattainment area for the 1997 eight-hour ozone NAAQS, with an attainment deadline of June 15, 2019. On December 31, 2007, the EPA published its proposal to grant the governor's request and took comments on a range of dates for the state to submit a revised SIP (72 FR 74252). The TCEQ provided comments to the EPA that supported the reclassification and justification for an April 2010 SIP submission date. On October 1, 2008, the EPA published approval of the governor's request to voluntarily reclassify the HGB ozone nonattainment area from a moderate to a severe nonattainment area for the 1997 eight-hour ozone NAAQS (73 FR 56983), effective October 31, 2008. The EPA set April 15, 2010 as the date for the state to submit a SIP revision addressing the severe-ozone nonattainment requirements and set a new attainment deadline of June 15, 2019.

The 2010 HGB 1997 Eight-Hour Ozone RFP SIP Revision, as required by the EPA, demonstrated an 18% emissions reduction occurred for the 2002 through 2008 RFP analysis period and that an average of 3% per year emissions reduction would occur between each of the analysis years 2008, 2011, 2014, 2017, and 2018. The RFP SIP revision established baseline emission levels, calculated reduction targets, identified control strategies to meet emission target levels, and tracked actual emission reductions against established emissions growth. This revision also included an MVEB for each analysis year and a contingency plan.

On January 25, 2011, the EPA published a notice of its determination that the MVEBs in the March 10, 2010 SIP revisions, which were developed using the on-road mobile source emissions inventories based on the EPA’s MOBILE 6.2 model, were adequate for transportation conformity purposes (76 FR 4342). On January 2, 2014, the EPA published approval of the RFP SIP revision (79 FR 51). On April 23, 2013, the commission adopted the 2013 HGB 1997 Eight-Hour Ozone MVEB SIP Revision. The SIP revision updated on-road mobile source emissions inventories and MVEBs for the HGB area using the MOVES2010a version of the EPA's mobile emissions estimation model. The 2013 MVEB SIP revision also met the primary obligation of the mid-course review commitment in the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision by demonstrating that the outstanding 3% contingency requirement was fulfilled. Updated on-road inventories and emissions analysis based on the EPA's August 30, 2012 vehicle miles traveled offset guidance and a modified version of the MOVES model demonstrated compliance with FCAA requirements for transportation control measures in severe nonattainment areas.

On January 2, 2014, the EPA published approval of this 2013 HGB 1997 Eight-Hour Ozone MVEB SIP Revision along with its approval of the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision (79 FR 57). On March 6, 2015, the EPA revoked the 1997 eight-hour ozone NAAQS, effective April 6, 2015 (80 FR 12264).

The HGB area monitored attainment of the 1997 eight-hour ozone NAAQS based on 2012 through 2014 monitoring data. In February 2015, the TCEQ submitted certification of 2014 ozone data in support of the TCEQ's subsequent request for a determination of attainment, also known as a clean data determination, for the 1997 eight-hour ozone NAAQS for the HGB area. The EPA published a final determination of attainment for the 1997 eight-hour ozone NAAQS for the HGB area on December 30, 2015 (80 FR 81466).

On August 18, 2015, the TCEQ submitted the Redesignation Substitute Report for the HGB 1997 Eight-Hour Ozone Standard Nonattainment Area, which fulfilled the EPA's redesignation substitute requirements in its 2008 eight-hour ozone standard SIP requirements rule to lift anti-backsliding obligations for the revoked 1997 eight-hour ozone NAAQS by ensuring that specific redesignation requirements are met for the HGB area under the revoked standard. The redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. The EPA approved the 1997 eight-hour ozone HGB redesignation substitute demonstration on November 8, 2016 (81 FR 78691).

1.1.3 Redesignation Request and Maintenance Plan SIP Revisions for the One-Hour and 1997 Eight-Hour Ozone NAAQS

On February 16, 2018, the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit Court) issued an opinion in the case *South Coast Air Quality Management District v. EPA, 882 F.3d 1138 (D.C. Cir. 2018)*. The case was a challenge to the EPA's final 2008 eight-hour ozone standard SIP requirements rule, which revoked the 1997 eight-hour ozone NAAQS as part of the implementation of the more stringent 2008 eight-hour ozone NAAQS. The court's decision vacated parts of the EPA's final 2008 eight-hour ozone standard SIP requirements rule, including the redesignation substitute, removal of anti-backsliding requirements for areas designated nonattainment under the 1997 eight-hour ozone NAAQS, waiver of requirements for transportation conformity for maintenance areas under the 1997 eight-hour ozone NAAQS, and elimination of the requirement to submit a second 10-year maintenance plan.

To address the court's ruling, the commission adopted a formal redesignation request and maintenance plan SIP revision for the one-hour and 1997 eight-hour ozone NAAQS for the HGB area on December 12, 2018 and for the DFW area on March 27, 2019. The SIP revisions included a request that the DFW and HGB area be redesignated to attainment for the revoked one-hour and 1997 eight-hour ozone NAAQS. The SIP revisions also included maintenance plans ensuring the areas remain in attainment of the standards through 2032. The maintenance plans use a 2014 base year inventory and include interim year inventories for 2020 and 2026, establish MVEBs for 2032, and include a contingency plan.

1.1.4 2008 Eight-Hour Ozone NAAQS

On March 27, 2008, the EPA lowered the primary and secondary eight-hour ozone NAAQS to 0.075 ppm or 75 ppb (73 FR 16436). Attainment of the standard (expressed as 0.075 ppm) is achieved when an area's design value does not exceed 75 ppb. On May 21, 2012, the EPA published final designations for the 2008 eight-hour ozone standard with an effective date of July 20, 2012 (77 FR 30088). The EPA's implementation rule for the 2008 eight-hour ozone NAAQS, also published on May 21, 2012 (77 FR 30160), established December 31 of each relevant calendar year as the attainment date for all nonattainment area classification categories.

On June 6, 2013, the EPA published the proposed 2008 eight-hour ozone standard SIP requirements rule (78 FR 34178). The proposed rule addressed SIP requirements, the timing of SIP submissions, revocation of the 1997 eight-hour ozone NAAQS, and anti-backsliding requirements for previous ozone standards.

The D.C. Circuit Court published an opinion on December 23, 2014 agreeing with two challenges to the EPA's May 21, 2012 implementation rule for the 2008 eight-hour ozone NAAQS). The court vacated the provisions of the rule relating to attainment deadlines and revocation of the 1997 eight-hour ozone NAAQS for transportation conformity purposes. As part of the final 2008 eight-hour ozone standard SIP requirements rule, the EPA modified 40 CFR §51.1103 consistent with the D.C. Circuit Court decision to establish attainment dates that run from the effective date of designation, i.e., July 20, 2012, and revoked the 1997 eight-hour ozone NAAQS for all purposes (80 FR 12264).

1.1.4.1 DFW 2008 Eight-Hour Ozone NAAQS History

On May 21, 2012, the EPA designated a 10-county DFW area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties) as nonattainment for the 2008 eight-hour ozone NAAQS with a moderate classification, effective July 20, 2012. The attainment date for the DFW moderate nonattainment area was originally established in the EPA's implementation rule for the 2008 eight-hour ozone NAAQS, published on May 21, 2012, and was set as December 31, 2018 (77 FR 30160). Due to the D.C. Circuit Court ruling, the attainment date changed from December 31, 2018 to July 20, 2018. In addition, because the attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment date, the attainment year for the DFW moderate nonattainment area changed from 2018 to 2017.

On July 2, 2014, the commission adopted a SIP revision to satisfy FCAA, §172(c)(3) and §182(a)(1) EI reporting requirements for the DFW nonattainment area under the 2008 eight-hour ozone standard. The EPA published direct final approval of this SIP revision on February 20, 2015 (80 FR 9204).

To meet FCAA requirements for a moderate ozone nonattainment area, the commission adopted the DFW RFP SIP revision for the 2008 Eight-Hour Ozone NAAQS on June 3, 2015. The SIP revision provided an RFP analysis for a 2017 attainment year, a contingency plan, and 2017 NO_X and VOC MVEBs. The RFP demonstration was made according to the following increments:

- a 15% emissions reduction in VOC for the six-year period from January 1, 2012 through December 31, 2017 for the newly designated one-county portion of the DFW 2008 eight-hour ozone nonattainment area consisting of Wise County;
- a 15% emissions reduction in VOC and/or NO_X for the six-year period from January 1, 2012 through December 31, 2017 for the previously designated nine-county portion of the DFW 2008 eight-hour ozone nonattainment area consisting of Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties; and
- a 3% emissions reduction in VOC and/or NO_X for the one-year period from January 1, 2018 through December 31, 2018 as attainment year RFP contingency for all counties of the DFW 2008 eight-hour ozone nonattainment area.

The 2017 Wise County RFP demonstration in the adopted DFW RFP SIP revision used a transfer of excess VOC reductions from the nine-county area previously designated as nonattainment to the newly designated Wise County. Upon notification that the option to transfer creditable VOC reductions between county groups was no longer available per the EPA's final 2008 eight-hour ozone SIP requirements rule (80 FR 12264), the TCEQ corrected the adopted DFW RFP analyses to remove the VOC reduction transfer and credit emission reductions from drilling rig controls that were available but had not been credited. The corrections were submitted to the EPA in an April 22, 2016 technical supplement.

On December 7, 2016, the EPA published final approval of the DFW RFP SIP revision for the 2008 eight-hour ozone NAAQS (81 FR 88124).

1.1.4.2 HGB 2008 Eight-Hour Ozone NAAQS History

On May 21, 2012, the EPA designated an eight-county HGB area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) as nonattainment for the 2008 eight-hour ozone NAAQS with a marginal classification, effective July 20, 2012. The attainment date for the HGB marginal nonattainment area was originally established in the EPA’s implementation rule for the 2008 eight-hour ozone NAAQS, published on May 21, 2012, and was set as December 31, 2015 (77 FR 30160). Due to the D.C. Circuit Court ruling, the attainment date changed from December 31, 2015 to July 20, 2015. In addition, because the attainment year ozone season is the ozone season immediately preceding a nonattainment area’s attainment date, the attainment year for the HGB marginal nonattainment area changed from 2015 to 2014.

On July 2, 2014, the commission adopted a SIP revision to satisfy FCAA, §172(c)(3) and §182(a)(1) EI reporting requirements for the HGB nonattainment area under the 2008 eight-hour ozone standard. The EPA published direct final approval of this SIP revision on February 20, 2015 (80 FR 9204).

Reclassification to Moderate for the 2008 Eight-Hour Ozone NAAQS

The HGB area did not attain the 2008 eight-hour ozone standard in 2014 but qualified for a one-year attainment date extension in accordance with FCAA, §181(a)(5). On May

4, 2016, the EPA granted a one-year attainment deadline extension for the HGB 2008 eight-hour ozone marginal nonattainment area to July 20, 2016 (81 FR 26697).

Because the HGB area's 2015 design value of 80 ppb exceeded the 2008 eight-hour ozone NAAQS, the EPA published a proposed determination of nonattainment and reclassification of the HGB area from marginal to moderate nonattainment on September 27, 2016 (81 FR 66240). The EPA proposed a January 1, 2017 deadline for the state to submit an attainment demonstration that addresses the 2008 eight-hour ozone NAAQS moderate nonattainment area requirements, including RFP. As indicated in the EPA's 2008 eight-hour ozone standard SIP requirements rule, the attainment deadline for moderate classification was July 20, 2018 with an attainment year of 2017.

On December 15, 2016, the commission adopted the HGB 2008 Eight-Hour Ozone RFP SIP revision to satisfy the requirements of FCAA, §182(b)(1) for moderate ozone nonattainment areas. The SIP revision demonstrated a 15% emissions reduction in ozone precursors from the 2011 base year through the 2017 attainment year, a 3% reduction for contingency in 2018, and set NO_X and VOC MVEBs for the 2017 attainment year. The EPA published final approval of this SIP revision on February 13, 2019 (84 FR 3708).

1.1.4.3 Reclassification to Serious for the 2008 Eight-Hour Ozone NAAQS

With a moderate classification, the DFW and HGB areas had to attain the 2008 eight-hour ozone NAAQS of 0.075 ppm by a July 20, 2018 attainment date. Based on monitoring data from 2015, 2016, and 2017, neither the DFW area nor the HGB area attained the 2008 eight-hour ozone NAAQS in 2017,[4] and neither qualified for a one-year attainment date extension in accordance with FCAA, §181(a)(5).[5] On August 23, 2019, the EPA published the final notice reclassifying the DFW and HGB nonattainment areas from moderate to serious for the 2008 eight-hour ozone NAAQS, effective September 23, 2019 (84 FR 44238).

Since the DFW and HGB areas have been reclassified by the EPA, they are subject to the serious nonattainment area requirements in FCAA, §182(c), and the TCEQ is required to submit serious area RFP SIP revisions to the EPA. As indicated in the EPA's 2008 eight-hour ozone standard SIP requirements rule, published on March 6, 2015 (80 FR 12264), the attainment deadline for a serious classification is July 20, 2021, with an attainment year of 2020.

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[4] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment deadline.

[5] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 ppb). The DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor (C63/C679). The DFW area's design value for 2017 was 79 ppb. The HGB area's fourth highest daily maximum eight-hour average for 2017 was 79 ppb as measured at the Conroe Relocated monitor (C78/A321). The HGB area's design value for 2017 was 81 ppb.

1.2 RFP REQUIREMENTS

The 1990 FCAA amendments, 42 United States Code §7410, require states to submit SIP revisions that contain enforceable measures to achieve the NAAQS. The FCAA also requires states with ozone nonattainment areas classified as moderate or above to submit plans showing reasonable further progress toward attainment. Section 182(b)(1)(A) of the FCAA requires states with ozone nonattainment areas classified as moderate or higher to submit plans providing for a 15% reduction in VOC emissions in those areas. Section 182(c)(2) of the FCAA requires states with ozone nonattainment areas classified as serious or higher to submit plans providing for additional 3% annual combined reductions of NO_X and/or VOC, averaged over three-year increments, until the area's attainment deadline.

For the 2008 eight-hour ozone NAAQS, the TCEQ previously adopted RFP SIP revisions for the DFW and HGB moderate nonattainment areas. The DFW RFP SIP revision adopted on June 3, 2015, demonstrated a 15% emissions reduction in VOC from the 2011 base year through the 2017 attainment year for the newly designated one-county portion of the DFW moderate nonattainment area (Wise County) and a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the previously designated nine-county portion of the DFW moderate nonattainment area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties). The HGB RFP SIP Revision adopted on December 15, 2016 demonstrated a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the eight-county HGB moderate nonattainment area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties).

While emissions and emissions reductions were calculated from 2011 through 2017 for this DFW and HGB serious classification RFP SIP revision, 2017 is not considered an analysis year because the EPA approved the RFP demonstration for the 2017 analysis year for the DFW area on December 7, 2016 (81 FR 88124) and approved the RFP demonstration for the 2017 analysis year for the HGB area on February 13, 2019 (84 FR 3708). This RFP SIP revision demonstrates that the DFW and HGB nonattainment areas will achieve emissions reductions in ozone precursors (NO_X and/or VOC) consistent with the serious ozone nonattainment area requirements of FCAA, §182(c)(2)(B) and the 2008 eight-hour ozone standard SIP requirements rule according to the following increments:

- a 9% emissions reduction in NO_X and/or VOC for all counties in each area for the three-year period from January 1, 2018 through December 31, 2020; and
- a 3% emissions reduction in NO_X and/or VOC for the one-year period from January 1, 2021 through December 31, 2021 for all counties in each area as an attainment year RFP contingency.

In addition to demonstrating the required emissions reductions, this SIP revision also provides MVEBs for the 2020 attainment year.

This SIP revision demonstrates RFP for the DFW and HGB serious nonattainment areas for the 2020 attainment year as well as the 2021 contingency year. A summary of the DFW and HGB areas' progress toward meeting RFP requirements can be found in

Appendix 1*: DFW Reasonable Further Progress Demonstration Spreadsheet* and Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet*.

1.3 PUBLIC HEARING AND COMMENT INFORMATION

The public comment period opened on September 13, 2019, 2019 and closed on October 28, 2019. The commission offered two public hearings for this SIP revision. The first hearing was held on October 14, 2019 at 2:00 p.m. in Houston at the Texas Department of Transportation. The second hearing was held on October 17, 2019 at 2:00 p.m. in Arlington at the City Council Chambers. Notice of the public hearings was published in the *Texas Register* as well as the *Houston Chronicle* and *Dallas Morning News* newspapers. TCEQ staff were present and ready to open both hearings for public comment; however, no attendees arrived to make comments on the record at either hearing. Therefore, the public hearings were not formally opened for comment and a transcript was not prepared.

Written comments were accepted via mail, fax, or through the eComments (https://www6.tceq.texas.gov/rules/ecomments/) system. During the comment period, staff received a comment from Earthjustice on behalf of Achieving Community Tasks Successfully, Air Alliance Houston, Earthjustice, Sierra Club, and Texas Environmental Justice Advocacy Services. A summary of this comment and the TCEQ response is provided as part of this SIP revision in the Response to Comments.

1.4 SOCIAL AND ECONOMIC CONSIDERATIONS

No new control strategies have been incorporated into this DFW and HGB RFP SIP revision. Therefore, there are no additional social or economic costs associated with this revision.

1.5 FISCAL AND MANPOWER RESOURCES

The state has determined that its fiscal and manpower resources are adequate and will not be adversely affected through the implementation of this plan.

CHAPTER 2: EMISSIONS INVENTORIES

2.1 INTRODUCTION

The Federal Clean Air Act (FCAA) Amendments of 1990 require that reasonable further progress (RFP) emissions inventories be prepared for ozone nonattainment areas. Ground-level (tropospheric) ozone is produced when ozone precursor emissions, volatile organic compounds (VOC) and nitrogen oxides (NO_X), undergo photochemical reactions in the presence of sunlight.

The Texas Commission on Environmental Quality (TCEQ) maintains an inventory of current information for sources of NO_X and VOC that identifies the types of emissions sources present in an area, the amount of each pollutant emitted, and the types of processes and control devices employed at each source or source category. The total inventory of NO_X and VOC emissions for an area is derived from estimates developed for four general categories of emissions sources: point, area, mobile (both non-road and on-road), and biogenic. The emissions inventory (EI) also provides data for a variety of air quality planning tasks, including establishing baseline emissions levels, calculating reduction targets, developing control strategies to achieve emissions reductions, developing emissions inputs for air quality models, and tracking actual emissions reductions against established emissions growth and control budgets.

This Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) Reasonable Further Progress (RFP) State Implementation Plan (SIP) revision demonstrates RFP for a 2020 attainment year per the guidance in the Environmental Protection Agency's (EPA) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule), published in the *Federal Register* (FR) on March 6, 2015 (80 FR 12264). Specifically, this DFW and HGB RFP SIP revision demonstrates a 9% emissions reduction from calendar years 2018 through 2020 for the counties designated as nonattainment for ozone by combining NO_X and VOC emissions reductions.

To complete the RFP calculations, a set of inventories and control measures reduction estimates is required. In accordance with the requirement for these inventories and estimates, this DFW and HGB RFP SIP revision includes documentation of emissions inventories for the 2011 base year, for the 2020 attainment year, and for the attainment year RFP contingency requirement (2021). Those emissions inventories provide the basis for demonstrating how the required RFP emissions reductions will be met.

To develop an RFP SIP revision for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS), states must: (1) determine the base year emissions for NO_X and VOC; (2) calculate RFP target emissions reductions levels based on the RFP percent reduction requirements; (3) determine the attainment year inventories according to RFP requirements; and (4) account for creditable emissions reductions in the attainment year EI in accordance with applicable requirements. When the RFP controlled emissions reductions meet or exceed the calculated target emissions reductions, then RFP is demonstrated.

The requirement to calculate and account for the non-creditable emissions reductions due to pre-1990 Federal Motor Vehicle Control Program (FMVCP) reductions in RFP analyses was removed under the 2008 eight-hour ozone standard SIP requirements rule. This rule change eliminates the requirements to: calculate the adjusted base year (ABY) EI that estimates the effects of the non-creditable pre-1990 FCAA controls, use the ABY EI to calculate the percent reductions, and include the non-creditable reductions in the RFP target calculations. Accordingly, the RFP analyses presented in this DFW and HGB RFP SIP revision do not include any of the RFP elements or non-creditable effects related to the pre-1990 FMVCP, including ABY emissions inventories and related summaries and documentation.

This DFW and HGB RFP SIP revision includes:

- a 2011 base year EI;

  The base year EI is the starting point for calculating the target levels of emissions. A base year of 2011 was selected in accordance with the EPA's 2008 eight-hour ozone standard SIP requirements rule.

- 2020 uncontrolled EI;

  The RFP analysis requires an uncontrolled EI with growth between the base year and the attainment year. The uncontrolled EI serves as the basis for determining the amount of emissions reductions required to meet the RFP target for the attainment year.

- quantification of control measure reductions for the 2020 attainment year;

  The RFP analysis requires the calculations of emissions reductions for control strategies, which are then subtracted from the uncontrolled or existing controlled emissions to determine the controlled RFP EI. The RFP emissions reductions are individually quantified for each control strategy that pertains to particular source categories. A discussion of RFP control strategies is provided in Chapter 4: *Control Measures to Achieve Target Levels*.

- 2020 controlled EI; and

  The controlled EI represents the projected (forecasted) EI with all controls implemented. The controlled projected RFP EI is the result of subtracting the emissions reductions for controls that are used to demonstrate RFP from the uncontrolled or existing controlled projected EI.

- 2020 attainment year RFP contingency control reductions.

  The RFP analysis requires the calculation of the emissions reductions for control strategies for the year following the attainment year. These control reductions must be implemented if an RFP requirement is not met. A discussion of the RFP contingency control strategies for this DFW and HGB RFP SIP revision is provided in Chapter 4.

2.1.1 Updated Uncontrolled 2020 Attainment Year Inventories for Mobile Sources

Uncontrolled attainment year emissions inventories for mobile sources represent what each attainment year's emissions would be if the post-1990 mobile control strategies were never implemented. First, emissions inventories are calculated for each mobile source category using EPA-approved methodologies. The inventories are then combined to derive the total uncontrolled attainment year EI for NO_X and VOC. The uncontrolled attainment year EI includes 1990 or prior FCAA and/or state controls as well as growth in activity from 2011 to the attainment year, but the inventory does not include post-1990 FCAA and/or state controls.

2.1.2 Updated Controlled 2020 Attainment Year Inventory for Mobile Sources

The controlled attainment year EI represents projected emissions for 2020, accounting for emissions growth from either 2011 or the projection base year as detailed below and specified applicable controls. Emissions inventories are calculated for each source category using EPA-approved methodologies. Then, the inventories are combined to obtain the total controlled attainment year EI for NO_X and VOC. The controlled attainment year EI includes: specified FCAA and/or state controls implemented prior to the base year or analysis year, growth in activity from the base year or the projection base year to the attainment year, and specified FCAA and/or state controls used to meet the RFP target emissions levels.

2.1.3 Updated Uncontrolled and Controlled 2020 Attainment Year Inventory for Stationary Sources

For stationary sources, the uncontrolled attainment year emissions inventories represent the estimated attainment year emissions if no further action to control emissions growth were taken beyond the controls already accounted for in the EI. More recent stationary source data than the 2011 base year data is available; this newer data reflects growth that has occurred since the base year. This newer data also reflects more recent operations and applied controls since the 2011 base year. Therefore, the most recent annual EI was selected as the year from which to forecast emissions and is referred to as the *projection base year*.

Stationary source emissions inventories are calculated for each source category using methods as detailed in the appropriate sections below. The inventories are then combined to derive the total attainment year EI for NO_X and VOC. This attainment year EI reflects specified FCAA and/or state controls implemented by the end of the projection base year. The attainment year EI also reflects growth in activity from the projection base year to the attainment year. The uncontrolled 2011 EI for stationary sources includes all controls and associated reductions implemented by the end of the 2011 base year.

No stationary source controls beyond the controls previously described in this section are quantified for this DFW and HGB RFP SIP revision; therefore, for the attainment year, the uncontrolled stationary source EI is equivalent to the controlled stationary source EI.

2.1.4 Updated Adjusted Base Year Inventories

The on-road ABY emissions inventories are not required for this DFW and HGB RFP SIP revision. See Section 2.1: *Introduction* for additional information.

2.2 POINT SOURCES

2.2.1 Emissions Inventory Development

Stationary point source emissions data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) § 101.10. This rule, referred to as the TCEQ EI reporting rule, establishes point source EI reporting thresholds in ozone nonattainment areas that are currently at or less than major source thresholds in the DFW and HGB ozone nonattainment areas. Therefore, some minor sources in the DFW and HGB ozone nonattainment areas report to the point source EI.

To collect the data, the TCEQ sends notices to all sites identified as potentially meeting the reporting requirements. Companies are required to report emissions data and to provide sample calculations used to determine the emissions. Information characterizing the process equipment, the abatement units, and the emission points is also required. Per FCAA §182(a)(3)(B), company representatives certify that reported emissions are true, accurate, and fully represent emissions that occurred during the calendar year to the best of the representative's knowledge.

All data submitted in the EI are reviewed for quality-assurance purposes and then stored in the State of Texas Air Reporting System (STARS) database. Emissions Inventory guidance documents and historical point source emissions of criteria pollutants are available on the TCEQ's Point Source Emissions Inventory webpage (https://www.tceq.texas.gov/airquality/point-source-ei/psei.html). Additional information is available upon request from the TCEQ's Air Quality Division.

2.2.2 Updated 2011 Base Year Inventory

The TCEQ extracted the 2011 point source inventory data from STARS on March 1, 2019. The extracted data include reported annual and ozone season daily emissions of NO_X and VOC for each site in the DFW or HGB area that submitted a 2011 EI and reflect revisions made on or before the extract date.

2.2.3 Updated 2020 Attainment Year Inventories

Updated attainment year inventories were developed according to the general requirements described in Section 2.2.1: *Emissions Inventory Development*. The TCEQ designated the 2016 EI as the starting point for EI projections. The year 2016 was chosen as the projection base year for point sources because it was more representative of typical point source operations than 2017, when Hurricane Harvey occurred. The TCEQ extracted the 2016 point source EI data from STARS on March 1, 2019. The extracted data include reported annual and ozone season daily emissions of NO_X and VOC for each site in the DFW or HGB area that submitted a 2016 EI and reflect revisions made on or before the extract date.

2.2.3.1 DFW 2020 Attainment Year Inventory

The TCEQ reviewed major and minor sources separately. For major sources, the TCEQ reviewed cement kilns separately from other major sources. Cement kiln NO_X emissions were projected by adding either 30 TAC Chapter 117 limits or site- or source-specific directly enforceable limits, as appropriate. Other major source emissions were projected by adding emissions growth allowed under the nonattainment New Source Review (NSR) major modification thresholds. Minor source emissions were projected using growth factors. Unused emissions reductions credits were then added to the projections. For further details, please reference Appendix 3: *Development of Reasonable Further Progress Point Source Emissions Inventories for the DFW and HGB Nonattainment Areas.*

A summary of the point source RFP inventories is presented in:

- Table 2-5: *Nine-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day);*
- Table 2-6: *One-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day);*
- Table 2-7: *10-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day);* and
- Table 2-9: *10-County DFW RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day*).

2.2.3.2 HGB 2020 Attainment Year Inventory

For both major and minor sources, NO_X emissions from sites with equipment applicable to the Mass Emissions Cap and Trade (MECT) Program were projected using the MECT cap. Major source VOC emissions were projected by adding emissions growth allowed under the nonattainment NSR major modification thresholds. NO_X emissions from sites not listed in the MECT Program and VOC emissions from sources not identified as major for VOC were assumed to be minor source emissions and were projected using growth factors. Unused emissions reductions credits were then added to the projections. For further details, please reference Appendix 3.

A summary of the point source RFP inventories is presented in:

- Table 2-8: *HGB RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day);* and
- Table 2-10: *HGB RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day).*

2.3 AREA SOURCES

2.3.1 Emissions Inventory Development

Stationary emissions sources that do not meet the reporting requirements for point sources are classified as area sources. Area sources are small-scale stationary industrial, commercial, and residential sources that use materials or perform processes that generate emissions. Examples of typical VOC emissions sources include: oil and gas production sources, printing operations, industrial coatings, degreasing solvents, house paints, gasoline service station underground tank filling, and vehicle refueling operations. Examples of typical fuel combustion sources that emit NO_X include: oil and gas production sources, stationary source fossil fuel combustion at residences and businesses, outdoor refuse burning, and structure fires.

Area source emissions are calculated as county-wide totals rather than as individual sources. Area source emissions are typically calculated by multiplying an established emissions factor (emissions per unit of activity) by the appropriate activity or activity surrogate responsible for generating emissions. Population is one of the more commonly used activity surrogates for area source calculations. Other activity data commonly used include the amount of gasoline sold in an area, employment by industry type, and crude oil and natural gas production.

2.3.2 Updated 2011 Base Year Inventory

The 2011 area source inventory was developed in accordance with the requirements of the Air Emissions Reporting Requirements (AERR) rule. The 2011 inventory was developed using EPA-generated emissions inventories; TCEQ-contracted projects to develop emission inventories; TCEQ staff projects to develop emission inventories; and projecting historical emissions inventories by applying growth factors derived from Eastern Research Group (ERG) study data, the Economy and Consumer Credit Analytics website (http://www.economy.com/default.asp), and the United States Energy Information Administration's (EIA) *Annual Energy Outlook* publication. The documentation for the development of the ERG study projection factors can be found in Appendix 4: *Growth Factors for Point and Area Sources.*

The EPA developed emissions inventories for states to use for many area source categories as part of the National Emissions Inventory (NEI). The states access these individual inventories through the EPA's NEI website (ftp://ftp.epa.gov/EmisInventory/2011nei/doc/). These source categories include but are not limited to: industrial coatings; degreasing; residential, commercial/institutional, and industrial fuel use; commercial cooking; aviation fuel use; and consumer products. For some source categories, the TCEQ developed state-specific emissions estimates by acquiring current state-specific activity data and applying appropriate emissions factors. These source categories include but are not limited to: gasoline storage tanks; structure fires; dry cleaners; and automobile fires.

Additionally, the TCEQ committed significant resources to improve the oil and gas area source inventory categories for the 2011 base year inventory. The improvements included the development and refinement of a state-specific oil and gas area source emissions calculator. This oil and gas area source emissions calculator uses county-level production and local equipment activity data with local emissions requirements to estimate emissions from individual production categories, including compressor engines, condensate and oil storage tanks, loading operations, heaters, and dehydrators. The documentation for the development of the oil and gas emissions calculator can be found in Appendix 5: *Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions and Specified Oil and Gas Well Activities Emissions Inventory Update*. A significant improvement made to the oil and gas calculator for the 2011 base year inventory was the development of refined emission factors for VOC emissions from condensate storage tanks. The documentation for the refined emission factors can be found in Appendix 6: *Condensate Tank Oil and Gas Activities*. Additionally, a recently completed study developed refined emissions factors for oil and gas well mud degassing as well as hydraulic pump engines. The documentation for these refined emission factors can be found in Appendix 7*: Specified Oil and Gas Well Activities Emissions Inventory Update.*

For those area source categories affected by TCEQ rules, rule effectiveness factors are applied to the baseline emissions to estimate controlled emissions. These factors address the efficiency of the controls and the percentage of the category's population affected by the rule. Quality assurance of area source emissions involves ensuring that the activity data used for each category is current and valid. Data such as current population figures, fuel usage, and material usage were updated, and the EPA guidance on emissions factors was used. Other routine efforts such as checking calculations for errors and conducting reasonableness and completeness checks were implemented.

2.3.3 Updated Attainment Year Inventories

Updated attainment year inventories were developed according to the general requirements described in Section 2.3.1: *Emissions Inventory Development*. The TCEQ designated the 2017 EI as the starting point for EI projections of area source categories for the attainment year because it is the most recently available periodic inventory year.

The 2017 area source inventory was developed in accordance with the requirements of the AERR rule. The 2017 inventory was developed using EPA-generated emissions inventories, TCEQ-contracted projects to develop emission inventories, and TCEQ staff projects to develop emission inventories.

The area source oil and gas inventory production categories have been updated using 2017 production data from the Railroad Commission of Texas (RRC).

The updated 2020 attainment year inventory for the area source categories were developed using projection factors derived from Appendix 4. The study in this appendix contains individual projection factors for each source category and for each forecasting year. This projection method is the EPA standard and accepted methodology for developing future year emissions inventories.

The 2020 area source EI was developed by applying the selected emissions projection factor to the 2017 emissions for each area source category. Rules controlling emissions from industrial coatings, portable fuel containers, 30 TAC Chapter 117 Subchapter D controls on minor sources in ozone nonattainment areas, and gasoline station underground tank filling (Stage I) and vehicle refueling (Stage II) were applied in the base year inventory. Federal New Source Performance Standards Subpart OOOO emissions reductions were applied to the 2017 projection base year inventory but not the 2011 base year inventory due to applicable compliance deadlines. No additional controls were incorporated into the attainment year inventories; see Chapter 4 for additional details.

A summary of the area source RFP inventories is presented in Tables 2-5 through 2-10.

2.4 NON-ROAD MOBILE SOURCES

Non-road vehicles do not normally operate on roads or highways and are often referred to as off-road or off-highway vehicles. Non-road emissions sources include: agricultural equipment, commercial and industrial equipment, construction and mining equipment, lawn and garden equipment, aircraft and airport equipment, locomotives, drilling rigs, and commercial marine vessels (CMV). For this DFW and HGB RFP SIP revision, emissions inventories for non-road sources were developed for the following subcategories: NONROAD model categories, airports, locomotives, CMVs, and drilling rigs used in upstream oil and gas exploration activities. The airport subcategory includes estimates for emissions from the aircraft, auxiliary power units (APU), and ground support equipment (GSE) subcategories added together and presented as a total. The sections below describe the emissions estimates methodologies used for the non-road mobile source subcategories.

2.4.1 NONROAD Model Categories Emissions Estimation Methodology

A Texas-specific version of the EPA's NONROAD 2008a model, called the Texas NONROAD (TexN) model, was used to calculate emissions from all non-road mobile source equipment and recreational vehicles, with the exception of airports, locomotives, commercial marine vessels, and drilling rigs used in upstream oil and gas exploration activities. Because emissions for airports, commercial marine vessels, and locomotives are not included in either the NONROAD model or the TexN model, the emissions for these categories are estimated using other EPA-approved methods and guidance as described in the sections below. Although emissions for drilling rigs are included in the NONROAD model, alternate emissions estimates were developed for that source category to develop more accurate county-level inventories as described in Section 2.4.2: *Drilling Rig Diesel Engines Emissions Estimation Methodology*. The equipment populations for drilling rigs were set to zero in the TexN model to avoid double counting emissions from these sources.

The TexN model is a software tool for estimating emissions for non-road mobile source categories that are included in the EPA NONROAD model, with the exception of drilling rigs, as discussed above. The model allows air quality planners to replace the EPA's default emissions data used in the NONROAD model with more specific local activity data, a practice encouraged by the EPA. Local, county-level input data are incorporated into the TexN model as they become available to the TCEQ. Several equipment survey studies have been conducted in Texas to improve upon the default data available in the EPA NONROAD model. Those studies focused on various equipment categories operating in different areas of the state, including: diesel construction equipment, liquid propane gas powered forklifts, transportation refrigeration units, commercial lawn and garden equipment, agricultural equipment, and recreational marine vessels. Using these county-level input data produces a more accurate representation of non-road emissions for the DFW and HGB nonattainment areas. The NONROAD model category emissions included in this DFW and HGB RFP SIP revision were developed using version 1.7.2 of the TexN emissions model.

2.4.2 Drilling Rig Diesel Engines Emissions Estimation Methodology

Drilling rig diesel engines used in upstream oil and gas exploration activities are included in the EPA NONROAD model. However, due to significant growth in the oil and gas exploration and production industry, a 2015 survey of oil and gas exploration and production companies was used to develop updated drilling rig emissions characterization profiles. The uncontrolled and controlled drilling rig emissions characterization profiles from this study were combined with county-level drilling activity data obtained from the RRC to develop the drilling rigs EI. The documentation of procedures used in developing the drilling rigs EI can be found in Appendix 8: *2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories.*

2.4.3 Commercial Marine Vessel and Locomotive Emissions Estimation Methodology

The CMV EI was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The CMV EI includes at-port and underway emissions activity data from Category I, II, and III CMVs by county for applicable counties in the HGB nonattainment area. Documentation of the methods and procedures used to develop the CMV EI can be found in Appendix 9: *2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories.*

The locomotive EI was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The locomotive EI includes line haul and rail yard emissions activity data from all Class I, II, and III locomotive activity and emissions by rail segment. Documentation of methods and procedures used to develop the locomotive EI can be found in Appendix 10: *2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories.*

2.4.4 Airport Emissions Estimation Methodology

The airport EI was developed from a TCEQ-commissioned study using the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT). AEDT is the most recent FAA model for estimating airport emissions and has replaced the FAA's Emissions and Dispersion Modeling System.

The airport emissions categories used for this DFW and HGB RFP SIP revision included aircraft (commercial air carriers, air taxis, general aviation, and military), APU, and GSE operations. Documentation of methodology and procedures used to develop the DFW and HGB airport emissions inventories can be found in Appendix 11: *Development of the Statewide Aircraft Inventory for 2011* and Appendix 12: *Development of the Statewide Aircraft Inventory for 2020.*

2.4.5 Updated 2011 Base Year Inventory

For certain non-road mobile source categories detailed below, the updated 2011 base year EI was developed from the 2014 periodic EI to provide consistency between emissions estimation approaches used for this DFW and HGB RFP SIP revision. Exceptions and specific details about non-road source category inventory development are included in the relevant section below.

2.4.5.1 Updated 2011 Base Year NONROAD Model Category Inventory

The 2011 base year inventory used for all non-road mobile model-specific source categories was developed using the latest version of the TexN model with updated county-specific input data. More detailed information on the TexN emissions model, guidance document, and updates to the model can be found in the TexN directory (ftp://amdaftp.tceq.texas.gov/pub/EI/nonroad/TexN/) on the TCEQ's Air Modeling and Data Analysis file transfer protocol (FTP) site.

2.4.5.2 Updated 2011 Base Year Drilling Rig Diesel Engines Inventory

The 2011 base year EI for drilling rig diesel engines used in upstream oil and gas exploration activities was developed using the results of a 2015 statewide EI improvement study combined with 2011 drilling activity data from the RRC. The documentation of procedures used in developing the 2011 drilling rigs EI can be found in Appendix 8.

2.4.5.3 Updated 2011 Base Year Commercial Marine Vessel and Locomotive Inventory

The 2011 base year CMV inventory was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The CMV EI includes Category I, II, and III

CMV activity and emissions for all coastal counties within Texas. The CMV EI was developed using Automatic Identification System activity data for CMVs from PortVision, which provided vessel location, speed, and other identifying information. In addition to activity data, vessel-specific data from the Information Handling Services Vessel Database were used to determine which subsets of emissions factors were applicable for each vessel. Documentation of the methods and procedures used to develop the CMV EIs can be found in Appendix 9.

The 2011 base year Texas locomotive inventory was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The locomotive inventory was developed by ERG under contract with the TCEQ and includes Class I, II, and III locomotive activity and emissions by rail segment for all counties within Texas. The locomotive line haul and rail yard activity data were reported by companies operating in Texas to create a county-level Class I line haul inventory. Activity and emissions profiles were used for Class II and Class III railroads; these data were developed by the Eastern Regional Technical Advisory Committee in collaboration with the Federal Railroad Administration, the American Short Line and Regional Railroad Association (ASLRRA), and members of the Class II and III railroad communities. The annual gallons of fuel used by railroads were estimated from data compiled by ASLRRA from the Class II and III railroads, including total industry fuel use in 2008 for locomotives and total Class II/III route miles. Based on the EIA's *Annual Energy Outlook*, 2008 fuel usage values were projected to estimate 2011 emissions. Documentation of methods and procedures used to develop the locomotive emissions inventories can be found in Appendix 10.

2.4.5.4 Updated 2011 Base Year Airport Inventory

The 2011 base year airport emissions inventories were developed by ERG under contract with the TCEQ using the FAA's AEDT along with applicable 2011 aircraft activity, fleet mix, and other AEDT model input parameters for airports within the DFW and HGB areas. Documentation of methodology and procedures used to develop the DFW and HGB airport emissions inventories can be found in Appendix 11.

2.4.6 Updated Uncontrolled Analysis Year Inventories

The NONROAD model category uncontrolled emissions for each analysis year (2011 base year, 2020 attainment year, and 2021 contingency year) were calculated by removing all federal and state controls from the model runs.

The TCEQ calculated updated, uncontrolled emissions from airports based on the information and growth factors from the ERG reports found in Appendix 11 and Appendix 12.

The updated uncontrolled analysis year emissions for the locomotive sources were developed by applying activity adjustment factors by source classification code (SCC) per the ERG report in Appendix 10. The activity adjustment factors used were based on the EIA's Transportation Sector Key Indicators and Delivered Energy Consumption data (http://www.eia.gov/forecasts/aeo/tables_ref.cfm).

Uncontrolled emissions for CMVs were based on emission factors developed by ERG with guidance from the EPA that excluded adjustments for fleet turnover and the implementation of state and federal regulatory programs; see Appendix 9 for more information.

The uncontrolled 2011 EI for drilling rigs was developed using 2011 drilling activity data and the 2011 year-specific uncontrolled factors from the ERG report found in Appendix 8. A 2020 EI for drilling rigs was developed using 2017 drilling activity data and the 2020 year-specific uncontrolled factors from the ERG report found in Appendix 8. Because future drilling activity is difficult to predict, the 2017 drilling activity data were held constant to the 2020 attainment year, since 2017 data were the most current available.

2.4.7 Updated Controlled Analysis Year Inventories

For the NONROAD model category sources, the TCEQ developed county-level controlled inventories for the 2020 attainment and 2021 contingency year using the latest version of the TexN model. The model runs were performed accounting for all state and federal control measures.

The updated controlled attainment year emissions for airports were calculated based on the information from the ERG report found in Appendix 12. Control strategies for airport emissions included emission reductions from the GSE and APU electric conversions.

Controlled emissions for locomotive sources were determined by applying activity adjustment factors by SCC, and emission rate adjustment factors. The emission rate adjustment factors were obtained from the EPA's Emission Factors for Locomotives Fact Sheet (https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100500B.TXT). The activity adjustment factors used were based on the EIA's Transportation Sector Key Indicators and Delivered Energy Consumption data (http://www.eia.gov/forecasts/aeo/tables_ref.cfm).

Controlled emissions for CMVs were based on emissions factors developed by ERG with guidance from the EPA, which took into account fleet turnover and the implementation of state and federal regulatory programs; see Appendix 9 for more information.

Controlled 2020 emissions for diesel drilling rigs were based on 2017 drilling activity data combined with the 2020 year-specific controlled emission factors from the ERG report found in Appendix 8.

A summary of the non-road mobile source RFP inventories is presented in Tables 2-5 through 2-10.

2.5 ON-ROAD MOBILE SOURCES

The 2011, 2020, and 2021 on-road mobile source emissions inventories for this DFW and HGB RFP SIP revision were developed under contract by the North Central Texas Council of Governments (NCTCOG) and the Texas A&M Transportation Institute (TTI) for the DFW and HGB nonattainment areas, respectively. The data, methods, activity inputs, emissions factors, and results are documented in the NCTCOG and TTI reports provided in Appendix 13: *Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-road Inventories and Control Strategy Reductions for 2011, 2017, 2018,* *2020, and 2021* and Appendix 14: *Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories.* The inventories include the 10 DFW and eight HGB area counties designated as nonattainment for the 2008 eight-hour ozone NAAQS. As required by the RFP implementation rules, the on-road inventories are based on vehicle miles traveled (VMT) estimates and emission rates for an average summer work weekday. The latest major revision of the EPA's mobile source emission model, the Motor Vehicle Emission Simulator (MOVES) model, MOVES2014a, was used to estimate the summer weekday emission rates in units of grams per mile for NO_X and VOC.[6] The roadway link-level VMT estimates were obtained from travel demand modeling for the 10-county DFW and eight-county HGB nonattainment areas for each analysis year.

2.5.1 On-Road Emissions Inventory Development

On-road mobile emissions sources consist of automobiles, trucks, motorcycles, and other motor vehicles traveling on public roadways. On-road mobile source ozone precursor emissions are usually categorized as combustion-related emissions or evaporative hydrocarbon emissions. Combustion-related emissions are estimated for vehicle engine exhaust. Evaporative hydrocarbon emissions are estimated for the fuel tank and other evaporative leak sources on the vehicle. To calculate emissions, both the rate of emissions per unit of activity (emission factors) and the number of units of activity must be determined.

Emission factors for this DFW and HGB RFP SIP revision were developed using the EPA's mobile emissions factor model, MOVES2014a. The MOVES2014a model may be run using national default information or the default information may be modified to simulate data specific to an area, such as the control programs, driving behavior, meteorological conditions, and vehicle characteristics. Because modifications to the national default values influence the emission factors calculated by the MOVES2014a model, to the extent that local values are available, parameters that are used reflect local conditions. The localized inputs used for the on-road mobile EI development include vehicle speeds for each roadway link, vehicle populations, vehicle hours idling, temperature, humidity, vehicle age distributions for each vehicle type, percentage of miles traveled for each vehicle type, type of inspection and maintenance (I/M) program, fuel control programs, and gasoline Reid vapor pressure controls.

To estimate on-road mobile source emissions, emission factors calculated by the MOVES2014a model must be multiplied by the level of vehicle activity. On-road mobile source emissions factors are expressed in units of grams per mile, grams per vehicle (evaporative), and grams per hour (extended idle); therefore, the activity data required to complete the inventory calculation are VMT in units of miles per day, vehicle populations, truck hoteling activity, and source hours idling. The level of vehicle travel activity is developed using travel demand models (TDM) run by the Texas Department of Transportation or by the local metropolitan planning organizations. The TDMs are validated against a large number of ground counts, i.e., traffic passing over counters placed in various locations throughout a county or area. For SIP inventories, VMT estimates are calibrated against outputs from the federal Highway Performance

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[6] For on-road EI development, MOVES2014a is technically the most recent on-road release. The more recent MOVES2014b update only impacts non-road model components and does not change the on-road portion of the model.

Monitoring System, a model built from a different set of traffic counters. Vehicle populations by source type are derived from the Texas Department of Motor Vehicles' registration database and, as needed, national estimates for vehicle source type population.

In addition to the number of miles traveled on each roadway link, the speed on each roadway type or segment is also needed to complete an on-road EI. Roadway speeds, required inputs for the MOVES2014a model, are calculated by using the activity volumes from the TDM and a post-processor speed model.

A summary of the on-road mobile source VMT used to develop the various NO_X and VOC emissions estimates for the DFW area are presented in Table 2-1: *DFW RFP Ozone Season Weekday On-Road Mobile Source VMT (miles per day).*

A summary of the on-road mobile source VMT used to develop the various NO_X and VOC emissions estimates for the HGB area are presented in Table 2-2*: HGB RFP Ozone Season Weekday On-Road Mobile Source VMT (miles per day).*

The controlled and uncontrolled on-road mobile source emissions inventories are summarized in Table 2-3: *2020 DFW RFP Ozone Season Weekday On-Road Mobile Source* NO_X *and VOC Emissions and Control Strategy Reductions* for the DFW area and in Table 2-4: *2020 HGB RFP Ozone Season Weekday On-Road Mobile Source* NO_X *and VOC Emissions and Control Strategy Reductions* for the HGB area.

For complete documentation of the development of the on-road mobile source emissions inventories for the DFW RFP demonstration, refer to Appendix 13, for the HGB demonstration, refer to Appendix 14. The complete set of input and output files are available upon request from the TCEQ's Air Quality Division.

Table 2-1: DFW RFP Ozone Season Weekday On-Road Mobile Source VMT[1] (miles per day)

RFP Analysis Year	VMT
2011 Base Year	191,251,636
2020 Attainment Year	231,949,231

Note 1: For this RFP SIP revision, the same VMT is used for the uncontrolled and controlled scenarios.

Table 2-2: HGB RFP Ozone Season Weekday On-Road Mobile Source VMT[1] (miles per day)

RFP Analysis Year	VMT
2011 Base Year	145,136,623
2020 Attainment Year	193,683,005

Note 1: For this RFP SIP revision, the same VMT is used for the uncontrolled and controlled scenarios.

2.5.2 On-Road Mobile Updated 2011 Base Year Inventory

The 2011 base year EI for on-road mobile sources was updated using emission factors calculated using the MOVES2014a model. Additional updates were made to incorporate the latest activity estimates from the DFW and HGB TDM 2011 networks. Only control strategies implemented prior to 2011 were included in the input to the EI development for the 2011 on-road mobile source base year emissions inventories. Those controls include: the pre-1990 FMVCP, the 1990 to 2011 FMVCP, reformulated gasoline (RFG), the East Texas Regional Low RVP Gasoline Program, federal ultra-low sulfur diesel, the vehicle I/M program, and on-road Texas Low Emission Diesel (TxLED), where applicable. The activity levels used to calculate the EI reflect the 2011 roadway networks with 2011 VMT and speeds. A summary of the EI is presented in Table 2-3 for the DFW area and Table 2-4 for the HGB area. For complete documentation of the development of the EI and details on MOVES2014a model inputs, refer to Appendix 13 for the DFW area and Appendix 14 for the HGB area.

2.5.3 On-Road Mobile Updated 2011 Adjusted Base Year Inventories for the Base and Attainment Years

The on-road adjusted base year emissions inventories are not required for this DFW and HGB RFP SIP revision. See Section 2.1 for additional information.

2.5.4 On-Road Mobile Updated Uncontrolled Attainment Year Inventories

The uncontrolled on-road mobile emissions inventories for each RFP attainment year were developed using emission factors that reflect only control strategies implemented prior to 1990. Those controls include pre-1990 FMVCP and the 1992 RVP control. MOVES2014a was used to develop the emissions inventories for this DFW and HGB RFP SIP revision. The activity levels were updated to include the latest output from the DFW and HGB TDMs. The activity levels used to calculate the EI reflect the attainment roadway network, with attainment year VMT and speeds. A summary of the emissions inventories is presented in Tables 2-3 and 2-4. For complete documentation of the development of the EI and details on MOVES2014a model inputs, refer to Appendix 13 for the DFW area and Appendix 14 for the HGB area.

2.5.5 On-Road Mobile Updated Controlled Attainment Year Inventories

The controlled on-road mobile emissions inventories for the attainment year were developed using emission factors that include: the effects of pre-1990 control strategies, the effects of all control strategies between 1990 and 2011, and the effects of all control strategies from 1990 through the attainment year. The effects of the post-1990 control strategies between 2011 and the attainment year are creditable reductions used to demonstrate compliance with RFP requirements. The pre- and post-1990 controls include pre-1990 FMVCP, post-1990 FMVCP, RFG, the East Texas Regional Low RVP Gasoline Program, federal ultra-low sulfur diesel, the vehicle I/M program, and TxLED, where applicable. All control strategies used to demonstrate RFP for DFW and HGB are documented in Chapter 4. The on-road control strategies are documented in Section 4.5: *On-Road Mobile Source Controls.*

The activity levels used to calculate the attainment year emissions inventories reflect the 2020 roadway network, with 2020 VMT and speeds. A summary of the uncontrolled on-road mobile EI, the on-road mobile control reductions, and the resulting controlled on-road mobile EI for the attainment year are summarized in Table 2-3 for the HGB area. For complete documentation of the development of the DFW and HGB emissions inventories and details on MOVES2014a model inputs, refer to Appendix 13 and Appendix 14, respectively.

Table 2-3: 2020 DFW RFP Ozone Season Weekday On-Road Mobile Source NO_x and VOC Emissions and Control Strategy Reductions

Emissions Inventory and Control Strategy Description	NO_x (tons per day)	VOC (tons per day)
2020 Uncontrolled Inventory	957.90	370.27
Post-1990 FMVCP	796.66	290.23
On-road RFG/East Texas Regional Low RVP/Low Sulfur/federal ultra-low sulfur diesel	54.23	15.17
Inspection and Maintenance Program	6.87	8.14
On-road TxLED	2.65	0.00
2020 Controlled Inventory	97.49	56.73

Table 2-4: 2020 HGB RFP Ozone Season Weekday On-Road Mobile Source NO_x and VOC Emissions and Control Strategy Reductions

Emissions Inventory and Control Strategy Description	NO_x (tons per day)	VOC (tons per day)
2020 Uncontrolled Inventory	750.39	322.18
Post-1990 FMVCP	561.84	245.62
On-road RFG with Tier 3 sulfur, and federal ultra-low sulfur diesel	101.55	16.96
Inspection and Maintenance Program	5.13	7.39
On-road TxLED	2.39	0.00
2020 Controlled Inventory	79.48	52.21

Quantification of specific control reductions is documented in Chapter 4. Motor vehicle emissions budget (MVEB) calculations for the attainment year are documented in Chapter 5: *Motor Vehicle Emissions Budgets*.

2.6 BIOGENIC SOURCES

Biogenic sources include VOC emissions from crops, lawn grass, and trees as well as small amounts of NO_x from soils and other sources. Previously, under the Consolidated Emissions Reporting Rule (June 2002) and earlier emissions reporting rules, biogenic sources were required to be reported along with point, nonpoint, on-road mobile, and non-road mobile sources. Beginning with the AERR rule (December 2008), the emissions required to be reported to the EPA no longer include emissions from biogenic sources. Therefore, as of the 2011 reporting year, the TCEQ's comprehensive triennial EI no longer includes emissions from biogenic sources. Biogenic inventories may still be developed for air quality modeling purposes, as necessary.

The RFP demonstrations are based upon the emissions from anthropogenic sources only. The guidance for RFP calculations shows the first step is to subtract the emissions from biogenic sources from the total base year emissions to obtain the total anthropogenic emission inventory. As of 2011, under the AERR rule, the base year emissions do not include biogenic sources and already represent the total anthropogenic emissions. In this case, step one of the RFP process is not needed, and the inclusion of emissions from biogenic sources is unnecessary. Therefore, this DFW and HGB RFP SIP revision does not include quantification of emissions from biogenic sources.

2.7 EMISSIONS SUMMARY

Uncontrolled and controlled base year NO_X and VOC emissions for each RFP source category are summarized in Tables 2-5, 2-6, 2-7, and 2-8.[7]

For the 2020 attainment year, the uncontrolled and controlled NO_X and VOC emissions for each RFP source category and analysis year are summarized in Tables 2-9 and 2-10.

Between 1990 and 2011, substantial emissions reductions have occurred in all EI source categories (stationary sources as well as mobile sources) due to regulations implemented at the federal, state, and local levels and innovative programs implemented by the TCEQ. As noted in Section 2.1, the uncontrolled 2011 EI for stationary sources includes all controls and associated reductions implemented by the end of the 2011 base year. No additional stationary source controls are quantified for this DFW and HGB RFP SIP revision; therefore, the 2011 controlled stationary source EI is equivalent to the 2011 uncontrolled stationary source EI.

Similarly, the 2020 attainment year inventory reflects: 1) all controls and associated reductions implemented by the end of the projection base EI year and 2) growth from the projection base EI. Where there is no difference between the uncontrolled and controlled emissions for the base year or the attainment year, there were no controls quantified for the projected source inventories.

Table 2-5: Nine-County[1] DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	231.95	86.08	141.05	40.28
On-Road Mobile Sources	749.37	231.83	296.35	100.19
Area Sources	37.69	37.69	262.35	262.35
Point Sources	31.34	31.34	27.54	27.54
Total of All Sources	1,050.35	386.94	727.29	430.36

Note 1: The nine-county DFW Area includes the nine DFW counties previously designated nonattainment under the one-hour and/or the 1997 eight-hour ozone NAAQS: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties.

Table 2-6: One-County[1] DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	13.74	5.96	4.35	1.21
On-Road Mobile Sources	18.39	7.24	4.80	2.05
Area Sources	13.29	13.29	28.95	28.95
Point Sources	8.61	8.61	2.35	2.35
Total of All Sources	54.03	35.10	40.45	34.56

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[7] Wise County is the only county in the DFW 10-county area designated as nonattainment under the 2008 eight-hour ozone NAAQS but not previously designated as nonattainment under a prior ozone NAAQS (i.e., one-hour or 1997). The timing of Wise County's designation impacts certain RFP requirements and therefore Wise County is grouped separately, when appropriate.

Note 1: The one-county DFW Area includes the one DFW county newly designated nonattainment under the 2008 eight-hour ozone NAAQS: Wise County.

Table 2-7: 10-County[1] DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	245.69	92.04	145.40	41.49
On-Road Mobile Sources	767.76	239.07	301.15	102.24
Area Sources	50.98	50.98	291.30	291.30
Point Sources	39.95	39.95	29.89	29.89
Total of All Sources	1,104.38	422.04	767.74	464.92

Note 1: The 10-county DFW Area includes all 10 counties designated nonattainment under the 2008 NAAQS: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties.

Table 2-8: HGB RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	242.73	144.84	116.94	50.11
On-Road Mobile Sources	536.68	168.60	239.63	80.45
Area Sources	21.15	21.15	308.53	308.53
Point Sources	108.33	108.33	95.97	95.97
Total of All Sources	908.89	442.92	761.07	535.06

Table 2-9: 10-County DFW RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	264.51	70.03	162.12	36.58
On-Road Mobile Sources	957.90	97.49	370.27	56.73
Area Sources	38.69	38.69	299.22	299.22
Point Sources	46.83	46.83	24.35	24.35
Total of All Sources	1307.93	253.04	855.96	416.88

Table 2-10: HGB RFP Summary of the 2020 Attainment Year Average Summer Weekday NO_X and VOC Emissions (tons per day)

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	254.17	77.44	136.26	31.49
On-Road Mobile Sources	750.39	79.48	322.18	52.21
Area Sources	30.04	30.04	310.98	310.98
Point Sources	131.06	131.06	85.23	85.23
Total of All Sources	1165.66	318.02	854.65	479.91

CHAPTER 3: PROGRESS TOWARD MEETING TARGET EMISSIONS LEVELS

3.1 INTRODUCTION

3.1.1 General RFP Requirements

This chapter describes how the Dallas-Fort Worth (DFW) and the Houston-Galveston-Brazoria (HGB) reasonable further progress (RFP) demonstrations are calculated, documents the RFP calculations, and provides a summary of the DFW and HGB RFP demonstrations for all RFP analysis years. Based upon the United States Environmental Protection Agency's (EPA) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard state implementation plan (SIP) requirements rule), published in the *Federal Register* (FR) on March 6, 2015 (80 FR 12264), the attainment date for serious nonattainment areas is July 20, 2021, with an attainment year of 2020.

For this DFW and HGB RFP SIP revision, a base year of 2011 was used to harmonize the RFP base year with the triennial reporting requirement of the Air Emissions Reporting Requirements (AERR) rule and for consistency with previous DFW and HGB 2008 eight-hour ozone National Ambient Air Quality Standards (NAAQS) SIP revisions. The required emissions reductions for RFP, as detailed below, are calculated as a percentage of the base year (2011) emissions inventory (EI) and must occur no later than the required timeframe.

The RFP requirements for this DFW and HGB RFP SIP revision are to demonstrate:

- a 9% emissions reduction for the three-year period from January 1, 2018 through December 31, 2020 for the 10-county DFW nonattainment area;
- a 3% emissions reduction for the one-year period between January 1, 2021 through December 31, 2021 as attainment year RFP contingency for the 10-county DFW nonattainment area;
- a 9% emissions reduction for the three-year period from January 1, 2018 through December 31, 2020 for the eight-county HGB nonattainment area; and
- a 3% emissions reduction for the one-year period between January 1, 2021 through December 31, 2021as attainment year RFP contingency for the eight-county HGB nonattainment area.

For RFP and contingency analyses, the requirement to calculate and account for the non-creditable emissions reductions due to pre-1990 Federal Motor Vehicle Control Program (FMVCP) reductions was removed under the 2008 eight-hour ozone standard SIP requirements rule. The RFP analyses presented in this DFW and HGB RFP SIP revision does not include any of the RFP elements or non-creditable effects related to the pre-1990 FMVCP.

3.1.2 Fifteen Percent Emissions Reduction Requirement

The 2008 eight-hour ozone standard SIP requirements rule requires states with serious nonattainment areas to submit an RFP plan with a 15% emissions reduction from the RFP base year to the first RFP analysis year, and an average 3% reduction per year from the first RFP analysis year to an area's attainment year. In accordance with the 2008 eight-hour ozone standard SIP requirements rule, if a state chooses 2011 as a base year for a serious area designated nonattainment in 2012, the 15% reduction requirement covers the period from January 1, 2012 through December 31, 2017.

The first 15% RFP reduction achieved by an area must be from volatile organic compounds (VOC) emissions. In subsequent RFP demonstrations, this reduction requirement can be fulfilled with a combination of nitrogen oxides (NO_X) and VOC emissions. The EPA previously approved demonstrations of the 15% VOC-only reduction requirements for all counties within the HGB and DFW 2008 ozone nonattainment areas, as noted in Table 3-1: *EPA Approval of 15% VOC-Only RFP SIP Revision for HGB and DFW Ozone Nonattainment Areas*.

Table 3-1: EPA Approval of 15% VOC-Only RFP SIP Revision for HGB and DFW Ozone Nonattainment Areas

Area	County or Counties	Ozone NAAQS	Date of EPA Approval	Federal Register Notice Citation
HGB	Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller	One-hour	November 14, 2001	66 FR 57160
DFW	Collin, Dallas, Denton, and Tarrant	One-hour	April 12, 2005	70 FR 18993
DFW	Ellis, Johnson, Kaufman, Parker, and Rockwall	1997 eight-hour	October 7, 2008	73 FR 58475
DFW	Wise	2008 eight-hour	December 7, 2016	81 FR 88124

For the 2008 eight-hour ozone NAAQS, the TCEQ previously adopted moderate classification RFP SIP revisions for the DFW and HGB areas to address the 15% emissions reduction requirement in VOC only (if not already satisfied) or in NO_X and/or VOC for the six-year period from January 1, 2012 through December 31, 2017. The DFW RFP SIP revision adopted on June 3, 2015, demonstrated a 15% emissions reduction in VOC only from the 2011 base year through the 2017 attainment year for the newly designated one-county portion of the DFW moderate nonattainment area (Wise County) and a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the previously designated nine-county portion of the DFW moderate nonattainment area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties). The HGB RFP SIP Revision adopted on December 15, 2016 demonstrated a 15% emissions reduction in NO_X and/or VOC from the 2011 base year through the 2017 attainment year for the eight-county HGB moderate nonattainment area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties). The EPA approved the DFW RFP SIP revision on December 7, 2016 (81 FR 88124) and approved the HGB RFP SIP revision on February 13, 2019 (84 FR 3708).

3.1.3 Additional Emissions Reduction Requirements

To demonstrate RFP for the DFW and HGB serious ozone nonattainment areas for the 2008 eight-hour ozone NAAQS, an additional 9% emissions reduction is required for the three-year period from January 1, 2018 to December 31, 2020. A combination of VOC and NO_X emissions reductions may be used to achieve the 9% reduction requirements.[8]

For certain source categories, 2017 was used as the projection base year to forecast 2020 attainment year emissions. However, 2017 is not an analysis year for this SIP revision because the RFP requirement to demonstrate a 15% emissions reduction from January 1, 2012 through December 31, 2017 was previously submitted to the EPA and approved, as noted in Section 3.1.2: *Fifteen Percent Emissions Reduction Requirement*.

3.1.4 Contingency Demonstration

The RFP requirements also include a 3% contingency demonstration for the one-year period after each RFP analysis year and the attainment year. A combination of VOC and NO_X emissions reductions may be used to achieve the 3% contingency reduction requirements.

With a 2020 attainment year under the serious classification, this DFW and HGB RFP SIP revision includes a 3% post-attainment year contingency for DFW and HGB for the one-year period from January 1, 2021 through December 31, 2021. Under the former moderate classification, a 2017 attainment year contingency requirement for the one-year period from January 1, 2018 through December 31, 2018 was demonstrated and approved in previous DFW and HGB RFP SIP revisions. The emissions reductions required to account for the 2018 RFP contingency year continue to be reserved out of the creditable reductions used between 2011 and 2020 to assure reductions are not double counted.

3.1.5 RFP Demonstration Method

Required serious nonattainment area RFP demonstration elements for the 10-county DFW and the eight-county HGB ozone nonattainment areas include:

- the 2011 base year emissions;
- 2020 target levels;
- 2020 projected emissions, with growth; and
- individually quantified emissions reductions from control measures for 2020.

Progress toward the 2020 attainment year emissions reductions requirements is demonstrated using EPA methodologies to calculate the elements of the RFP demonstration and complete the RFP analyses. First, the emissions inventories and control reductions are developed for each analysis year. Second, the target level of emissions is calculated for each analysis year. Third, the RFP control measure reductions for each analysis year are subtracted from the uncontrolled or existing controlled EI for the corresponding analysis year. The difference includes growth from

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[8] NO_X may be substituted for VOC under conditions defined in the EPA's December 1993 NO_X Substitution Guidance (https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2_old/19931201_oaqps_nox_substitution_guidance.pdf).

the base year to the selected analysis year. When the combined uncontrolled and existing controlled projected inventory for each analysis year minus the RFP controls is less than or equal to the target level of emissions for VOC and/or NO_X, the RFP requirement has been met.

3.2 TARGET LEVEL METHODOLOGY

EPA guidance specifies the method that should be used to calculate the maximum amount of emissions a nonattainment area can emit for each RFP analysis year. Those RFP target levels of emissions are calculated using a three-step process, which is used for this DFW and HGB RFP SIP revision. The two steps previously required to account for pre-1990 non-creditable reductions are no longer required and are not included. The three steps used to calculate the RFP targets are listed below.

1. Determine the 2011 RFP base year EI.
2. Calculate the required 15% and 9% emissions reduction amounts between 2011 and 2020.
3. Calculate the 2020 emissions target levels for NO_X and VOC.

Each of these steps is explained in more detail in Section 3.3: *Calculation of Target Emissions Levels*.

3.3 CALCULATION OF TARGET EMISSIONS LEVELS

A summary of the three-step process described above for target calculations for 2020 is presented in:

- Table 3-2: *Summary of the Calculation Process for 2020 DFW RFP Target Levels;* and
- Table 3-3: *Summary of the Calculation Process for 2020 HGB RFP Target Levels.*

The 2020 DFW and HGB attainment year VOC and NO_X target levels are found in Line 11 of Table 3-2: *Summary of the Calculation Process for 2020 DFW RFP Target Levels*, and, Line 7 of Table 3-3: *Summary of the Calculation Process for 2020 HGB RFP Target Levels.* In these tables, VOC and NO_X target levels are expressed in tons per day (tpd) unless a percent reduction (%) is specified.

Table 3-2: Summary of the Calculation Process for 2020 DFW RFP Target Levels

Line	Description	NO_X (tpd or %)	VOC (tpd or %)
Line 1	Step 1A: 2011 base year (BY) EI for one DFW newly designated county (See Table 2-6)	35.10	34.56
Line 2	15% VOC reduction requirement for one DFW newly designated county	N/A	15%
Line 3	Step 1B: 2011 BY EI for nine DFW previously designated counties (See Table 2-5)	386.94	430.36
Line 4	Percent of NO_X (PN) and VOC (PV) to meet 15% reduction requirement for nine DFW previously designated counties, PN plus PV = 15	14%	1%
Line 5	Step 1C: 2011 BY EI for 10 DFW counties (Equals Line 1 plus Line 3, See Table 2-7)	422.04	464.92
Line 6	PN and PV to meet 9% reduction requirement, PN plus PV = 9	8%	1%

Line	Description	NO_X (tpd or %)	VOC (tpd or %)
Line 7	Step 2A: Calculate the 2011-to-2017 15% VOC reduction requirement for one DFW newly designated county (set to zero for NO_X, and Line 1 multiplied by Line 2 for VOC)	0.00	5.18
Line 8	Step 2B: Calculate the 2011-to-2017 15% NO_X and VOC reduction requirement for nine DFW previously designated counties (Line 3 multiplied by Line 4)	54.17	4.30
Line 9	Step 2C: Calculate the 2017-to-2020 9% reduction requirement for 10 DFW counties (Line 5 multiplied by Line 6)	33.77	4.65
Line 10	Step 2D: Calculate the total 2011-to-2020 percent reduction requirement (Line 7 plus Line 8 plus Line 9)	87.94	14.13
Line 11	Step 3: Calculate the 2020 target level of emissions for 10 DFW counties (Line 5 minus Line 10)	334.10	450.79

Table 3-3: Summary of the Calculation Process for 2020 HGB RFP Target Levels

Line	Description	NO_X (tpd or %)	VOC (tpd of %)
Line 1	Step 1: 2011 BY EI for HGB (see Table 2-8)	442.92	535.06
Line 2	PN and PV to meet 15% reduction requirement (PN plus PV = 15)	10%	5%
Line 3	PN and PV to meet 9% reduction requirement (PN plus PV = 9)	6.2%	2.8%
Line 4	Step 2A: Calculate the 15% NO_X and VOC reduction requirement between 2011 and 2017 (Line 1 multiplied by Line 2)	44.29	26.75
Line 5	Step 2B: Calculate the 9% NO_X and VOC reduction requirement between 2017 and 2020 (Line 1 multiplied by Line 3)	27.46	14.98
Line 6	Step 2C: Calculate the total NO_X and VOC reduction requirement between 2011 and 2020 (Line 4 plus Line 5)	71.75	41.73
Line 7	Step 3: Calculate the 2020 target level of emissions for the HGB counties (Line 1 minus Line 6)	371.17	493.33

Step one of the RFP target calculation process involves the development of the 2011 base year EI, which represents the total anthropogenic emissions for the area. EPA guidance specifies the methodology that must be used to develop the base year EI and all other SIP emissions inventories.[9] Details of the development of the 2011 DFW and HGB base year emissions inventories are discussed in Chapter 2: *Emissions Inventories*. Summaries for the 2011 DFW and HGB base year NO_X and VOC emissions inventories are presented in Table 2-5: *Nine-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*, Table 2-6: *One-County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day)*, Table 2-7: *Ten-County DFW RFP Summary of the 2011*

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[9] References for guidance documents used for EI development in this SIP revision are listed in the *References for Guidance Documents* section at the end of this document.

Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day) , and Table 2-8: *HGB RFP Summary of the 2011 Base Year Average Summer Weekday NO_X and VOC Emissions (tons per day).*

Step two of the RFP target calculation process, calculating the emissions reduction amount required for each analysis year, is accomplished by multiplying the RFP base year EI values by the percent reduction needed to meet RFP requirements. For the DFW and HGB nonattainment areas, the first requirement is to reduce emissions by 15% between 2011 and 2017. The post-2017 requirement is to reduce emissions by 3% per year from January 1, 2018 to the end of the attainment year. Since the attainment year for the DFW and HGB areas for the 2008 eight-hour ozone NAAQS is 2020, a 9% reduction in emissions is required from the end of 2017 through 2020.

The EPA's final 2008 eight-hour ozone standard SIP requirements rule allows ozone nonattainment areas to substitute NO_X reductions for VOC reductions, but the use of NO_X emissions reductions must meet the criteria in §182(c)(2)(C) in the Federal Clean Air Act (FCAA). The eight-county HGB area, which was previously designated nonattainment under the one-hour ozone NAAQS and the 1997 eight-hour ozone NAAQS, has already satisfied the 15% VOC emissions reduction requirement; therefore, all eight HGB nonattainment counties may substitute NO_X reductions for VOC under the conditions detailed in the EPA's NO_X substitution guidance.[10] Nine of the 10 DFW counties were originally designated nonattainment under the one-hour ozone standard and/or the 1997 eight-hour ozone NAAQS and have already satisfied the 15% VOC-only requirement prior to designation under the 2008 eight-hour ozone NAAQS; therefore, an equivalent percentage of NO_X reductions may be substituted for VOC reductions requirements in those counties between 2011 and 2017. For the one county (Wise) added to the DFW nonattainment area under the 2008 eight-hour ozone NAAQS, the 15% reduction requirement from 2011 through 2017 must be all VOC.

For the DFW area, the 2011 through 2017 VOC-only reduction requirement was met for the one DFW nonattainment county (Wise) added under the 2008 eight-hour ozone standard through a 15% VOC emissions reduction. The 2011 through 2017 reduction requirement was met for the nine previously designated nonattainment counties through a 14% NO_X reduction and 1% VOC reduction. After 2017, all 10 DFW nonattainment counties may substitute NO_X reductions for VOC under the conditions of the EPA's NO_X substitution guidance.[11] For the 10 DFW counties for the 2020 attainment year, the 9% reduction requirement between the end of 2017 and 2020 for this RFP SIP revision is satisfied by taking an 8% reduction from NO_X emissions and a 1% reduction from VOC for the 10 DFW nonattainment counties. Equation 3-1 describes the method to calculate the percentage of NO_X emissions substituted for VOC emissions for the previous 2017 RFP analysis year. Equation 3-2 describes the method to calculate the percentage of NO_X emissions substituted for VOC emissions for the 2020 RFP attainment year.

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[10] NO_X may be substituted for VOC under conditions defined in the EPA's December 1993 NO_X Substitution Guidance (https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2_old/19931201_oaqps_nox_substitution_guidance.pdf).

[11] See footnote 10.

Equation 3-1: $N_{AY} = 15 - V_{AY}$

where:

AY = First RFP analysis year

N_{AY} = percentage NO_X reductions for year AY

V_{AY} = percentage VOC reductions for year AY

Equation 3-2: $N_{AY} = [3 \times (CY_{AY} - CY_{AY-1})] - V_{AY}$

where:

AY = RFP analysis year

$AY - 1$ = previous RFP analysis year

N_{AY} = percentage NO_X reductions for year AY

CY = calendar year

V_{AY} = percentage VOC reductions for year AY

For the HGB area, the 15% reduction requirement for 2011 through 2017 was met for the eight HGB counties through a 10% NO_X reduction and 5% VOC reduction. For the eight HGB counties for the 2020 attainment year, the 9% reduction requirement between the end of 2017 and 2020 for this RFP SIP revision is satisfied by taking a 6.2% reduction from NO_X emissions and a 2.8% reduction from VOC. As with DFW, Equations 3-1 and 3-2 describe the method to calculate the percentage of NO_X emissions substituted for VOC emissions for the previous 2017 RFP analysis years and the 2020 RFP attainment year.

Emissions reduction percentages are multiplied by their corresponding NO_X and VOC base year emissions inventories to calculate the required NO_X and VOC emissions reductions for each RFP analysis year. Tables 3-2: *Summary of the Calculation Process for 2020 DFW RFP Target Levels* and 3-3*: Summary of the Calculation Process for 2020 HGB RFP Target Levels* provide a summary of the NO_X and VOC reductions needed to satisfy the initial 15% and the subsequent 3% per year requirement for all RFP analysis years. The equations for calculating the 9% required reductions for NO_X and VOC are shown in Equations 3-3A and 3-3B. Summaries of the NO_X and VOC reductions needed to satisfy the 15% and post-2017 3% per year requirements for the RFP attainment year are provided for the DFW area in Lines 7, 8 and 9 of Table 3-2, and, for the HGB area in Lines 4 and 5 of Table 3-3.

Equation 3-3A: $RPR_{AY, VOC} = [\ BY_{2011, VOC}\ ] \times PV_{AY}$

and

Equation 3-3B: $RPR_{AY, NOx} = [\ BY_{2011, NOx}\ ] \times PN_{AY}$

where:

AY = RFP analysis year

$RPR_{AY, VOC}$ = required VOC emission reductions between 2011 and AY

$RPR_{AY, NOx}$ = required NO_X emission reductions between 2011 and AY

$BY_{2011, VOC}$ = 2011 base year EI for VOC

$BY_{2011, NOx}$ = 2011 base year EI for NO_X

PV_{AY} = percentage VOC reductions for year AY

PN_{AY} = percentage NO_X reductions for year AY

Step three of the RFP target calculation process, calculating RFP target levels of emissions, is accomplished by subtracting the required emissions reductions (step two) from the 2011 base year EI. The target level represents the level of emissions for each RFP analysis year, for each county group, for the HGB and DFW nonattainment areas to meet their 2008 eight-hour ozone standard RFP requirements. The method for calculating the target levels of emissions for the DFW and HGB RFP analysis years is shown in Equation 3-4.

Equation 3-4: $TL_{AY, X} = TL_{(AY-1), X} - RPR_{AY, X}$

where:

AY = RFP analysis year

$AY - 1$ = previous RFP analysis year

$TL_{AY, X}$ = target level of emissions for AY

$TL_{(AY-1), X}$ = target level of emissions for the previous RFP analysis year (Note: For 2017, the target level of emissions for the previous RFP analysis year is equal to the 2011 base year EI.)

$RPR_{AY, X}$ = emission reduction requirement for AY for pollutant X

X = either VOC or NO_X

The calculations of the target values for the RFP attainment year for the DFW and HGB RFP demonstrations are documented in Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet* and Appendix 2: *HGB Reasonable Further Progress*

Demonstration Spreadsheet. Table 3-2 and Table 3-3 provide a step-by-step summary of the calculation of the 2020 DFW and HGB RFP target levels of VOC and NO_X emissions.

In Section 3.5: *RFP Demonstration*, the target levels are integrated into the RFP demonstration.

3.4 GROWTH

This DFW and HGB RFP SIP revision must account for any growth in emissions between the RFP base year (2011) and the attainment year (2020). For future analysis years, the uncontrolled (for mobile sources) or existing controlled (for stationary sources) NO_X and VOC emissions inventories are developed by applying the appropriate projection methodologies to the most recent EI estimates, emissions factors, and/or to activity-level estimates. The resulting emissions inventories include any growth between 2011 and 2020.

The projection methodology for the uncontrolled or existing controlled RFP EI excludes changes in the emissions factor due to control strategies so that the projections represent the total growth in emissions. When the creditable RFP control reductions are subtracted from uncontrolled or existing controlled projected emissions inventories that include growth, the result will be the forecasted controlled RFP emissions.

The controlled RFP emissions are compared to the target emissions levels to determine if a nonattainment area successfully demonstrates RFP, thereby meeting RFP requirements. The method for accounting for growth is based on EPA guidance for performing RFP calculations.[12] The development of the uncontrolled or existing controlled projected EI is documented in Chapter 2: *Emissions Inventories*. The development of the projected control reductions is documented in Chapter 4: *Control Measures to Achieve Target Levels*.

3.5 RFP DEMONSTRATION

The EPA's final 2008 eight-hour ozone standard SIP requirements rule requires the RFP control strategy plan to show ozone precursor (NO_X and VOC) emissions reductions that will reduce controlled RFP analysis year emissions to values equal to or less than the emissions target values. To demonstrate RFP, the creditable RFP control reductions are subtracted from the uncontrolled or existing controlled forecast EI for each RFP analysis year. The contingency reductions for the one-year period from January 1, 2018 through December 31, 2018 set aside under the previous moderate nonattainment SIP revisions for the 2008 eight-hour ozone NAAQS are reserved to avoid double-counting these reductions. The RFP requirement is met for each analysis year if the resulting controlled RFP EI forecast is less than the target level of emissions. The following two sections provide the DFW and HGB RFP demonstrations for this RFP SIP revision.

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[12] United States Environmental Protection Agency, "Final Rule to Implement the 8-Hour Ozone National Ambient Air Quality Standard; Final Rule," *Federal Register* (70 FR 71631), November 29, 2005.

3.5.1 DFW RFP Demonstration

The RFP demonstration calculations were completed for the 2020 DFW attainment year. A summary of the 2020 DFW RFP demonstration is provided in Table 3-4*: Summary of the 2020 DFW RFP Demonstration (tons per day)*. As concluded in the final row of the table, the 10-county DFW area demonstrates the required RFP emission reductions for 2020. All RFP calculations, including the required reductions and the target emissions levels, are calculated and shown in Appendix 1. Details of the emissions reductions used to calculate the creditable RFP control reductions for 2020 are documented in Chapter 4 and summarized in Table 4-1: *Summary of DFW RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day).*

Table 3-4: Summary of the 2020 DFW RFP Demonstration (tons per day)

Line	Description	NO_X	VOC
Line 1	Uncontrolled or existing controlled 10-county DFW 2020 emissions forecast with growth	1307.94	855.96
Line 2	Creditable 10-county DFW RFP control reductions between 2011 and 2020	1023.27	432.82
Line 3	Controlled 10-county DFW 2020 RFP emissions forecast (Line 1 minus Line 2)	284.67	423.14
Line 4	Amount of creditable reductions reserved for 2017 to 2018 RFP milestone contingency	8.44	4.65
Line 5	Controlled 10-county DFW 2020 RFP emission forecast with 2018 contingency (Line 3 plus Line 4)	293.11	427.79
Line 6	Amount of NO_X reduction substitution (see Sheet 9)	0.00	0.00
Line 7	Controlled 10-county DFW 2020 RFP forecast without reductions reserved for contingency and accounting for NO_X substitution (Line 5 plus Line 6)	293.11	427.79
Line 8	10-county DFW 2020 RFP target level of emissions	334.10	450.79
Line 9	Excess (+) / Shortfall (-) (Line 8 minus Line 7)	+ 40.99	+ 23.00
Line 10	Is controlled RFP EI less than target level of emissions?	Yes	Yes

3.5.2 HGB RFP Demonstration

The RFP demonstration calculations were completed for the 2020 HGB attainment year. A summary of the 2020 HGB RFP demonstration is provided in Table 3-5*: Summary of the 2020 HGB RFP Demonstration (tons per day)*. As concluded in the final row of the table, the eight-county HGB area demonstrates the required RFP emission reductions for 2020. All RFP calculations, including the required reductions and the target emissions levels, are calculated and shown in Appendix 2. Details of the emissions reductions used to calculate the creditable RFP control reductions for 2020 are documented in Chapter 4 and summarized in Table 4-2: *Summary of HGB NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day).*

Table 3-5: Summary of the 2020 HGB RFP Demonstration (tons per day)

Line	Description	NO_X	VOC
Line 1	Uncontrolled or existing controlled eight-county HGB 2020 emissions forecast with growth	1165.66	854.65
Line 2	Creditable RFP control reductions between 2011 and 2020	821.70	370.04
Line 3	Controlled eight-county HGB 2020 RFP emissions forecast (Line 1 minus Line 2)	343.96	484.61
Line 4	Amount of creditable reductions reserved for 2017-to-2018 RFP milestone contingency	13.29	0.00
Line 5	Controlled eight-county HGB 2020 RFP emission forecast accounting for 2018 contingency (Line 3 plus Line 4)	357.25	484.61
Line 6	Amount of NO_X reduction substitution	0.00	0.00
Line 7	Controlled 2020 RFP forecast without reductions reserved for contingency and accounting for NO_X substitution (Line 5 plus Line 6)	357.25	484.61
Line 8	2020 RFP target level of emissions	371.17	493.33
Line 9	Excess (+) / Shortfall (-) (Line 8 minus Line 7)	+13.92	+8.72
Line 10	Is controlled RFP EI less than target level of emissions?	Yes	Yes

CHAPTER 4: CONTROL MEASURES TO ACHIEVE TARGET LEVELS

4.1 OVERVIEW OF CONTROL MEASURES

This chapter describes the methods used to achieve the emissions reductions in volatile organic compounds (VOC) and nitrogen oxides (NO_X) required to demonstrate reasonable further progress (RFP) for both the Dallas-Fort Worth (DFW) 2008 eight-hour ozone nonattainment area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties) and the Houston-Galveston-Brazoria (HGB) 2008 eight-hour ozone nonattainment area (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties).

The projected emissions reductions reflect the identified federal and state emissions controls. All state control measures are codified in regulations for the State of Texas. Control measures used for RFP do not include all emissions reduction programs and requirements for the DFW and HGB areas. Only the controls used to meet the DFW and HGB RFP requirements for the 2020 attainment year are presented in Table 4-1: *Summary of DFW RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day)* and Table 4-2: *Summary of HGB RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day).*

Individual and total values shown in the summary tables have been extracted from the spreadsheets in Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet* and Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet.*

Table 4-1: Summary of DFW RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day)

Control Strategy Description	NO_X Reduction	VOC Reduction
Chapter 117 NO_X controls[1]	0.00	0.00
Chapter 115 storage tank rules	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers[1]	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	796.66	290.23
Reformulated Gasoline (RFG)[2]/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra-Low Sulfur Diesel	54.23	15.17
Inspection and Maintenance (I/M)	6.87	8.14
On-road Texas Low Emissions Diesel (TxLED)	2.65	0.00
Tier I and II locomotive NO_X standards	19.15	0.74
Small non-road spark ignition (SI) engines (Phase I)[3]	-3.88	33.19
Heavy duty non-road engines	37.44	14.79
Tiers 2 and 3 non-road diesel engines	38.06	3.15
Small non-road SI engines (Phase II)	2.71	32.19
Large non-road SI and recreational marine	36.77	16.48
Non-road TxLED	3.89	0.00
Non-road RFG	0.01	0.49
Tier 4 non-road diesel engines	25.93	1.14
Diesel recreational marine	0.00	0.00

Control Strategy Description	NO_X Reduction	VOC Reduction
Small SI (Phase III)	2.47	16.99
Chapter 117 NO_X area source engine controls[1]	0.00	0.00
Drilling rigs: federal engine standards and TxLED	0.31	0.11
Sum of reductions from projected uncontrolled or existing controlled emissions	1,023.27	432.82

Note 1: These rules had compliance deadlines before 2011 in the DFW area. The 2011 base year emissions inventory (EI) includes the effect of the control. No additional emissions reductions beyond 2011 are claimed.

Note 2: The 10-county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with federal RFG are: Collin, Dallas Denton and Tarrant. The six counties with Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise.

Note 3: The small SI Phase 1 rule is shown to provide a substantial reduction in VOC emissions. A slight increase in NO_X emissions is due to the engine modifications required to meet the VOC and CO standards of the Small SI Phase 1.

Table 4-2: Summary of HGB RFP NO_X and VOC Cumulative Emissions Reductions from Control Strategies for 2011 through 2020 (tons per day)

Control Strategy Description	NO_X Reduction	VOC Reduction
Chapter 117 NO_X controls	0.00	0.00
Chapter 115 Storage Tank Rule	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers	0.00	0.00
FMVCP	561.84	245.62
RFG/Low Sulfur Gasoline/Ultra-Low Sulfur Diesel	101.55	16.96
I/M	5.13	7.39
On-road TxLED	2.39	0.00
Tier I and II locomotive NO_X standards	21.02	0.81
Small non-road SI engines (Phase I)[1]	-3.17	25.60
Heavy duty non-road engines	26.71	13.71
Tiers 2 and 3 non-road diesel engines	30.22	2.62
Small non-road SI engines (Phase II)	2.22	23.67
Large non-road SI and recreational marine	37.37	16.51
Non-road TxLED	1.36	0.00
Non-road RFG	0.01	0.73
Tier 4 non-road diesel engines	17.70	0.78
Diesel recreational marine	0.00	0.00
Small SI (Phase III)	2.16	15.43
Chapter 117 NO_X area source engine controls	0.00	0.00
Drilling rigs: federal engine standards and TxLED	0.43	0.09
Commercial marine vessel engine certification standards and fuel programs	14.76	0.12
Sum of reductions from projected uncontrolled or existing controlled emissions	821.70	370.04

Note 1: The small SI Phase 1 rule is shown to provide a substantial reduction in VOC emissions. A slight increase in NO_X emissions is due to the engine modifications required to meet the VOC and CO standards of the Small SI Phase 1.

4.2 POINT SOURCE CONTROLS

Specific point source controls required by state rules and the associated emissions reductions were incorporated into the 2011 base year inventory and the 2020 attainment-year inventory, as appropriate, according to compliance deadlines. These controls include Title 30 Texas Administrative Code (TAC) Chapter 117 reductions of NO_X emissions from cement plants, electric generating units, internal combustion engines, and heaters and 30 TAC Chapter 115 reductions of VOC emissions, which had compliance deadlines before 2011. Point source emissions for attainment year 2020 are summarized in Table 4-3: *DFW RFP 2020 Point Source Emissions and Reductions for NO_X and VOC (tons per day)* and Table 4-4: *HGB RFP 2020 Point Source Emissions and Reductions for NO_X and VOC (tons per day).*

Table 4-3: DFW RFP 2020 Point Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011)	46.83	24.35
RFP point source reduction	0.00	0.00
RFP post-2011 controlled emissions	46.83	24.35

Table 4-4: HGB RFP 2020 Point Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011	131.06	85.23
RFP point source reduction	0.00	0.00
RFP post-2011 controlled emissions	131.06	85.23

4.3 AREA SOURCE CONTROLS

Area source controls required by state and federal rules and the associated emissions reductions were incorporated into the 2011 base year inventory and the 2020 attainment year inventory, as appropriate, according to compliance deadlines. These controls include 30 TAC Chapter 117 reductions of NO_X emissions from internal combustion engines in the HGB and DFW areas, which had compliance deadlines before 2011; and the federal portable fuel containers rule, which also had compliance deadlines prior to 2011. Other reductions, including Federal New Source Performance Standards Subpart OOOO emissions reductions, are included in the projection base year EI (2017) for this state implementation plan (SIP) revision and are included in the 2020 attainment year EI.

Area source emissions for attainment year 2020 are summarized in Table 4-5: *DFW RFP 2020 Area Source Emissions and Reductions Summary for NO_X and VOC (tons per day) and* Table 4-6: *HGB RFP 2020 Area Source Emissions and Reductions Summary of NO_X and VOC (tons per day).*

Table 4-5: DFW RFP 2020 Area Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011)	38.69	299.22
RFP area source reduction	0.00	0.00
RFP post-2011 controlled emissions	38.69	299.22

Table 4-6: HGB RFP 2020 Area Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Existing controlled emissions (specified controls implemented as of 2011)	30.04	310.98
RFP area source reduction	0.00	0.00
RFP post-2011 controlled emissions	30.04	310.98

4.4 NON-ROAD MOBILE SOURCE CONTROLS

Non-road mobile source controls required by state and federal rules and the associated emissions reductions were incorporated into the 2011 base year inventory and the 2020 attainment year inventory, as appropriate, according to compliance deadlines. Emissions reductions were calculated as detailed in the following sections. Summaries of all non-road mobile source RFP emissions inventories and control strategy reductions are presented in Table 4-7: *DFW RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)* and Table 4-8: *HGB RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day).*

Table 4-7: DFW RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Uncontrolled emissions	264.52	162.12
RFP non-road source reduction	162.86	119.28
RFP controlled (post-control) emissions	101.66	42.84

Table 4-8: HGB RFP 2020 Non-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Emissions	NO_X	VOC
Uncontrolled emissions	254.17	136.26
RFP non-road source reduction	150.79	100.07
RFP controlled (post-control) emissions	103.38	36.19

4.4.1 NONROAD Model Categories

For this DFW and HGB RFP SIP revision, the Texas NONROAD Model (TexN) 1.7.2 model was run using county-specific population and activity files, where available. To evaluate RFP requirements, a series of TexN model runs was performed for both controlled and uncontrolled scenarios for each federal and state control program and each analysis year. The applicable federal and state rules that were modeled are located in Section 4.1*: Overview of Control Measures*. The emissions inventories developed include county-level ozone season daily controlled and uncontrolled emissions estimates for the 2011 and 2020 analysis years for the DFW and HGB nonattainment areas.

Emissions reductions from individual federal and state controls for non-road equipment were calculated by subtracting the controlled (post-control) emissions estimates from the uncontrolled emissions estimates.

4.4.2 Non-Road Categories Not Included in the EPA NONROAD Model

Emissions from the non-road mobile sources that are not estimated using the TexN model include commercial marine vessels (CMV), locomotives, aircraft, auxiliary power units (APU), and ground support equipment (GSE), and drilling rigs used in upstream oil and gas exploration activities. Emissions for those source categories were calculated using alternate United States Environmental Protection Agency (EPA)-approved methods and guidance.

4.4.2.1 Drilling Rigs

The 2011 emissions were developed by using 2011 drilling activity data combined with the 2011 year-specific controlled and uncontrolled emission factors from Appendix 8: *2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories.* A 2020 EI for drilling rigs was developed using 2017 drilling activity data and the 2020 year-specific controlled and uncontrolled emission factors from Appendix 8. Because future drilling activity is difficult to predict, the 2017 drilling activity data were held constant to the attainment year since those were the most current data available. Emissions reductions from individual federal and state controls for these specific types of non-road equipment were calculated by subtracting the controlled (post-control) emissions estimates from the uncontrolled emissions estimates.

4.4.2.2 Commercial Marine Vessels and Locomotives

Controlled emissions for CMV were based on emissions factors developed by Eastern Research Group, Inc. (ERG) with guidance from the EPA, which took into account fleet turnover and the implementation of state and federal regulatory programs. Uncontrolled emissions were based on a separate set of emissions factors that excluded adjustments for fleet turnover and the implementation of state and federal regulatory programs. Documentation of methods and procedures used in developing the CMV emissions inventories can be found in Appendix 9: *2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories.*

The locomotive EI was developed from a Texas Commission on Environmental Quality (TCEQ)-commissioned study using EPA-accepted EI development methods. The locomotive EI includes line haul and yard emissions activity data from all Class I, II, and III locomotive activity and emissions by rail segment. Controlled emissions for locomotive sources were determined by applying activity adjustment factors by source classification code and emissions rate adjustment factors. The emissions rate adjustment factors were obtained from the EPA's Emission Factors for Locomotives

Fact Sheet (https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100500B.TXT). Documentation of methods and procedures used by ERG in developing the locomotive emissions inventories can be found in Appendix 10: *2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories*. The emissions inventories developed include county-level ozone season day controlled and uncontrolled emissions estimates for 2011 and 2020.

4.4.2.3 Airports

Emissions for aircraft, APU and GSE were calculated using the Federal Aviation Administration's Aviation Environmental Design Tool (AEDT). The updated controlled analysis year emissions for the airports were calculated based on the information provided by ERG in Appendix 11: *Development of the Statewide Aircraft Inventory for 2011* and Appendix 12: *Development of the Statewide Aircraft Inventory for 2020.* Control strategies for airport emissions included emission reductions from GSE and APU electric conversions.

4.5 ON-ROAD MOBILE SOURCE CONTROLS

The on-road mobile source emissions inventories and the corresponding on-road mobile source control strategy reductions for this DFW and HGB RFP SIP revision were developed using the Motor Vehicle Emissions Simulator (MOVES) 2014a model. The TCEQ recently completed development of 2011, 2020, and 2021 on-road emission inventories for the DFW and HGB areas. The inventories were completed under contract with the North Central Texas Council of Governments (NCTCOG) and the Texas A&M Transportation Institute for the DFW and HGB areas, respectively.

For RFP analyses, the requirement to calculate and account for non-creditable emissions reductions due to pre-1990 FMVCP reductions was removed under the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule.* The RFP analyses presented in this DFW and HGB RFP SIP revision do not include any of the RFP elements or non-creditable effects related to the pre-1990 FMVCP. The on-road mobile control strategy reduction summaries and documentation do not include quantification of the pre-1990 FMVCP as a separate reduction.

4.5.1 DFW RFP On-Road Mobile Source Control Strategies

The on-road mobile emissions inventories were developed using emissions factors that reflect creditable control strategies for each analysis year. The controls that were modeled include: pre-1990 FMVCP, post-1990 FMVCP, ultra-low sulfur diesel, summer RFG, the East Texas Regional Low RVP Gasoline Program, the vehicle I/M program, Tier 3 FMVCP, the lower sulfur gasoline associated with Tier 3 FMVCP, and TxLED. A summary of the DFW on-road mobile source control strategies used for the DFW RFP demonstration is presented in Table 4-9: *Summary of DFW On-Road Mobile Control Strategies.*

Table 4-9: Summary of DFW On-Road Mobile Control Strategies

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
Pre-1990 FMVCP	Pre-1990 control	Pre-1990	No
1992 Federal Controls on Gasoline Volatility	Pre-1990 control. Collin, Dallas, Denton and Tarrant Counties: Maximum Reid Vapor Pressure of 7.8 pounds per square inch Ellis, Johnson, Kaufman, Parker, Rockwall and Wise: Maximum Reid Vapor Pressure of 9.0 pounds per square inch	1992	No
Anti-Tampering Program (Dallas and Tarrant counties only)	According to Section 2.8.9.3 of the MOBILE6.2 User's Guide, "the mere presence of an I/M program is expected to act as a deterrent to tampering… All 1996 and newer model year vehicles are assumed to have negligible tampering effects. As a result, there is no tampering reduction benefit associated with the 1996 and newer vehicles." Section 5.2 of the MOBILE6.2 User's Guide elaborates further by stating that "with the introduction of the phase 2 of the onboard diagnostic (OBD) electronics in 1996, the explicit modeling of the effects of tampering on vehicle emissions will phase out because OBD vehicles are assumed to have negligible tampering rates." Year 1995-and-older vehicles are currently a very small portion of the fleet, and their total number will continue to decline with fleet turn-over.	1986	No
I/M Program (Dallas and Tarrant counties only)	None	1990	Yes
Tier 1, FMVCP	None	1994	Yes
Reformulated Gasoline	Collin, Dallas, Denton and Tarrant Counties only	1995 for phase one, 2000 for phase two	Yes

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
East Texas Regional Low RVP Gasoline Program	Ellis, Johnson, Kaufman, Parker, Rockwall and Wise Counties	2000	Yes
National Low Emission Vehicle Program	None	2001	Yes
Expanded I/M and ATP	Expanded to Collin, Denton counties	2002	Yes
Expanded I/M and ATP	Expanded to Ellis, Johnson, Kaufman, Parker, and Rockwall Counties	2003	Yes
Tier 2, FMVCP	Phase in from 2004 to 2009	2004	Yes
TxLED	15 parts per million maximum sulfur content. Low aromatic hydrocarbon and high cetane number to control NO_X	2006	Yes
Ultra-Low-Sulfur Diesel	15 parts per million maximum sulfur content	2006	Yes
2007 Heavy duty FMVCP	Phase in from 2007 to 2010	2007	Yes
Tier 3, FMVCP	Phase in from 2017 to 2025	2017	Yes
I/M Program (Dallas and Tarrant counties only)	None	1990	Yes

4.5.2 HGB RFP On-Road Mobile Source Control Strategies

The on-road mobile emissions inventories were developed using emission factors that reflect all creditable control strategies for each analysis year. The controls that were modeled include: pre-1990 FMVCP, post-1990 FMVCP, summer RFG, the HGB vehicle I/M program, the lower sulfur gasoline associated with Tier 3 FMVCP, ultra-low sulfur diesel, and TxLED. A summary of the HGB on-road mobile source control strategies used for the HGB RFP demonstration is presented in Table 4-10: *Summary of HGB On-Road Mobile Control Strategies.*

Table 4-10: Summary of HGB On-Road Mobile Control Strategies

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
Pre-1990 FMVCP	Pre-1990 control	Pre-1990	No
1992 Federal Controls on Gasoline Volatility	Pre-1990 control. Maximum Reid Vapor Pressure of 7.8 pounds per square inch.	1992	No
I/M Program	Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties	1997	Yes
Tier 1, FMVCP	Included in MOVES post-1990 FMVCP	1994	Yes

Control Program Description	Additional Information	Year Control Program Started	Creditable for RFP
RFG	Eight HGB counties	1995 for phase one, 2000 for phase two	Yes
National Low Emission Vehicle Program	Included in MOVES post-1990 FMVCP	2001	Yes
Tier 2, FMVCP	Phased in from 2004 to 2009. Included in MOVES post-1990 FMVCP.	2004	Yes
TxLED	15 parts per million (ppm) maximum sulfur content. Low aromatic hydrocarbon and high cetane number to control NO_X.	2006	Yes
Ultra-Low-Sulfur Diesel	15 ppm maximum sulfur content	2006	Yes
2007 Heavy Duty FMVCP	Phased in from 2007 to 2010. Included in MOVES post-1990 FMVCP.	2007	Yes
Tier 3, FMVCP	Phased in from 2017 to 2025. Included in MOVES post-1990 FMVCP.	2017	Yes
Tier 3, Low Sulfur Gasoline	A part of the Tier 3 FMVCP lowers the limit on gasoline sulfur content; also improves the performance of Tier 2 equipment	2017	Yes

4.5.3 On-Road Mobile Source Control Strategy Reductions

The projected mobile source emissions inventories documented in Appendix 13: *Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021* and Appendix 14: *Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories* include quantification of emissions reductions for all federal and state on-road mobile source control rules for the attainment year for the DFW and HGB nonattainment areas. A summary of the on-road mobile control scenarios included in the 2011, 2020, and 2021 RFP emissions inventories is presented in Table 4-11: *DFW Control Programs Modeled for each RFP Control Scenario* and Table 4-12: *HGB Control Programs Modeled for each RFP Control Scenario*. The summary of 2020 uncontrolled emissions, control program reductions, and controlled (post-control) emissions for on-road mobile sources in the DFW and HGB nonattainment areas may be found in Table 4-13: *DFW RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)* and Table 4-14: *HGB RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)* for the DFW and HGB areas, respectively.

Table 4-11: DFW Control Programs Modeled for each RFP Control Scenario

Control Scenario Description	Controls Modeled
Control Scenario 1 Pre-1990 Controls Only (for RFP purposes, this is the uncontrolled emissions inventory)	Pre-1990 FMVCP and 1992 federal controls on gasoline volatility
Control Scenario 2	Add: Post-1990 FMVCP (Tier 1 FMVCP, Tier 2 FMVCP, 2007 heavy duty diesel FMVCP, Tier 3 FMVCP)
Control Scenario 3	Add: Federal RFG with Tier 3 sulfur levels (Collin, Dallas, Denton and Tarrant Counties) and East Texas Regional Low RVP Gasoline Program with Tier 3 sulfur levels (Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise Counties) and ultra-low sulfur diesel (All DFW counties)
Control Scenario 4	Add: DFW I/M program: modeled for Dallas, Collin, Denton Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties
Control Scenario 5 RFP Post-Control Emissions	Add: TxLED program, 15 ppm maximum sulfur content, low aromatic hydrocarbons, and high cetane number to control NO_X

Table 4-12: HGB Control Programs Modeled for each RFP Control Scenario

Control Scenario Description	Controls Modeled
Control Scenario 1 Pre-1990 Controls Only (for RFP purposes, this is the uncontrolled emissions inventory)	Pre-1990 FMVCP and 1992 federal controls on gasoline volatility
Control Scenario 2	Add: Federal RFG with Tier 3 sulfur levels and ultra-low sulfur diesel
Control Scenario 3	Add: Post-1990 FMVCP (Tier 1 FMVCP, Tier 2 FMVCP, 2007 heavy duty diesel FMVCP, Tier 3 FMVCP)
Control Scenario 4	Add: HGB I/M program: modeled for Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties

Control Scenario Description	Controls Modeled
Control Scenario 5 RFP Post-Control Emissions	Add: TxLED program, 15 ppm maximum sulfur content, low aromatic hydrocarbons, and high cetane number to control NO_X

Table 4-13: DFW RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Inventory or Control Strategy Description	NO_X	VOC
2020 uncontrolled emissions	957.90	370.27
Post-1990 FMVCP	796.66	290.23
On-road RFG with Tier 3 sulfur and ultra-low sulfur diesel	54.23	15.17
DFW I/M program	6.87	8.14
On-road TxLED	2.65	0.00
2020 RFP controlled (post-control) emissions	97.49	56.73

Table 4-14: HGB RFP 2020 On-Road Mobile Source Emissions and Reductions Summary for NO_X and VOC (tons per day)

Inventory or Control Strategy Description	NO_X	VOC
2020 uncontrolled emissions	750.39	322.18
Post-1990 FMVCP	561.84	245.62
On-road RFG with Tier 3 sulfur and ultra-low sulfur diesel	101.55	16.96
HGB I/M program	5.13	7.39
On-road TxLED	2.39	0.00
2020 RFP controlled (post-control) emissions	79.48	52.21

4.6 VEHICLE MILES TRAVELED DEMONSTRATION

Transportation control measures (TCM) are required to offset growth in vehicle miles traveled (VMT) that result in an increase in vehicle emissions for nonattainment areas classified as serious under the National Ambient Air Quality Standards (NAAQS). There is growth in VMT for the DFW and HGB ozone nonattainment areas for the years between the RFP base year of 2011 and the attainment year, 2020, as illustrated in Figure 4-1: *2011 and 2020 DFW and HGB RFP VMT Trends (miles per day)*. However, the growth in VMT for both areas is more than offset by control measures that reduce the per-mile emission rates, resulting in a decrease in emissions of both VOC and NO_X for the same time period, as shown in Figure 4-2: *DFW 2011 and 2020 RFP NO_X and VOC Emissions (tons per day)* and Figure 4-3: *HGB 2011 and 2020 RFP NO_X and VOC Emissions (tons per day).* The increase in VMT and decrease in vehicle emissions for the RFP time period are summarized in Table 4-15: *DFW RFP On-Road Mobile Controlled NO_X Emissions, VOC Emissions, and Vehicle Miles Traveled* and Table 4-16: *HGB RFP On-Road Mobile Controlled NO_X Emissions, VOC Emissions, and Vehicle Miles Traveled.* A list of the DFW and HGB on-road mobile source control measures used to demonstrate RFP in this SIP revision are provided in Tables 4-9 and Table 4-10. Since vehicle emissions are decreasing with the current list of controls, no additional controls from TCMs are required.

Table 4-15: DFW RFP On-Road Mobile Controlled NO_x Emissions, VOC Emissions, and Vehicle Miles Traveled

RFP Analysis Year	NO_x (tons per day)	VOC (tons per day)	VMT (miles per day)
2011 Base Year	239.07	102.24	191,251,636
2020 Attainment Year	97.49	56.73	231,949,231

Table 4-16: HGB RFP On-Road Mobile Controlled NO_x Emissions, VOC Emissions, and Vehicle Miles Traveled

RFP Analysis Year	NO_x (tons per day)	VOC (tons per day)	VMT (miles per day)
2011 Base Year	168.60	80.45	145,136,623
2020 Attainment Year	79.48	52.21	193,683,005

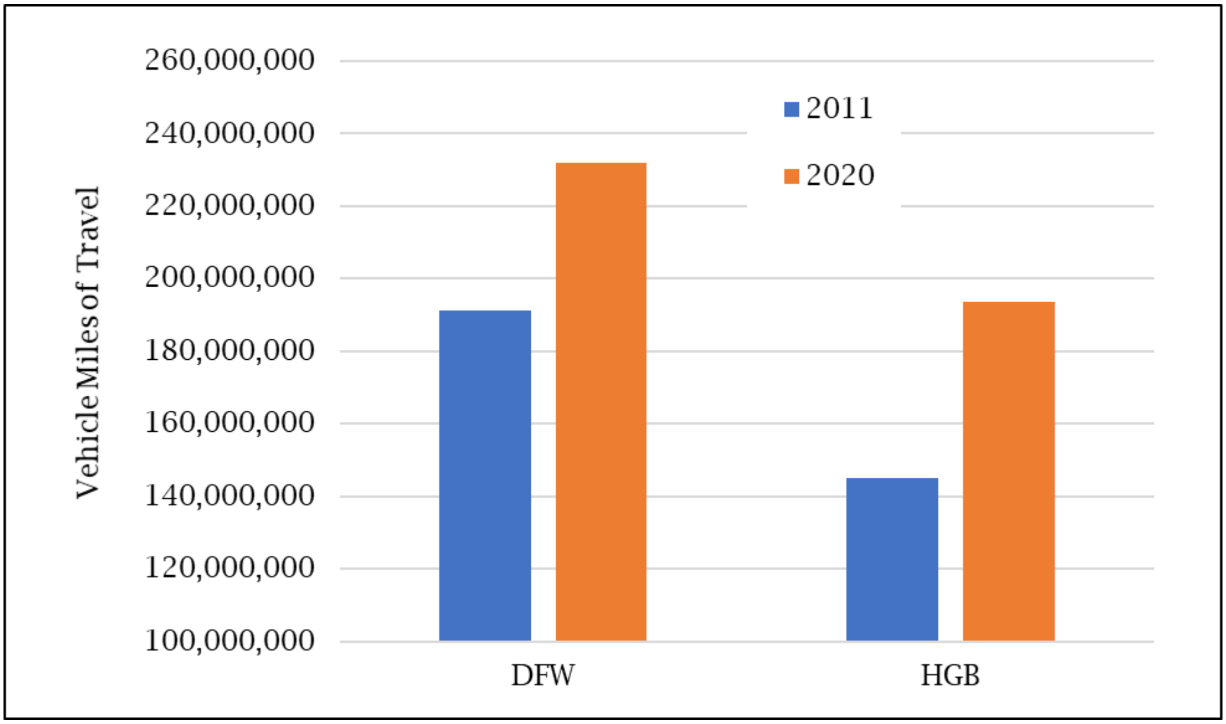

Figure 4-1: 2011 and 2020 DFW and HGB RFP VMT Trends (miles per day)

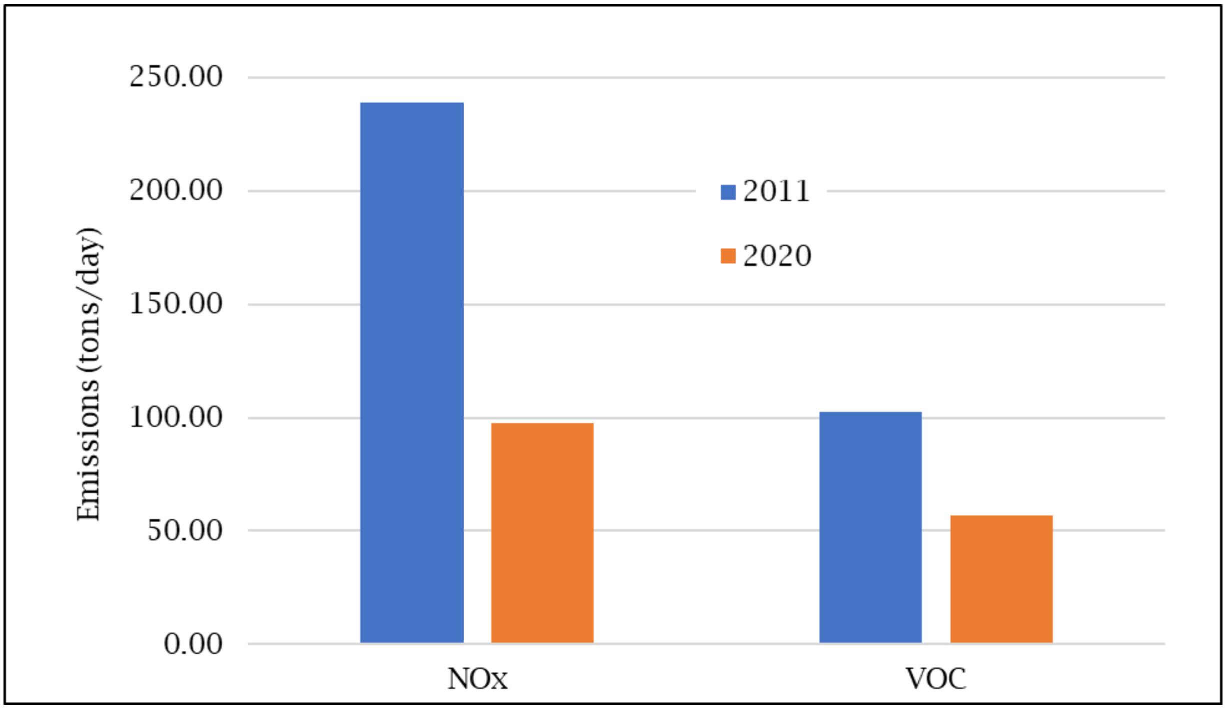

Figure 4-2: DFW 2011 and 2020 RFP NO_x and VOC Emissions (tons per day)

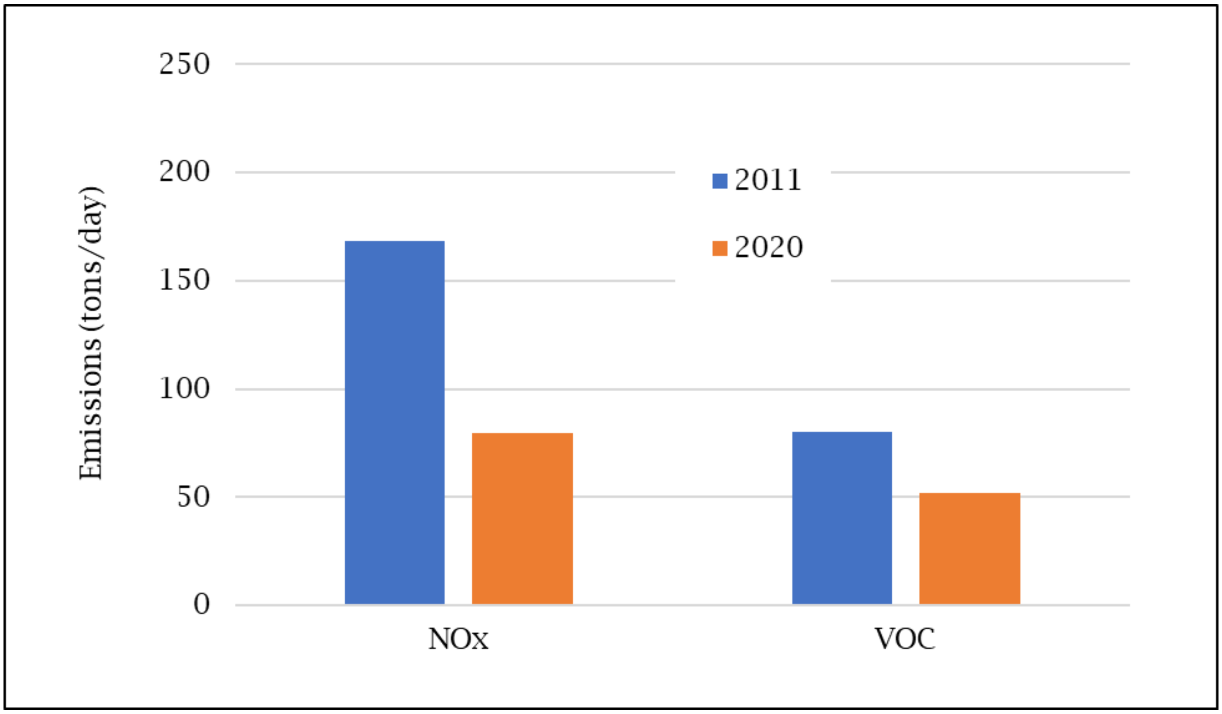

Figure 4-3: HGB 2011 and 2020 RFP NO_x and VOC Emissions (tons per day)

4.7 CONTINGENCY MEASURES

The RFP requirements include a 3% contingency demonstration for the one-year period after each RFP analysis year and the one-year period after the attainment year. In the event an RFP requirement is not met, the contingency control measures will provide the required emissions reduction. For this DFW and HGB RFP SIP revision, the only RFP analysis year is the attainment year. As with the 3% per year reduction requirement, the 3% contingency requirement is based on the RFP base year EI and may be met using VOC and/or NO_x reductions. This section contains an attainment year RFP contingency demonstration based on the 2020 attainment year.

The 3% attainment year RFP contingency analysis is based on a 2% reduction in NO_x and a 1% reduction in VOC for the DFW area and a 3% reduction in NO_x only (no VOC reduction) for the HGB area to be achieved for the one-year period from January 1, 2021 through December 31, 2021. EI analyses were performed for fuel control programs and for the fleet turnover effects for the federal emissions certification programs for on-road and non-road vehicles. The emissions reductions for the year between 2020 and 2021 were estimated for those programs in both the DFW and HGB areas. Controlled (post-control) emissions reductions not previously used in the 2020 RFP demonstration may also be used to satisfy contingency requirements, so the excess emissions reductions from the 2020 RFP demonstration are included in the contingency analysis. This DFW and HGB RFP SIP revision provides for a motor vehicle emissions budget (MVEB) safety margin using some of the excess emissions reductions from the 2020 RFP demonstration; those emissions are subtracted from the amount available to demonstrate RFP contingency for the 2020 attainment year. The MVEB safety margin has been set to use 23.8% of the excess NO_x reductions and 24.7% of the excess VOC reductions in the DFW area and 59% of the excess NO_x reductions and 63% of the excess VOC reductions in the HGB area and is reflected in the contingency calculation. Summaries of the 2020 attainment year RFP contingency analyses for DFW and HGB are provided in Table 4-17*: DFW RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted)* and Table 4-18: *HGB RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted).*

The analysis demonstrates that the attainment year RFP contingency reductions exceed the 3% reduction requirement; therefore, the RFP contingency requirement is fulfilled for the DFW and HGB areas.

Table 4-17: DFW RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted)

Line	Contingency Demonstration Description	NO_x	VOC
Line 1	2011 base year (BY) emissions inventory	422.04	464.92
Line 2	Percent for 2020 attainment year contingency calculation (total of 3%)	2.00	1.00
Line 3	Required contingency reductions between 2020 and 2021 (BY emissions inventory multiplied by contingency percent: Line 1 multiplied by Line 2)	8.44	4.65
	Control reductions to meet contingency requirements	**NO_x**	**VOC**
Line 4	Excess reductions from 2020 RFP demonstration (from Table 3-4: *Summary of the 2020 DFW RFP Demonstration [tons per day]*)	40.99	23.00

Line	Contingency Demonstration Description	NO_x	VOC
Line 5	Subtract 2020 RFP demonstration MVEB safety margin from excess reductions from 2020 RFP demonstration (see Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet*, Sheet 6)	-9.76	-5.68
Line 6	2020 to 2021 emission reductions due to FMVCP, (I/M, RFG/East Texas Regional Low RVP,2017 low sulfur gasoline standard on-road TxLED, and Ultra-Low Sulfur Diesel (ULSD) (Note: The 10-county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with RFG are: Collin, Dallas Denton and Tarrant. The six counties with Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall and Wise)	24.69	9.12
Line 7	2020 to 2021 emission reductions due to federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	2.75	2.48
Line 8	Total RFP demonstration contingency reductions (sum of Line 4, Line 5, Line 6, and Line 7)	58.67	28.92
Line 9	**Contingency Excess (+) or Shortfall (–) (Line 8 minus Line 3)**	+ 50.23	+ 24.27

Table 4-18: HGB RFP Contingency Demonstration for the 2020 Attainment Year (tons per day unless otherwise noted)

Line	Contingency Demonstration Description	NO_x	VOC
Line 1	2011 base year (BY) emissions inventory	442.92	535.06
Line 2	Percent for 2020 attainment year contingency calculation (total of 3%)	3.00	0.00
Line 3	Required contingency reductions between 2020 and 2021 (BY emissions inventory multiplied by contingency percent: Line 1 multiplied by Line 2)	13.29	0.00
	Control reductions to meet contingency requirements	**NO_x**	**VOC**
Line 4	Excess reductions from 2020 RFP demonstration (from Table 3-5: *Summary of the 2020 HGB RFP Demonstration [tons per day]*)	13.92	8.72
Line 5	Subtract 2020 RFP demonstration MVEB safety margin from excess reductions from 2020 RFP demonstration (see Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet*, Sheet 6)	-8.21	-5.49
Line 6	2020 to 2021 emission reductions due to FMVCP, (I/M, RFG, 2017 low sulfur gasoline standard on-road TxLED, and ULSD	24.19	13.05
Line 7	2020 to 2021 emission reductions due to federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	4.59	2.29
Line 8	Total RFP demonstration contingency reductions (sum of Line 4, Line 5, Line 6, and Line 7)	34.49	18.57
Line 9	**Contingency Excess (+) or Shortfall (–) (Line 8 minus Line 3)**	+21.20	+18.57

CHAPTER 5: MOTOR VEHICLE EMISSIONS BUDGET

5.1 INTRODUCTION

The Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) reasonable further progress (RFP) state implementation plan (SIP) revision establishes motor vehicle emissions budgets (MVEB), setting the allowable on-road mobile emissions an area can produce while continuing to demonstrate RFP. The DFW and HGB RFP MVEBs are calculated by subtracting the on-road mobile source control strategies emissions reductions necessary to demonstrate RFP from the uncontrolled, projected on-road mobile source emissions inventories. Local transportation planning organizations use applicable MVEBs to demonstrate that projected emissions from transportation plans, programs, and projects are equal to or less than the MVEBs, as required by the federal transportation conformity rule (40 Code of Federal Regulations (CFR) Part 93, Subpart A).

The on-road mobile source emissions inventories and the corresponding MVEBs for this DFW and HGB RFP SIP revision were developed using the latest major revision to the United States Environmental Protection Agency's (EPA) mobile source emission model, the Motor Vehicle Emission Simulator (MOVES) 2014 model, MOVES2014a.[13] The Texas Commission on Environmental Quality (TCEQ), working with the North Central Texas Council of Governments (NCTCOG), and the Texas A&M Transportation Institute (TTI), recently completed development of 2011, 2020, and 2021 on-road emission inventories using MOVES2014a for the DFW and HGB areas, respectively. The planning assumptions, fleet characteristics, and vehicle miles traveled estimates were updated to incorporate the latest available information at the time the inventories and MVEBs were developed.

5.2 OVERVIEW OF METHODOLOGIES AND ASSUMPTIONS

The TCEQ developed updated on-road mobile source emissions inventories and control strategy reduction estimates using the latest planning assumptions and the EPA's MOVES2014a emissions factor model. Updated emissions inventory (EI) development included development of a 2011 base year EI, uncontrolled emissions inventories for 2020 and 2021, controlled emissions inventories for 2020 and 2021, and control strategies reduction estimates for 2020 and 2021. The TCEQ contracted NCTCOG and TTI to develop the RFP emissions inventories and control strategies reductions for the DFW and HGB areas, respectively. Detailed documentation of the on-road mobile EI development is provided in the contractor reports:

- Appendix 13: *Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021*; and
- Appendix 14: *Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories.*

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[13] For on-road EI development, MOVES2014a is technically the most recent on-road release. The more recent MOVES2014b update only impacts non-road model components and does not change the on-road portion of the model.

5.3 MOTOR VEHICLE EMISSIONS BUDGETS FOR RFP ANALYSIS YEARS

The RFP MVEBs use the on-road mobile source emissions inventories for RFP analysis years, the on-road mobile source reductions strategies used to demonstrate RFP, and a transportation conformity safety margin, if one is used. A transportation conformity safety margin is allowed when there is an excess of emissions reductions beyond those required to demonstrate RFP. However, the amount of the safety margin cannot exceed the nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions reductions required for the RFP demonstration. This ensures that even if the safety margin is used for a transportation conformity determination, the DFW and HGB 2008 eight-hour ozone nonattainment areas will meet the 2008 eight-hour ozone standard RFP requirements. Summaries of the MVEB calculations for 2020 are presented in:

- Table 5-1: *2020 RFP MVEBs for the DFW 10-County Ozone Nonattainment Area (tons per day)*; and
- Table 5-2: *2020 RFP MVEBs for the HGB Eight-County Ozone Nonattainment Area (tons per day)*.

Details for MVEB calculations are documented in Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet* for the DFW area and in Appendix 2: *HGB Reasonable Further Progress Demonstration Spreadsheet* for the HGB area. The RFP control strategies produce more than the required emissions reductions for the 2020 attainment year in both the DFW and HGB nonattainment areas. Some of the excess in emissions reductions for the 2020 attainment years is used to provide MVEB safety margins. In the DFW area, these MVEB safety margins are 10.01% for NO_X and 10.01% for VOC. The DFW percentage safety margins represent 23.8% of the excess NO_X reductions and 24.7% of the excess VOC reductions. In the HGB area, these MVEB safety margins are 10.33% for NO_X and 10.52% for VOC. The HGB percentage safety margins represent 59% of the excess NO_X reductions and 63% of the excess VOC reductions. These safety margins are less than the total emissions reductions needed for the RFP demonstration in both the DFW and HGB areas. Therefore, even if this safety margin is used, the DFW and HGB areas will still demonstrate RFP for 2020.

Table 5-1: 2020 RFP MVEBs for the DFW 10-County Ozone Nonattainment Area (tons per day)

Control Strategy Description	NO_X	VOC
2020 on-road emissions projection without post-1990 Federal Clean Air Act (FCAA) controls	957.90	370.27
Federal Motor Vehicle Control Program (FMVCP), inspection and maintenance (I/M), reformulated gasoline (RFG), East Texas Regional Low Reid Vapor Pressure Gasoline Program, on-road Texas low emission diesel (TxLED), and ultra-low sulfur diesel (ULSD).	860.41	313.54
2020 on-road emissions projection with post-1990 FCAA controls (uncontrolled emissions inventory minus control reductions)	97.49	56.73
Add transportation conformity safety margin	9.76	5.68
2020 DFW RFP MVEBs with safety margin	**107.25**	**62.41**

Table 5-2: 2020 RFP MVEBs for the HGB Eight-County Ozone Nonattainment Area (tons per day)

Control Strategy Description	NO_x	VOC
2020 on-road emissions projection without post-1990 FCAA controls	750.39	322.18
FMVCP, I/M, RFG, on-road TxLED, and ULSD	670.91	269.97
2020 on-road emissions projection with post-1990 FCAA controls (uncontrolled emissions inventory minus control reductions)	79.48	52.21
Add transportation conformity safety margin	8.21	5.49
2020 HGB RFP MVEBs with safety margin	**87.69**	**57.70**

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Appendices Available Upon Request

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

THE STATE OF TEXAS
COUNTY OF TRAVIS
I HEREBY CERTIFY THAT THIS IS A TRUE AND CORRECT COPY OF A TEXAS COMMISSION ON ENVIRONMENTAL QUALITY DOCUMENT WHICH IS FILED IN THE PERMANENT RECORDS

MAR 09 2020

OF THE COMMISSION GIVEN UNDER MY HAND AND THE SEAL OF OFFICE ON
Bridget C Bohac
BRIDGET C. BOHAC, CHIEF CLERK
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

ORDER ADOPTING
REVISIONS TO THE STATE IMPLEMENTATION PLAN

Docket No. 2019-0660-SIP
Project No. 2019-079-SIP-NR

On March 4, 2020, the Texas Commission on Environmental Quality (Commission), during a public meeting, considered adoption of the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) Serious Classification Reasonable Further Progress (RFP) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone Standard. The commission adopts the DFW and HGB 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision. This RFP SIP revision demonstrates that the DFW and HGB 2008 eight-hour ozone nonattainment areas will achieve emissions reductions in ozone precursors (volatile organic compounds (VOC) and/or nitrogen oxides (NO_x) consistent with the serious ozone nonattainment area requirements of FCAA, §182(c)(2)(B) and the 2008 eight-hour ozone standard SIP requirements rule according to the following increments: a 9% emissions reduction in NO_x and/or VOC for all counties in each area for the three-year period from January 1, 2018 through December 31, 2020; and a 3% emissions reduction in NO_x and/or VOC for the one-year period from January 1, 2021 through December 31, 2021 for all counties in each area as an attainment year RFP contingency. This SIP revision also provides motor vehicle emissions budgets (MVEB) for the 2020 attainment year. This SIP revision demonstrates RFP for the DFW and HGB serious nonattainment areas for the 2020 attainment year as well as the 2021 contingency year. Under Tex. Health & Safety Code Ann. §§ 382.011, 382.012, and 382.023 (West 2016), the Commission has the authority to control the quality of the state's air and to issue orders consistent with the policies and purposes of the Texas Clean Air Act, Chapter 382 of the Tex. Health & Safety Code. Notice of the proposed SIP revision was published for comment in the September 27, 2019, issue of the *Texas Register* (44 TexReg 5658).

Pursuant to Tex. Health & Safety Code Ann. § 382.017 (West 2016), Tex. Gov't Code Ann., Chapter 2001 (West 2016), and 40 Code of Federal Regulations § 51.102, and after proper notice, the Commission offered public hearings to consider the revisions to the SIP. Proper notice included prominent advertisement in the areas affected at least 30 days prior to the dates of the hearings. Public hearings were offered in Houston on October 14, 2019 and in Arlington on October 17, 2019.

The Commission circulated hearing notices of its intended action to the public, including interested persons, the Regional Administrator of the EPA, and all applicable local air pollution control agencies. The public was invited to submit data, views, and recommendations on the proposed SIP revisions, either orally or in writing, at the hearings or during the comment period. Prior to the scheduled hearings, copies of the proposed SIP revisions were available for public inspection at the Commission's central office and on the Commission's website.

Data, views, and recommendations of interested persons regarding the proposed SIP revisions were submitted to the Commission during the comment period and were considered by the Commission as reflected in the analysis of testimony incorporated by reference to this Order. The Commission finds that the analysis of testimony includes the names of all interested groups or associations offering comment on the proposed SIP revisions and their position concerning the same.

IT IS THEREFORE ORDERED BY THE COMMISSION that the DFW and HGB 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision incorporated by reference to this Order are hereby adopted. The Commission further authorizes staff to make any non-substantive revisions to the rules necessary to comply with *Texas Register* requirements. The adopted revisions to the SIP are incorporated by reference in this Order as if set forth at length verbatim in this Order.

IT IS FURTHER ORDERED BY THE COMMISSION that on behalf of the Commission, the Chairman should transmit a copy of this Order, together with the adopted revisions to the SIP, to the Regional Administrator of EPA as a proposed revision to the Texas SIP pursuant to the Federal Clean Air Act, codified at 42 U.S. Code Ann. §§ 7401 - 7671q, as amended.

This Order constitutes the Order of the Commission required by the Administrative Procedure Act, Tex. Gov't Code Ann., Chapter 2001 (West 2016).

If any portion of this Order is for any reason held to be invalid by a court of competent jurisdiction, the invalidity of any portion shall not affect the validity of the remaining portions.

TEXAS COMMISSION ON
ENVIRONMENTAL QUALITY

Jon Niermann, Chairman

March 6, 2020

Date Signed

LIST OF APPENDICES

APPENDIX 1

DFW REASONABLE FURTHER PROGRESS DEMONSTRATION SPREADSHEET

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Appendix 1 - Sheet 01

Dallas-Fort Worth Eight-Hour Ozone Nonattainment Area

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Reasonable Further Progress Demonstration Calculation Spreadsheet

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4	04 Calc 10 DFW 2021 RFP Cont	2021 Attainment Year RFP Contingency Demonstration for 10 DFW Counties
5	05 Calc 10 DFW 2021 AD Cont	2021 Attainment Demonstration Contingency Demonstration for 10 DFW Counties
6	06 Calc 2020 RFP MVEB	2020 RFP Motor Vehicle Emissions Budgets
7	07 Calc NonCred Red	Calculation of RFP Non-Creditable Reductions from Pre-1990 FMVCP
8	08 Calc Red for % Req	Calculate the Reductions to Meet the 15%, the 3% Per Year, and the 3% Contingency Requirements
9	09 Calc Targets 9 PDC	Calculation of Post-2011 Target Levels of VOC and NO$_X$ Emissions for 9 Previously Designated Counties
10	10 Calc Targets 1 NDC	Calculation of Post-2011 Target Levels of VOC and NO$_X$ Emissions for 1 Newly Designated County
11	11 Calc 9 PDC RFP MS Cont	2017 to 2018 Milestone Year RFP Contingency Amount for 9 Previously Designated Counties
12	12 Calc 1 NDC RFP MS Cont	2017 to 2018 Milestone Year RFP Contingency Amount for 1 Newly Designated County
13	13 Enter % RFP Cont & Conf SM	Enter: Percent Reductions for 15 and 3% RFP, 3% Contingency, Conformity Safety Margins and NOx Substitution
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18	18 Enter Locomotive EI	Enter Locomotive EI, All Years, Controlled and Uncontrolled
19	19 Enter NONROAD Categories EI	Enter NONROAD Model Categories EI, All Years, Controlled and Uncontrolled
20	20 Enter On-road EI	Enter On-road EI, All Years, Controlled and Uncontrolled
21	21 Enter ABY On-road EI	Enter Adjusted Base Year (ABY) On-road EI, All Years
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Appendix 1 - Sheet 02

10 DFW 2020 RFP Demonstration Analysis

DFW Eight-Hour Ozone Nonattainment Area

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

2020 RFP 10 DFW Demonstration Analysis: To determine if the 2020 RFP requirements are met, the 2020 target level of emissions is compared to the 2020 controlled forecast inventory. The 2020 forecast inventory includes growth between the 2011 base year and the 2020 milestone year. The controlled forecast inventory has been reduced by subtracting the RFP control reductions from 2011 to 2020. If the 2020 controlled forecasted RFP EI is less than the 2020 RFP target level of emissions the 2020 RFP requirement is satisfied.

Line #	**Description**	**NO_X (tpd)**	**VOC (tpd)**
Line 1	Uncontrolled or existing controlled 10 County DFW 2020 emissions forecast with growth	1307.94	855.96
Line 2	Creditable 10 County DFW RFP control reductions between 2011 and 2020	1023.27	432.82
Line 3	Controlled 2020, 10 DFW RFP emissions forecast (Line 1 minus Line 2)	284.67	423.14
Line 4	Amount of creditable reductions reserved for 2017 to 2018 RFP milestone contingency	8.44	4.65
Line 5	Controlled 2020, 10 DFW RFP emission forecast with milestone contingency (Line 3 plus Line 4)	293.11	427.79
Line 6	Amount of NO_X reduction substitution (see Sheet 9)	0.00	0.00
Line 7	Controlled 2020, 10 DFW RFP forecast without reductions reserved for contingency, accounting for reduction transfer to newly designated county, and accounting for NOx substitution (Line 5 plus Line 6)	293.11	427.79
Line 8	2020 10 County DFW RFP target level of emissions	334.10	450.79
Line 9	Excess (+) / Shortfall (-) (Line 10 minus Line 9)	40.99	23.00
Line 10	**Is controlled RFP EI less than target level of emissions?**	**Yes**	**Yes**

Notes:

1) To calculate the RFP controlled forecast for each milestone/attainment year, the total RFP creditable control strategy reductions to date (total RFP reductions from 2011 to the current RFP milestone year) are subtracted from the total uncontrolled RFP EI.

2) To calculate the final excess or shortfall for each milestone/attainment year, the controlled RFP emissions forecast is subtracted from the RFP target level of emissions. The RFP target level of emissions for all milestone years is calculated on the "Calc Targets" page.

3) Excess emissions reductions (Line 9) may be used to provide a transportation conformity safety margin. The safety margin must be less than or equal to the excess emissions reductions.

4) The most recent 8-hour implementation rule does not allow transfer of creditable emission reductions between county groups within the same nonattainmnet area. The line in the calculation process to account for this type of trnasfer has been removed. If a future implementation rule permits the transfer of creditable emissions reductions between couty groups in the same nonattainment area, and a transfer is intended, the tons of NOx and VOC for transfer would be inlcuded in the RFP calculation.

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Appendix 1 - Sheet 03

2020 RFP NOX Substitution Analysis with MOVES2014

DFW Eight-Hour Ozone Nonattainment Area

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

The NO_X substitution calculation includes six steps. First, calculate the percent target reduction for both VOC and NO_X by comparing the base year and target inventories. Second, calculate the percent actual reduction by comparing the base year and the actual inventory. Third, compare the percent required reduction to the percent actual reduction. If the percent actual reduction is greater than the percent required, then there are surplus reductions. If the percent actual reduction is less than the percent target, then there is a shortfall of reductions. The difference between the percent actual and the percent target reduction (when there are surplus reductions) is the amount that is available for substitution. For the fourth step, determine the percent NO_X needed for substitution. The minimum base year VOC percentage needed is equal to the percent base year shortfall in VOC plus the smallest increment possible, or 0.01. The respective NO_X percent is calculated using the NO_X base year inventory. The percent base year NO_X transfer should not exceed the percent base year NO_X surplus. The percent NO_X available to transfer is based upon the base year because the base year is the basis for the required reduction calculations. Fifth, convert the percent base year NO_X to a percent target NO_X using the percent base year NO_X from step 5 and the relative values of the base year and target NO_X inventory. The percent NO_X transfer is derived from milestone year target values because those are the values modified by NO_X transfer. The percent NO_X transfer is a percentage of the milestone year target NO_X value that is added back into the NO_X inventory and a percentage of the milestone year target VOC that is subtracted from the VOC inventory. For the sixth step, calculate the resulting tons per day (tpd) associated with the percent NO_X transfer. For NO_X, multiply the NO_X percent transfer and the NO_X milestone year target value. For VOC, multiply the percent NO_X transfer (which is the same as the percentage of the milestone year target VOC that is subtracted from the VOC inventory) and the VOC milestone year target value. The NO_X transfer amount (in tpd) is added to the NO_X actual (in tpd) inventory in the RFP demonstration calculation, and the VOC transfer amount (in tpd) is subtracted from the VOC actual (in tpd) inventory.

Line #	**Description**	**NO_X**	**VOC**
Line 1	2011 10 DFW base year emissions (tpd)	422.04	464.92
Line 2	2020 10 DFW controlled RFP EI (tpd)	293.11	427.79
Line 3	Total actual reductions for 9 PDC 2011 to 2018 (Line 1 minus Line 2) (tpd)	128.93	37.13
Line 4	Percent actual reductions for 9 PDC 2011 to 2018 (percent Line 3 is of Line 1) (%)	30.55	7.99
Line 5	2020 10 DFW target RFP EI (tpd)	334.10	450.79
Line 6	10 DFW 2020 total target reductions for 2011 to 2020 (Line 1 minus Line 5) (tpd)	87.94	14.13
Line 7	Percent target reductions for 2011 to 2020 (percent Line 6 is of Line 1) (%)	20.84	3.04
Line 8	Percent surplus or shortfall (percent actual minus percent target, Line 4 minus Line 7) (%)	9.71	4.95
Line 9	Percent surplus to transfer (NO_X percentage should be less than Line 8) (%)	0.00	0.00
Line 10	Convert the percent surplus to transfer to tons per day (tpd)	0.00	Only NOx Value Needed
Line 11	Calculate what percentage Line 10 is of target (this is the percentage to transfer) (%)	0.00	0.00
Line 12	**Tons equivalent to percent for transfer [Line 5 times (Line 10 divided by 100)] (tpd)**	**0.00**	**0.00**
Line 13	NO_X substitution amount okay? (Check to assure NO_X substitution does not exceed maximum available: Sheet 05, Line 10 must be greater than zero)	Okay to Substitute	Okay to Substitute

Notes:

Line 7: The percent target reduction includes the 15% required reductions from 2011 through 2017, the 3% required reductions for each year after 2017, and accounts for noncreditable reductions betweeen 2011 and the RFP milestone year; therefore, the total percent reduction may not be exaclty 15 plus 3.

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Appendix 1 - Sheet 4

2021 Contingency Demonstration for RFP

DFW Eight-Hour Ozone Nonattainment Area

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Summary 2021 Contingency for 2020 RFP

Contingency Element Description	NO_X	VOC
10 DFW Counties 2011 Base Year EI	422.04	464.92
Percent for contingency calculation (total of 3%)	2.00	1.00
2020 to 2021 required contingency reductions (ABY EI x (contingency percent))	**8.44**	**4.65**
Control reductions to meet contingency requirements		
Excess reductions from 2020 RFP demonstration	40.99	23.00
Subtract 2020 RFP demonstration motor vehicle emissions budget (MVEB) safety margin from excess reductions from 2020 RFP demonstration	-9.76	-5.68
Federal Motor Vehicle Control Program (FMVCP), inspection and maintenance (I/M), reformulated gasoline (RFG)/East Texas Regional Low RVP, 2017 Low Sulfur Gasoline Standard and on-road TxLED (Note: This list of controls is the complete list for the 9 DFW counties. However, RFG is required, and all control reductions are modeled with RFG, only in the 4 core counties.)	24.69	9.12
Federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	2.75	2.48
Total RFP demonstration contingency reductions	**58.67**	**28.92**
Contingency Excess (+) or Shortfall (-)	**50.23**	**24.27**

If changes are made to the enter reductions page, please assure the control reduction summary values above are consistent with the table below. The enter reductions page allows for the control reduction for a row to change. The table above adds particular rows from below.

Contingency Element Description	NO_X	VOC
10 DFW Counties 2011 Base Year EI	422.04	464.92
Percent for contingency calculation (total of 3%)	2.00	1.00
2020 to 2021 10 DFW RFP required contingency reductions (ABY EI x (contingency percent))	**8.44**	**4.65**
Calculate available reductions to meet contingency requirements: add excess 2018 control reductions; subtract MVEB safety margin adjustment; and add each 2018 to 2019 control reduction		
Excess reductions from 2020 RFP demonstration	40.99	23.00
Subtract 2020 RFP MVEB safety margin from excess reductions from 2020 RFP demonstration	-9.76	-5.68
Chapter 117 NOX controls	0.00	0.00
Chapter 115 Storage Tank Rule	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	30.05	10.30
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	-4.29	-0.75
Inspection and Maintenance (I/M)	-0.84	-0.43
On-road TxLED	-0.23	0.00
Tier I and II locomotive NOX standards	0.00	0.00
Small non-road spark ignition (SI) engines (Phase I)	-0.40	0.53
Heavy duty non-road engines	0.76	0.31
Tiers 2 and 3 non-road diesel engines	1.20	0.11
Small non-road SI engines (Phase II)	0.05	0.50
Large non-road SI & recreational marine	1.03	0.51
Non-road TxLED	-2.01	0.00

Non-road RFG	0.00	0.00
Tier 4 non-road diesel engines	2.05	0.07
Diesel recreational marine	0.00	0.00
Small SI (Phase III)	0.07	0.45
Chapter 117 NOX area source engine controls	0.00	0.00
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	0.00	0.00
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Total 2021 10 DFW RFP contingency reductions	**58.67**	**28.92**
Contingency Excess (+) or Shortfall (-)	**50.23**	**24.27**
Are contingency reductions greater than required contingency reduction?	**Yes**	**Yes**

Note 1: The ten county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with RGF are: Collin, Dallas Denton and Tarrant. The six counties with East Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall and Wise.

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Appendix 1 - Sheet 05

2021 Contingency Demonstration for 2020 Attainment Demonstration

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Summary 2021 Contingency for 2020 Attainment Demonstration

Contingency Element Description	NO_X	VOC
2011 DFW RFP base year (BY) emissions inventory (EI)	422.04	464.92
Percent for contingency calculation (total of 3%)	2.00	1.00
2020 to 2021 AD required contingency reductions (ABY EI x (contingency percent))	**8.44**	**4.65**
Control reductions to meet contingency requirements		
Excess reductions from 2020 attainment demonstration	0.00	0.00
Subtract reductions reserved for 2018 attainment demonstration MVEB safety margin	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP), inspection and maintenance (I/M), reformulated gasoline (RFG), East Texas Regional Low RVP, 2017 Low Sulfur Gasoline Standard and on-road TxLED (Note: RFG is required, and modeled, only in Collin, Dallas Denton and Tarrant counties; Texas Regional Low RVP is modeled only for the non-RFG counties, Ellis, Johnson, Kaufman, Parker, Rockwall and Wise.)	24.69	9.12
Federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	2.75	2.48
Total attainment demonstration contingency reductions	**27.44**	**11.60**
Contingency Excess (+) or Shortfall (-)	**19.00**	**6.95**

Note:

1) If changes are made to the enter reductions page please assure the control reduction summary values above are consistent with the table below. The enter reductions page allows for the control reductio for a row to change. The table above adds particular rows from below.

2) The ten county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with RFG are: Collin, Dallas Denton and Tarrant. The six counties with Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall and Wise.

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Contingency Element Description	NO_X	VOC
2020 10 NAC ABY EI	422.04	464.92
Percent for AD contingency calculation (total of 3%)	2.00	1.00
2020 to 2021 required AD contingency reductions (ABY EI x (contingency percent))	**8.44**	**4.65**
Control reductions to meet contingency requirements		
Add excess reductions from 2020 attainment demonstration	0.00	0.00
Subtract 2020 attainment demonstration MVEB safety margin	0.00	0.00
Chapter 117 NOX controls	0.00	0.00
Chapter 115 Storage Tank Rule	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	30.05	10.30
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	-4.29	-0.75
Inspection and Maintenance (I/M)	-0.84	-0.43
On-road TxLED	-0.23	0.00
Tier I and II locomotive NOX standards	0.00	0.00

Small non-road spark ignition (SI) engines (Phase I)	-0.40	0.53
Heavy duty non-road engines	0.76	0.31
Tiers 2 and 3 non-road diesel engines	1.20	0.11
Small non-road SI engines (Phase II)	0.05	0.50
Large non-road SI & recreational marine	1.03	0.51
Non-road TxLED	-2.01	0.00
Non-road RFG	0.00	0.00
Tier 4 non-road diesel engines	2.05	0.07
Diesel recreational marine	0.00	0.00
Small SI (Phase III)	0.07	0.45
Chapter 117 NOX area source engine controls	0.00	0.00
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	0.00	0.00
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Total attainment demonstration contingency reductions	**27.44**	**11.60**
Contingency Excess (+) or Shortfall (-)	**19.00**	**6.95**

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Appendix 1 - Sheet 06

Calculations: 2020 RFP MVEBs

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X (tons per day)

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Summary 2020 DFW RFP MVEB

Description	NO_X	VOC
2020 9 PDC on-road emissions projection without post-1990 FCAA controls	935.61	364.37
2020 1 NDC on-road emissions projection without post-1990 FCAA controls	22.29	5.90
2020 10 DFW on-road emissions projection without post-1990 FCAA controls	957.90	370.27
Total 2020 10 DFW on-road mobile source RFP control reductions	860.41	313.54
2020 10 DFW On-road mobile controlled inventory	97.49	56.73
Transportation conformity safety margin	9.76	5.68
Excess emissions reduction for 2020	40.99	23.00
Is excess emissions enough for safety margin?	yes	yes
2020 10 DFW MVEB with safety margin	**107.25**	**62.41**

Note: If safety margin is > than excess emission reductions modify percent safety margin input on the "Enter % for RFP Cont & Conf SM" page.

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Appendix 1 - Sheet 07

RFP Non-creditable Reductions Calculations

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Two County Groups:

Nine Nonattainment Counties; Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant; and

One Nonattainment County; Wise County

9 PDC Calculation of Non-creditable NO_X and VOC Reductions

RFP Analysis Year	On-Road Mobile ABY EI NO_X	On-Road Mobile ABY EI VOC	Non-Creditable Fleet Turn Over Reductions NO_X	Non-Creditable Fleet Turn Over Reductions VOC	Non-Creditable Reduction Description
2011, 9 PDC	749.37	296.35	N/A	N/A	
2017, 9 PDC	750.00	300.48	-0.63	-4.13	Pre-1990 CAA fleet turnover reduction baseline 2011 through 2017 for 9 PDC
2020, 9 PDC	749.92	299.81	0.08	0.67	Pre-1990 CAA fleet turnover reduction 2017 through 2020 for 9 PDC

1 NDC Calculation of Non-creditable NO_X and VOC Reductions

RFP Analysis Year	On-Road Mobile ABY EI NO_X	On-Road Mobile ABY EI VOC	Non-Creditable Fleet Turn Over Reductions NO_X	Non-Creditable Fleet Turn Over Reductions VOC	Non-Creditable Reduction Description
2011, 1 NDC	18.39	4.80	N/A	N/A	
2017, 1 NDC	18.26	4.89	0.13	-0.09	Pre-1990 CAA fleet turnover reduction baseline 2011 through 2017 for 1 NDC
2020, 1 NDC	18.25	4.88	0.01	0.01	Pre-1990 CAA fleet turnover reduction 2017 through 2020 for 1 NDC

Notes:

1) Non-creditable fleet turnover corrections: The reductions due to the the 1992 low RVP rule and the pre-1990 FMVCP are not creditable toward the RFP requirements. Both non-creditable rules only affect on-road mobile sources. The non-creditable reductions for each RFP milestone year are the difference between the on-road mobile ABY EI for each RFP milestone year and the on-road mobile 2011 RFP ABY EI. Since the pre-1990 FMVCP fleet turnover corrections are cumulative in the MOVES model, the noncreditable reductions from previous milestone years must be subtracted from the current milestone year to obtain the non-creditable reductions between milestone years. The FMVCP non-creditable reductions are used to calculate the target value for each RFP milestone year.

2) ABY inventories: The on-road mobile ABY inventories for each milestone/attainment year are calculated using 2011 vehicle miles traveled (VMT) and MOVES emission factors for each RFP analysis year with only the effects of pre-1990 FCAA controls turned on. The pre-1990 FCAA controls include the 1992 Reid Vapor Pressure control and the pre-1990 on-road mobile source FMVCP controls.

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Appendix 1 - Sheet 08

Quantify the Reductions to Meet the Initial 15%, the 3% per Year and Contingency Requirements

DFW Eight-Hour Ozone Nonattainment Area

Two County Groups:

Nine Nonattainment Counties; Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant; and

One Nonattainment County; Wise County

The Initial 15%, the 3% per Year and Contingency Requirements: The FCAA mandates that an initial 15%, plus a 3% per year starting in year seven, VOC reduction, net of growth, occur from the baseline year 2011 through the attainment year. The reductions must be demonstrated for the six-year period from baseline 2011 through 2017, and every three years after 2017 through the attainment year, 2020. The one DFW county added to the nonattainment area under the 2008 eight-hour standard (newly designated counties (NDC)) must demonstrate an initial 15% reduction of VOC from the baseline 2011 through 2017. NO_X may be substituted for VOC for the nine DFW counties designated nonattainment under both the one-hour and 1997 eight-hour standards (previously designated counties (PDC)) from the baseline 2011 through 2017. After 2017, NO_X reductions may be substituted for VOC reductions for all ten DFW eight-hour nonattainment counties. An additional 3% reduction must be demonstrated as a contingency measure for the one-year period following the attainment year, 2021. The division of the percent reductions between VOC and NO_X are entered in the data entry sheet with tab name "Enter % for RFP Cont & Conf SM."

9 PDC Calculation of Required 15% VOC Reductions and 3% per Year NO_X and VOC Reductions

RFP Analysis Year	Total Percent Reduction Requirement	Percent NO_X	Percent VOC	RFP ABY EI NO_X (tpd)	RFP ABY EI VOC (tpd)	Required Reductions NO_X (tpd)	Required Reductions VOC (tpd)
2011	N/A	N/A	N/A	386.94	430.36	N/A	N/A
2017	15.0	14.0	1.0	386.94	430.36	54.17	4.30
2020	9.0	8.0	1.0	386.94	430.36	30.96	4.30
2021 Contingency	3.0	2.0	1.0	386.94	430.36	7.74	4.30

1 NDC Calculation of Required 15% VOC Reductions and 3% per Year NO_X and VOC Reductions

RFP Analysis Year	Total Percent Reduction Requirement	Percent NO_X	Percent VOC	RFP ABY EI NO_X (tpd)	RFP ABY EI VOC (tpd)	Required Reductions NO_X (tpd)	Required Reductions VOC (tpd)
2011	N/A	N/A	N/A	35.10	34.56	N/A	N/A
2017	15.0	N/A	15.0	35.10	34.56	0.00	5.18
2020	9.0	8.0	1.0	35.10	34.56	2.81	0.35
2021 Contingency	3.0	2.0	1.0	35.10	34.56	0.70	0.35

Notes:

1) The ABY EI is the base year (BY) emissions minus the non-creditable on-road mobile reductions. It is calculated by adding the BY EI for point, area and non-road to the ABY for on-road. When the ABY EI is multiplied by the required percent reduction, the result is the reductions required.

2) On-road mobile ABY inventories: The on-road mobile ABY inventories for each milestone/attainment year are calculated using 2011 VMT and MOVES emission factors for each RFP analysis year with only the effects of pre-1990 FCAA controls turned on. The pre-1990 FCAA controls include the 1992 Reid Vapor Pressure control and the pre-1990 on-road mobile source FMVCP controls. The on-road mobile ABY EI is equal to the on-road mobile BY EI minus the non-creditable FMVCP reductions.

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Appendix 1 - Sheet 9

Target Calculations 9 PDC: 2017 and 2020 9 PDC RFP Target Level of NO_X and VOC Emissions

DFW 2008 Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

Post-2011 target level of NO_X emissions: The NO_X target level is calculated by subtracting the reductions necessary to meet: the initial 15% from the baseline 2011 through 2017; the post-2017 3% per year; and the non-creditable fleet (FMVCP/RVP) reductions from the previous milestone/attainment year target level.

RFP Post-2011 9 PDC Target Level of NO_X Emissions

RFP Milestone Year	Previous Target	FMVCP Non-creditable Reduction	Post-2011 Percent Reduction Requirement NO_X (tpd)	NO_X Target (tpd)
2011 Base Year, 9 PDC	N/A	N/A	N/A	386.94
2017, 9 PDC	386.94	0.00	54.17	332.77
2020, 9 PDC	332.77	0.00	30.96	301.81

Post-2011 target level of VOC emissions: The VOC target level is calculated by subtracting the reductions necessary to meet: the initial 15% from the bseline 2011 through 2017; the post-2017 3% per year; and the non-creditable fleet (FMVCP/RVP) reductions from the previous milestone/attainment year target level.

RFP Post-2011 9 PDC Target Level of VOC Emissions

RFP Milestone Year	Previous Target	FMVCP Non-creditable Reduction	Post-2011 Percent Reduction Requirement VOC (tpd)	VOC Target (tpd)
2011 Base Year, 9 PDC	N/A	N/A	N/A	430.36
2017, 9 PDC	430.36	0.00	4.30	426.06
2020, 9 PDC	426.06	0.00	4.30	421.76

1)The EPA published the final implementation rule for the 2008 ozone NAAQS (SIP requirements rule) the Federal Register (FR) on March 6, 2015 (80 FR 12263). The final rule removed the requirement for states to account for non-creditable reductions when determining compliance with Reasonable Further Progress (RFP) emission reduction requirements. There is a toggle on Sheet 14 of this spreadsheet to turn the effects of non-creditable reductions either off or on. The default toggle is “No,” which turns off the calculated effects of pre-1990 control measures. The non-creditable reductions are calculated on Sheet 11 for use in the calculation of RFP Targets above. If the effects of non-creditable reductions are turned off on Sheet 14, the values for the non-creditable reductions will stoill be calculated on Sheet 11, however, zeros will automatically be substituted in the target calculations above. Should there be a nee to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle on Sheet 14 can be set to “Yes” and the values above will automatically be used in the calculation of the RFP targets.

2) A result of removing the non-creditable reductions from the RFP calculations is the RFP adjusted base year inventory (ABY) becomes equal to the RFP base year inventory. The ABY inventory is used to calculate the Post-2011 Percent Reductions used above. There is a toggle on Sheet 14 of this spreadsheet to turn the effects of non-creditable reductions either off or on. The default toggle is “No,” which turns off the calculated effects of pre-1990 control measures. Should there be a need to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle on Sheet 14 can be set to “Yes.”

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Appendix 1 - Sheet 10

Target Calculations 1 NDC: 2017 and 2020 1 NDC RFP Target Level of NO_X and VOC Emissions

DFW 2008 Eight-Hour Ozone Nonattainment Area

One Newly Designated Nonattainment County: Wise

Post-2011 target level of NO_X emissions: The NO_X target level is calculated by subtracting the reductions necessary to meet: the initial 15% from the bseline 2011 through 2017 (for the 1 NDC the initial 15% is all from VOC); the post-2017 3% per year; and the non-creditable fleet (FMVCP/RVP) reductions from the previous milestone/attainment year target level.

RFP Post-2011 1 NDC Target Level of NO_X Emissions

RFP Milestone Year	Previous Target	FMVCP Non-creditable Reduction	Post-2011 Percent Reduction Requirement NO_X (tpd)	NO_X Target (tpd)
2011 Base Year, 1 NDC	N/A	N/A	N/A	35.10
2017, 1 NDC	35.10	0.00	0.00	35.10
2020, 1 NDC	35.10	0.00	2.81	32.29

Post-2011 target level of VOC emissions: The VOC target level is calculated by subtracting the reductions necessary to meet: the initial 15% from the bseline 2011 through 2017 (for the 1 NDC the initial 15% is all from VOC); the post-2017 3% per year; and the non-creditable fleet (FMVCP/RVP) reductions from the previous milestone/attainment year target level.

'RFP Post-2011 1 NDC Target Level of VOC Emissions

RFP Milestone Year	Previous Target	FMVCP Non-creditable Reduction	Post-2011 Percent Reduction Requirement VOC (tpd)	VOC Target (tpd)
2011 Base Year, 1 NDC	N/A	N/A	N/A	34.56
2017, 1 NDC	34.56	0.00	5.18	29.38
2020, 1 NDC	29.38	0.00	0.35	29.03

1)The EPA published the final implementation rule for the 2008 ozone NAAQS (SIP requirements rule) in the Federal Register (FR) on March 6, 2015 (80 FR 12263). The final rule removed the requirement for states to account for non-creditable reductions when determining compliance with Reasonable Further Progress (RFP emission reduction requirements. There is a toggle on Sheet 14 of this spreadsheet to turn the effects of non-creditable reductions either off or on. The default toggle is “No,” which turns off the calculated effects of pre-1990 control measures. The non-creditable reductions are calculated on Sheet 11 for use in the calculation o RFP Targets above. If the effects of non-creditable reductions are turned off on Sheet 14, the values for the non-creditable reductions will stoill be calculated on Sheet 11, however, zeros will automatically be substituted in the target calculations above. Should there be a need to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle on Sheet 14 can be set to “Yes” and the values above will automatically be used in the calculation of the RFP targets.

2) A result of removing the non-creditable reductions from the RFP calculations is the RFP adjusted base year inventory (ABY) becomes equal to the RFP base year inventory. The ABY inventory is used to calculate the Post-2011 Percent Reductions used above. There is a toggle on Sheet 14 of this spreadsheet to turn the effects of non-creditable reductions either off or on. The default toggle is “No,” which turns off the calculated effects of pre-1990 control measures. Should there be a need to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle on Sheet 14 can be set to “Yes.”

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Appendix 1 - Sheet 11

9 PDC: Calculate RFP Milestone Year Contingency Values to be Reserved for Post-2017 Demonstrations

DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

Contingency Element Description	NO_X	VOC
DFW 9 PDC 2011 Base Year (BY) EI	386.94	430.36
Percent for 9 PDC 2017 milestone contingency calculation (total of 3%)	2.00	1.00
2017 to 2018 9 PDC required contingency reductions (BY EI x (contingency percent))	**7.74**	**4.30**

Notes:

1) The 2017 to 2018 9 County DFW contingency reductions are held in reserve for all RFP post-2018 milestone years in this RFP demonstration.

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Appendix 1 - Sheet 12

1 NDC: Calculate RFP Milestone Year Contingency Values to be Reserved for Post-2017 Demonstrations

DFW Eight-Hour Ozone Nonattainment Area

One Newly Designated Nonattainment County: Wise

Contingency Element Description	NO_X	VOC
DFW 1 NDC 2011 Base Year (BY) EI	35.10	34.56
Percent for 1 NDC 2017 milestone contingency calculation (total of 3%)	2.00	1.00
2017 to 2018 1 NDC required contingency reductions (BY EI x (contingency percent))	**0.70**	**0.35**

Notes:

1) The 2017 to 2018 1 County DFW contingency reductions are held in reserve for all RFP post-2018 milestone years in this RFP demonstratior

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Appendix 1 - Sheet 13

Enter RFP NO_X and VOC Percentage Reductions, Contingency Percents and Safety Margin

DFW Eight-Hour Ozone Nonattainment Area

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

A 15% reduction is required for DFW for the period from the bseline 2011 through 2017, with an additional 3% per year until the attainment year. The total reduction for 2017 includes an initial 15% reduction (VOC only) for the one NDC and an initial 15% reduction (NO_X may be substituted for VOC) for the nine PDCs. The reduction for 2017 to 2020 is 9% (3% times 3). Input percentage of NO_X and VOC reductions to be used to demonstrate RFP for 2017 and 2020. Only a NOx value needs to input. The VOC percent will be calculated automatically based upon the total required and the percent NO_X to be used.

RFP NO_X and VOC Percent Reductions for Milestone and Attainment Years

RFP Milestone Year	NO_X %	VOC %	Total Percent
2017, 1 Newly Designated County	N/A	15	15
2017, 9 Previously Designated Counties	14	1	15
2020, 1 Newly Designated County	8	1	9
2020, 9 Previously Designated Counties	8	1	9

A total of 3% RFP contingency measures reductions are required between 2017 to 2018. A 3% contingency is also required for the RFP attainment contingency for 2020 to 2021. A 3% contingency is also required for the attainment demonstration for 2020 to 2021. The contingency reductions can be from NOx or VOC. Input only the percent of the contingency reductions that will be from NOx. The VOC value will be calculated automatically as 3 minus the NOx percent.

'RFP and Attainment Demonstration NO_X and VOC Percent Reductions for 2020 and 2021 Contingency

Contingency Year	NO_X %	VOC %	Total Percent
9 PDC RFP Milestone Contingency	2	1	3
1 NDC RFP Milestone Contingency	2	1	3
10 DFW RFP 2020 to 2021	2	1	3
10 DFW AD 2020 to 2021	2	1	3

If there are excess RFP control reductions, a transportation conformity safety margin is allowed. The safety margin for this SIP revision is calculated based upon a percentage of excess emissions. If a safety margin will be used, enter the percentage of excess VOC and NOx emissions to be used below. The safety margin amount must be less than or equal to the excess reductions after demonstrating RFP. The percentage entered must be between 0 and 100. An error message will appear if a value over 100 is entered. Adjusting the safety margin below will automatically update the MVEB calculation to include the percent of excess emissions entered. For reference, the corresponding percent of the MVEB and tons per day are provided.

RFP Milestone Year	**Pollutant**	**Conformity Safety Margin % of Excess RFP Reductions**	**Percent of On-road EI (For Reference)**	**Tons Per Day Change to On-road EI (For Reference)**
2020	NOx	23.8	10.01	9.76
	VOC	24.7	10.01	5.68

The EPA published the final implementation rule for the 2008 ozone NAAQS (SIP requirements rule) in the *Federal Register* (FR) on March 6, 2015 (80 FR 12263). The final rule removed the requirement for states to account for non-creditable reductions when determining compliance with Reasonable Further Progress (RFP) emission reduction requirements. The Federal Clean Air Act (FCAA) §182(b)(1)(D) specifies four categories of control measures that are not creditable toward the 15% RFP requirement under FCAA §182(b)(1)(A). The EPA stated that for three of the categories, reductions from the measures were achieved many years ago, so the question of creditability is moot for RFP credits for the 2008 eight-hour ozone standard. For the one remaining category, measures related to motor vehicle exhaust or evaporative emissions promulgated by January 1, 1990, citing an assessment that at this point in history the ongoing emission reductions from pre-1990 control measures in this category are *de minimis* , the EPA finalized an approach that eliminates any obligation for states to continue to perform emission reduction calculations for the pre-1990 control measures listed under FCAA §182(b)(1)(D)(i). The "Yes/No" drop-down list in the table below allows non-creditable emission reductions to be turned on or off for this SIP revision. The default toggle is "No," which turns off the calculated effects of pre-1990 control measures. Should there be a need to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle can be set to "Yes."

Non-creditable Calculation	**Include Non-creditable Reductions in RFP Target Calculation?**
Applies to 2017 and 2020, VOC and NOx, nine county group and one county group	No

Enter the percent of the NOx milestone year target that will be transferred to VOC. Only the NOX percent is entered. The VOC percent is automatically equal to the NOX percent transfer. These vales are used on Sheets 03 and 06 in the NOX transfer calculations.

NOx Substitution	**Percent of NO$_X$ Reductions to Transfer to Percent VOC Reductions**	**Percent of VOC Reductions Transferred from Percent NO$_X$ Reductions**
2020	0.00	0.00

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Appendix 1 - Sheet 14

Enter Airport Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	14.63	14.63	0.00	0.00	5.56	5.56	0.00	0.00
9 PDC 2020	19.21	19.21	0.00	0.00	3.35	3.35	0.00	0.00

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	0.01	0.01	0.00	0.00	0.03	0.03	0.00	0.00
1 NDC 2020	0.00	0.00	0.00	100.00	0.01	0.01	0.00	0.00

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	14.64	14.64	0.00	0.00	5.59	5.59	0.00	0.00
10 County total 2020	19.21	19.21	0.00	0.02	3.36	3.36	0.00	0.00

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

4) The airport emissions inventory includes emissions from: airctraft; aircraft auxiliary power units (APU); and, airport ground support equipment (GSE).

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Appendix 1 - Sheet 15

Enter Area Source Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	37.69	37.69	0.00	0.00	262.35	262.35	0.00	0.00
9 PDC 2020	33.87	33.87	0.00	0.00	281.00	281.00	0.00	0.00

One Newly Designated Nonattainment County: Wise

RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	13.29	13.29	0.00	0.00	28.95	28.95	0.00	0.00
1 NDC 2020	4.82	4.82	0.00	0.00	18.22	18.22	0.00	0.00

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	50.98	50.98	0.00	0.00	291.30	291.30	0.00	0.00
10 County total 2020	38.69	38.69	0.00	0.00	299.22	299.22	0.00	0.00

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

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Appendix 1 - Sheet 16

Enter Biogenic Emissions Inventory

DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	See Note 1	N/A	N/A	N/A	See Note 1	N/A	N/A	N/A

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	See Note 1	N/A	N/A	N/A	See Note 1	N/A	N/A	N/A

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	See Note 1	N/A	N/A	N/A	See Note 1	N/A	N/A	N/A

Notes:

1) Beginning with the Air Emissions Reporting Requirements (December 2008), the emissions required to be reported no longer include emissions from biogenic sources. Therefore, as of the 2011 reporting year, the comprehensive triennial emissions inventory no longer includes emissions from biogenic sources.
The RFP demonstrations are based upon the emissions from anthropogenic sources. The guidance for RFP calculations shows the first step is to subtract the emissions from biogenic sources from the total base year emissions to obtain the total anthropogenic emission inventory. As of 2011, under the AERR, the base year emissions do not include biogenic sources and already represent the total anthropogenic emissions. In this case, step one of the RFP process is not needed, and the emissions from biogenic sources is unnecessary. This RFP SIP revision: uses a base year of 2011; does not require subtraction of the biogenic emissions in Step One of the RFP calculation process; and does not include quantification of emissions from biogenic sources.

2) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

3) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

4) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

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Appendix 1 - Sheet 17

Enter Oil and Gas Production, Drilling Rigs, Diesel Engines Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	25.16	13.33	11.830	47.0	4.32	0.64	3.680	85.2
9 PDC 2020	0.32	0.10	0.220	68.8	0.05	0.00	0.050	100.0

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	4.02	2.13	1.89	47.01	0.69	0.10	0.59	85.51
1 NDC 2020	0.13	0.04	0.09	69.23	0.02	0.00	0.02	100.00

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	29.18	15.46	13.72	47.02	5.01	0.74	4.27	85.23
10 County total 2020	0.45	0.14	0.31	68.89	0.07	0.00	0.07	100.00

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

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Appendix 1 - Sheet 18

Enter Locomotive Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	36.71	15.12	21.594	58.8	1.12	0.90	0.213	19.0
9 PDC 2020	28.50	11.31	17.190	60.3	1.19	0.53	0.660	55.5

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	2.81	1.48	1.33	47.33	1.12	0.09	1.03	92.26
1 NDC 2020	3.04	1.07	1.97	64.80	0.12	0.05	0.07	58.33

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	39.52	16.60	22.92	58.00	2.23	0.99	1.24	55.65
10 County total 2020	31.54	12.38	19.16	60.75	1.31	0.58	0.73	55.73

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

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Appendix 1 - Sheet 19

Enter NONROAD Categories Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	155.45	43.00	112.447	72.3	130.06	33.18	96.878	74.5
9 PDC 2020	206.17	37.39	168.779	81.9	154.55	32.05	122.498	79.3

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	6.90	2.34	4.56	66.07	2.51	0.99	1.52	60.43
1 NDC 2020	7.14	0.91	6.23	87.22	2.83	0.59	2.25	79.33

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	162.35	45.34	117.01	72.07	132.57	34.17	98.40	74.22
10 County total 2020	213.31	38.31	175.01	82.04	157.38	32.64	124.74	79.26

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

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Appendix 1 - Sheet 20

Enter On-road Mobile Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	749.37	231.83	517.540	69.1	296.35	100.19	196.160	66.2
9 PDC 2020	935.61	94.10	841.510	89.9	364.37	55.61	308.760	84.7

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	18.39	7.24	11.15	60.63	4.80	2.05	2.75	57.29
1 NDC 2020	22.29	3.39	18.90	84.79	5.90	1.12	4.78	81.02

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	767.76	239.07	528.69	68.86	301.15	102.24	198.91	66.05
10 County total 2020	957.90	97.49	860.41	89.82	370.27	56.73	313.54	84.68

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the 2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

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Appendix 1 - Sheet 21

Enter ABY On-Road Mobile Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

RFP Analysis Year	ABY NO_X (tpd)	ABY VOC (tpd)
9 PDC 2011	749.37	296.35
9 PDC 2017	750.00	300.48
9 PDC 2020	749.92	299.81

One Newly Designated Nonattainment County: Wise

RFP Analysis Year	ABY NO_X (tpd)	ABY VOC (tpd)
1 NDC 2011	18.39	4.80
1 NDC 2017	18.26	4.89
1 NDC 2020	18.25	4.88

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

RFP Analysis Year	ABY NO_X (tpd)	ABY VOC (tpd)
10 County Total 2011	767.76	301.15
10 County Total 2017	768.26	305.37
10 County total 2020	768.17	304.69

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

4) The ABY inventories are based upon the 2011 inventory adjusted for pre-1990 FMVCP controls projected to future years. The activity levels for all ABY inventories are equal to the 2011 base year activity levels. The emission rates are fully uncontrolled with alalysis years 2011, 2017, and 2020.

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Appendix 1 - Sheet 22

Enter Point Source Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	31.34	31.34	0.00	0.0	27.54	27.54	0.00	0.0
9 PDC 2020	40.39	40.39	0.00	0.0	21.53	21.53	0.00	0.0

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	8.61	8.61	0.00	0.00	2.35	2.35	0.00	0.00
1 NDC 2020	6.44	6.44	0.00	0.00	2.82	2.82	0.00	0.00

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	39.95	39.95	0.00	0.00	29.89	29.89	0.00	0.00
10 County total 2020	46.83	46.83	0.00	0.00	24.35	24.35	0.00	0.00

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

4) The difference between existing post-2011 Controlled emissions (as of 2011) and Post-2011 Controlled VOC emissions represents noncreditable

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Appendix 1 - Sheet 23

Enter 2020 Control Measure Reductions

DFW Nonattainment Area Eight-hour Ozone Season VOC and NO_X

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

RFP Control Strategy Description	Source Category	Total 2011 to 2020 NO_X Emissions Reductions (tpd)	Total 2011 to 2020 VOC Emissions Reductions (tpd)	Use this control for RFP demonstration? (Yes or No)	Is this an on-road mobile control that will change the MVEB? (Yes or No)
Chapter 117 NO_X controls	Point	0.00	0.00	Yes	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	Yes	No
Coating / printing rules	Point	0.00	0.00	Yes	No
Portable fuel containers	Area	0.00	0.00	Yes	No
Federal Motor Vehicle Control Program (FMVCP)	OR	778.79	285.62	Yes	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	53.32	15.00	Yes	Yes
Inspection and Maintenance (I/M)	OR	6.87	8.14	Yes	Yes
On-road TxLED	OR	2.52	0.00	Yes	Yes
Tier I and II locomotive NO_X standards	NR	17.18	0.66	Yes	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-3.85	32.97	Yes	No
Heavy duty non-road engines	NR	35.90	14.21	Yes	No
Tiers 2 and 3 non-road diesel engines	NR	36.35	3.04	Yes	No
Small non-road SI engines (Phase II)	NR	2.69	31.98	Yes	No
Large non-road SI & recreational marine	NR	36.55	16.13	Yes	No
Non-road TxLED	NR	1.95	0.00	Yes	No
Non-road RFG	NR	0.01	0.49	Yes	No
Tier 4 non-road diesel engines	NR	24.76	1.10	Yes	No
Diesel recreational marine	NR	0.00	0.00	Yes	No
Small SI (Phase III)	NR	2.44	16.75	Yes	No
Chapter 117 NO_X area source engine controls	Area	0.00	0.00	Yes	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.22	0.09	Yes	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
Total		995.70	426.18		

Note: Unspecified control rows were created only to allow for planners to easily add controls for alternative scenario analyses.

Notes

1) Point source Chapter 117 NO_X controls in the DFW area had compliance deadlines before 2011. The 2011 EI includes the effects of the control. No additional control beyond 2011 are claimed.

2) Area source Chapter 117 NO_X controls in the DFW area had compliance deadlines before 2011. The 2011 EI includes the effects of the control. No additional control beyond 2011 are claimed.

3) Area source Portable fuel containers controls in the DFW area had compliance deadlines before 2011. The 2011 EI includes the effects of the control. No additional control beyond 2011 are claimed.

4) The ten county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with RFG are: Collin, Dallas Denton and Tarrant. The six counties with Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall and Wise.

5) 1 NDC means the onr newly designated counties and indicates values are for the one county in the DFW ozone nonattainment area that were newly designated under the 2008 eight-hour ozone standard. Includes: Wise County

6) 9 PDC means the nine previously designated counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and were also designated under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton,Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties.

7) 10 NAC = means the values include all ten DFW area ozone nonattainment counties designated under the 2008 ozone standards.

8) Inspection and Maintenance Program is only modeled for the nine previously designated counties

9) "This row not used for current RFP" control rows were created only to allow for planners to easily add controls for alternative scenario analyses.

10) Three on-road control reduction values reflect corrections fo rrounding errors. The thre values are: NOx FMVCP minus 0.01; VOC FMVCP plus 0.01;and, NOx on-road fuel programs minus 0.01.

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Appendix 1 - Sheet 24

Enter 2020 Control Measure Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

One Newly Designated Nonattainment County: Wise

RFP Control Strategy Description	Source Category	Total 2011 to 2020 NO_X Emissions Reductions (tpd)	Total 2011 to 2020 VOC Emissions Reductions (tpd)	Use this control for RFP demonstration? (Yes or No)	Is this an on-road mobile control that will change the MVEB? (Yes or No)
Chapter 117 NOX controls	Point	0.00	0.00	Yes	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	Yes	No
Coating / printing rules	Point	0.00	0.00	Yes	No
Portable fuel containers	Area	0.00	0.00	Yes	No
Federal Motor Vehicle Control Program (FMVCP)	OR	17.87	4.61	Yes	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	0.91	0.17	Yes	Yes
Inspection and Maintenance (I/M)	OR	0.00	0.00	Yes	Yes
On-road TxLED	OR	0.13	0.00	Yes	Yes
Tier I and II locomotive NOX standards	NR	1.97	0.08	Yes	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-0.03	0.22	Yes	No
Heavy duty non-road engines	NR	1.54	0.59	Yes	No
Tiers 2 and 3 non-road diesel engines	NR	1.71	0.11	Yes	No
Small non-road SI engines (Phase II)	NR	0.02	0.21	Yes	No
Large non-road SI & recreational marine	NR	0.22	0.35	Yes	No
Non-road TxLED	NR	1.95	0.00	Yes	No
Non-road RFG	NR	0.00	0.00	Yes	No
Tier 4 non-road diesel engines	NR	1.17	0.04	Yes	No
Diesel recreational marine	NR	0.00	0.00	Yes	No
Small SI (Phase III)	NR	0.03	0.24	Yes	No
Chapter 117 NOX area source engine controls	Area	0.00	0.00	Yes	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.09	0.02	Yes	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
Total		27.57	6.64		

Notes

Please see notes for the control reductions on:

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Enter 2021 Contingency Measure Control Measure Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

RFP Control Strategy Description	Source Category	Total 2011 to 2021 NO_X Emissions Reductions (tpd)	Total 2011 to 2021 VOC Emissions Reductions (tpd)	Use this control for 2021 RFP contingency? (Yes or No)
Chapter 117 NOX controls	Point	0.00	0.00	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	No
Coating / printing rules	Point	0.00	0.00	No
Portable fuel containers	Area	0.00	0.00	No
Federal Motor Vehicle Control Program (FMVCP)	OR	808.08	295.74	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	49.11	14.26	Yes
Inspection and Maintenance (I/M)	OR	6.03	7.71	Yes
On-road TxLED	OR	2.30	0.00	Yes
Tier I and II locomotive NOX standards	NR	17.83	0.69	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-3.92	33.50	Yes
Heavy duty non-road engines	NR	36.64	14.51	Yes
Tiers 2 and 3 non-road diesel engines	NR	37.53	3.15	Yes
Small non-road SI engines (Phase II)	NR	2.73	32.47	Yes
Large non-road SI & recreational marine	NR	37.58	16.63	Yes
Non-road TxLED	NR	1.83	0.00	Yes
Non-road RFG	NR	0.01	0.49	Yes
Tier 4 non-road diesel engines	NR	26.74	1.17	Yes
Diesel recreational marine	NR	0.00	0.00	Yes
Small SI (Phase III)	NR	2.51	17.19	Yes
Chapter 117 NOX area source engine controls	Area	0.00	0.00	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.22	0.05	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
Total		1025.23	437.56	

Notes

Please see notes for the control reductions on:

23 Enter Reductions 9 PDC 2020

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05 Calc 10 DFW 2021 AD Cont
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Appendix 1 - Sheet 26

Enter 2021 Contingency Measure Control Measure Reductions
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
One Newly Designated Nonattainment County: Wise

RFP Control Strategy Description	Source Category	Total 2011 to 2021 NO_X Emissions Reductions (tpd)	Total 2011 to 2021 VOC Emissions Reductions (tpd)	Use this control for 2021 RFP contingency? (Yes or No)
Chapter 117 NOX controls	Point	0.00	0.00	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	No
Coating / printing rules	Point	0.00	0.00	No
Portable fuel containers	Area	0.00	0.00	No
Federal Motor Vehicle Control Program (FMVCP)	OR	18.63	4.79	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	0.83	0.16	Yes
Inspection and Maintenance (I/M)	OR	0.00	0.00	Yes
On-road TxLED	OR	0.12	0.00	Yes
Tier I and II locomotive NOX standards	NR	2.04	0.08	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-0.36	0.22	Yes
Heavy duty non-road engines	NR	1.56	0.59	Yes
Tiers 2 and 3 non-road diesel engines	NR	1.73	0.11	Yes
Small non-road SI engines (Phase II)	NR	0.02	0.22	Yes
Large non-road SI & recreational marine	NR	0.22	0.36	Yes
Non-road TxLED	NR	0.05	0.00	Yes
Non-road RFG	NR	0.00	0.00	Yes
Tier 4 non-road diesel engines	NR	1.24	0.04	Yes
Diesel recreational marine	NR	0.00	0.00	Yes
Small SI (Phase III)	NR	0.03	0.25	Yes
Chapter 117 NOX area source engine controls	Area	0.00	0.00	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.09	0.02	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
Total		26.20	6.85	

Notes
Please see notes for the control reductions on:
23 Enter Reductions 9 PDC 2020

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Appendix 1 - Sheet 27

Calculate 2011 RFP Base Year Emissions Inventory

(Add emissions from outside the nonattainment area that are to be included in the RFP analysis.)

DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

The PDC 2011 Base Year Inventory	**NO_X (tons/day)**	**VOC (tons/day)**
Point Source PDC 2011 EI	31.34	27.54
Area Source PDC 2011 EI	37.69	262.35
On-road mobile PDC 2011 EI	231.83	100.19
Non-road mobile PDC 2011 EI	86.08	40.28
Biogenic PDC 2011 EI (see Note 1)	See Note 1	See Note 1
Total PDC 2011 RFP Base Year Inventory with Adjustments	**386.94**	**430.36**

Notes:

1) Beginning with the Air Emissions Reporting Requirements (December 2008), the emissions required to be reported no longer include emissions from biogenic sources. Therefore, as of the 2011 reporting year, the comprehensive triennial emissions inventory no longer includes emissions from biogenic sources. The RFP demonstrations are based upon the emissions from anthropogenic sources. The guidance for RFP calculations shows the first step is to subtract the emissions from biogenic sources from the total base year emissions to obtain the total anthropogenic emission inventory. As of 2011, under the AERR, the base year emissions do not include biogenic sources and already represent the total anthropogenic emissions. In this case, step one of the RFP process is not needed, and the emissions from biogenic sources is unnecessary. This RFP SIP revision: uses a base year of 2011; does not require subtraction of the biogenic emissions in Step One of the RFP calculation process; and does not include quantification of emissions from biogenic sources.

4) 9 PDC means values are for the nine counties that had an existing designation under the one-hour or the 1997 eight hour ozone standards and were also designated under the 2008 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties.

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Appendix 1 - Sheet 28

Calculate NDC 2011 RFP Base Year Emissions Inventory

('Add emissions from outside the nonattainment area that are to be included in RFP analysis.)

DFW Eight-Hour Ozone Nonattainment Area

One Newly Designated Nonattainment County: Wise

The NDC 2011 Base Year Inventory	**NO_X (tons/day)**	**VOC (tons/day)**
Point Source NDC 2011 EI	8.61	2.35
Area Source NDC 2011 EI	13.29	28.95
On-Road Mobile NDC 2011 EI	7.24	2.05
Non-Road Mobile NDC 2011 EI	5.96	1.21
Biogenic NDC 2011 EI	See Note 1	See Note 1
Total NDC 2011 RFP Base Year Inventory with Adjustments	**35.10**	**34.56**

Notes:

1) Beginning with the Air Emissions Reporting Requirements (December 2008), the emissions required to be reported no longer include emissions from biogenic sources. Therefore, as of the 2011 reporting year, the comprehensive triennial emissions inventory no longer includes emissions from biogenic sources.
The RFP demonstrations are based upon the emissions from anthropogenic sources. The guidance for RFP calculations shows the first step is to subtract the emissions from biogenic sources from the total base year emissions to obtain the total anthropogenic emission inventory. As of 2011, under the AERR, the base year emissions do not include biogenic sources and already represent the total anthropogenic emissions. In this case, step one of the RFP process is not needed, and the emissions from biogenic sources is unnecessary. This RFP SIP revision: uses a base year of 2011; does not require subtraction of the biogenic emissions in Step One of the RFP calculation process; and does not include quantification of emissions from biogenic sources.

4) NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the 2008 eight-hour ozone standard. Includes: Wise County.

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Appendix 1 - Sheet 29

2020 Forecasted Uncontrolled or Existing Control Emissions Inventory with pre-2011 Controls
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

Uncontrolled or Existing Control EI with pre-2011 controls: These calculations add up to the total Uncontrolled or Existing Control NOX and VOC emissions (tpd) for the 2020 RFP milestone year. The totals for each source category used in these calculations were entered on enter EI sheets.

Forecasted 2020 Uncontrolled or Existing Control Emissions Inventory with pre-2011 Controls

Emissions Description	NO_X (tpd)	VOC (tpd)
Point Source	40.39	21.53
Area Source	33.87	281.00
On-Road Mobile Source	935.61	364.37
Non-Road Mobile Source	254.20	159.14
Total	1264.07	826.04

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06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
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Appendix 1 - Sheet 30

2020 Forecasted Uncontrolled or Existing Control Emissions Inventory with pre-2011 Controls
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
One Newly Designated Nonattainment County: Wise

Uncontrolled or Existing Control EI with pre-2011 controls: These calculations add up to the total Uncontrolled or Existing Control NOX and VOC emissions (tpd) for the 2020 RFP milestone year. The totals for each source category used in these calculations were entered on enter EI sheets.

Forecasted 2020 Uncontrolled or Existing Control Emissions Inventory with pre-2011 Controls

Emissions Description	NO_X (tpd)	VOC (tpd)
Point Source	6.44	2.82
Area Source	4.82	18.22
On-Road Mobile Source	22.29	5.90
Non-Road Mobile Source	10.31	2.98
Total	43.86	29.92

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Appendix - Sheet 31

Calculations: 9 PDC 2011 Adjusted Base Year Emissions Inventory with Pre-1990 Controls

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

ABY EI with pre-1990 controls: These calculations add up to the total ABY NO_X and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

9 PDC 2011 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	NO_X (tpd)	VOC (tpd)
Point Source 2011 9 PDC BY EI	31.34	27.54
Area Source 20119 PDC BY EI	37.69	262.35
On-Road Mobile Source 2011 9 PDC ABY EI	231.83	100.19
Non-Road Mobile Source 2011 9 PDCBY EI	86.08	40.28
9 PDC 2011 RFP Adjusted Base Year Emissions Inventory	386.94	430.36

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Appendix 1 - Sheet 32

Calculations: 1 NDC 2011 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
One Newly Designated Nonattainment County: Wise

ABY EI with pre-1990 controls: These calculations add up to the total ABY NOX and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

1 NDC 2011 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	**NO_X (tpd)**	**VOC (tpd)**
Point Source 1 NDC 2011 BY EI	8.61	2.35
Area Source 1 NDC 2011 BY EI	13.29	28.95
On-Road Mobile Source 1 NDC 2011 ABY EI	7.24	2.05
Non-Road Mobile Source 1 NDC 2011 BY EI	5.96	1.21
1 NDC 2011 RFP Adjusted Base Year Emissions Inventory	35.10	34.56

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Appendix 1 - Sheet 33

Calculations: 9 PDC 2017 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

ABY EI with pre-1990 controls: These calculations add up to the total ABY NOX and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

9 PDC 2017 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	**NO_X (tpd)**	**VOC (tpd)**
Point Source 2011 BY EI	31.34	27.54
Area Source 2011 BY EI	37.69	262.35
On-Road Mobile Source 2017 ABY EI	231.83	100.19
Non-Road Mobile Source 2011 BY EI	86.08	40.28
9 PDC 2017 RFP Adjusted Base Year Emissions Inventory	386.94	430.36

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM

Appendix 1 - Sheet 34

Calculations: 1 NDC 2017 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
One Newly Designated Nonattainment County: Wise

ABY EI with pre-1990 controls: These calculations add up to the total ABY NOX and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

1 NDC 2017 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	NO_X (tpd)	VOC (tpd)
Point Source 2011 1 NDC BY EI	8.61	2.35
Area Source 2011 1 NDC BY EI	13.29	28.95
On-Road Mobile Source 2017 ABY EI	7.24	2.05
Non-Road Mobile Source 2011 1 NDC BY EI	5.96	1.21
1 NDC 2017 RFP Adjusted Base Year Emissions Inventory	35.10	34.56

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06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM

Appendix 1 - Sheet 35

Calculations: 9 PDC 2020 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

ABY EI with pre-1990 controls: These calculations add up to the total ABY NOX and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

9 PDC 2020 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	**NO_X (tpd)**	**VOC (tpd)**
Point Source 2011 BY EI	31.34	27.54
Area Source 2011 BY EI	37.69	262.35
On-Road Mobile Source 2018 ABY EI	231.83	100.19
Non-Road Mobile Source 2011 BY EI	86.08	40.28
9 PDC 2018 RFP Adjusted Base Year Emissions Inventory	386.94	430.36

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM

Appendix 1 - Sheet 36

Calculations: 1 NDC 2020 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
One Newly Designated Nonattainment County: Wise

ABY EI with pre-1990 controls: These calculations add up to the total ABY NOX and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

1 NDC 2020 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	**NO_X (tpd)**	**VOC (tpd)**
Point Source 2011 1 NDC BY EI	8.61	2.35
Area Source 2011 1 NDC BY EI	13.29	28.95
On-Road Mobile Source 2018 ABY EI	7.24	2.05
Non-Road Mobile Source 2011 1 NDC BY EI	5.96	1.21
1 NDC 2018 RFP Adjusted Base Year Emissions Inventory	35.10	34.56

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM

Appendix 1 - Sheet 37

Calculations: 2011 to 2020 Control Measures Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "26 Enter Reductions 9 PDC 2020." The reduction is the reduction that is creditable from each control between 2011 and 2020. If the control has been turned off by inputting a "No" in the "Use this control for 2020 RFP demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Reductions 9 PDC 2020 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Reductions9 PDC 2020 Sheet and change the No to a Yes indicating that the control will be used for RFP demonstration.

Creditable Reductions Control Strategy	**Source Category**	**Total 2011 to 2020 NOX Emissions Reductions (tpd)**	**Total 2011 to 2020 VOC Emissions Reductions (tpd)**	**Use this control for RFP demonstration? (Yes or No)**	**Is this an on-road mobile control that will change the MVEB? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	Yes	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	Yes	No
Coating / printing rules	Point	0.00	0.00	Yes	No
Portable fuel containers	Area	0.00	0.00	Yes	No
Federal Motor Vehicle Control Program (FMVCP)	OR	778.79	285.62	Yes	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	53.32	15.00	Yes	Yes
Inspection and Maintenance (I/M)	OR	6.87	8.14	Yes	Yes
On-road TxLED	OR	2.52	0.00	Yes	Yes
Tier I and II locomotive NOX standards	NR	17.18	0.66	Yes	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-3.85	32.97	Yes	No
Heavy duty non-road engines	NR	35.90	14.21	Yes	No
Tiers 2 and 3 non-road diesel engines	NR	36.35	3.04	Yes	No
Small non-road SI engines (Phase II)	NR	2.69	31.98	Yes	No
Large non-road SI & recreational marine	NR	36.55	16.13	Yes	No
Non-road TxLED	NR	1.95	0.00	Yes	No
Non-road RFG	NR	0.01	0.49	Yes	No
Tier 4 non-road diesel engines	NR	24.76	1.10	Yes	No
Diesel recreational marine	NR	0.00	0.00	Yes	No
Small SI (Phase III)	NR	2.44	16.75	Yes	No
Chapter 117 NOX area source engine controls	Area	0.00	0.00	Yes	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission	NR	0.22	0.09	Yes	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
Total 2020 9 PDC RFP Control Reductions		995.70	426.18		

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC

Appendix 1 - Sheet 38

Calculations: 2011 to 2020 Control Measures Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

One Newly Designated Nonattainment County: Wise

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "26 Enter Reductions 9 PDC 2020." The reduction is the reduction that is creditable from each control between 2011 and 2020. If the control has been turned off by inputting a "No" in the "Use this control for 2020 RFP demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Reductions 9 PDC 2020 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Reductions9 PDC 2020 Sheet and change the No to a Yes indicating that the control will be used for RFP demonstration.

Creditable Reductions Control Strategy	**Source Category**	**Total 2011 to 2020 NOX Emissions Reductions (tpd)**	**Total 2011 to 2020 VOC Emissions Reductions (tpd)**	**Use this control for RFP demonstration? (Yes or No)**	**Is this an on-road mobile control that will change the MVEB? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	Yes	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	Yes	No
Coating / printing rules	Point	0.00	0.00	Yes	No
Portable fuel containers	Area	0.00	0.00	Yes	No
Federal Motor Vehicle Control Program (FMVCP)	OR	17.87	4.61	Yes	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	0.91	0.17	Yes	Yes
Inspection and Maintenance (I/M)	OR	0.00	0.00	Yes	Yes
On-road TxLED	OR	0.13	0.00	Yes	Yes
Tier I and II locomotive NOX standards	NR	1.97	0.08	Yes	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-0.03	0.22	Yes	No
Heavy duty non-road engines	NR	1.54	0.59	Yes	No
Tiers 2 and 3 non-road diesel engines	NR	1.71	0.11	Yes	No
Small non-road SI engines (Phase II)	NR	0.02	0.21	Yes	No
Large non-road SI & recreational marine	NR	0.22	0.35	Yes	No
Non-road TxLED	NR	1.95	0.00	Yes	No
Non-road RFG	NR	0.00	0.00	Yes	No
Tier 4 non-road diesel engines	NR	1.17	0.04	Yes	No
Diesel recreational marine	NR	0.00	0.00	Yes	No
Small SI (Phase III)	NR	0.03	0.24	Yes	No
Chapter 117 NOX area source engine controls	Area	0.00	0.00	Yes	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission D	NR	0.09	0.02	Yes	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
Total 2020 1 NDC RFP Control Reductions		27.57	6.64		

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04 Calc 10 DFW 2021 RFP Cont

05 Calc 10 DFW 2021 AD Cont

06 Calc 2020 RFP MVEB

09 Calc Targets 9 PDC

10 Calc Targets 1 NDC

Appendix 1 - Sheet 39

Calculations: Combined 9 PDC and 1 NDC 2011 to 2020 Control Measures Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

All Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "26 Enter Reductions 9 PDC 2020." The reduction is the reduction that is creditable from each control between 2011 and 2020. If the control has been turned off by inputting a "No" in the "Use this control for 2020 RFP demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Reductions 9 PDC 2020 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Reductions9 PDC 2020 Sheet and change the No to a Yes indicating that the control will be used for RFP demonstration.

RFP Control Strategy Description	**Source Category**	**Total 2011 to 2020 NOX Emissions Reductions (tpd)**	**Total 2011 to 2020 VOC Emissions Reductions (tpd)**	**Use this control for RFP demonstration? (Yes or No)**	**Is this an on-road mobile control that will change the MVEB? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	Yes	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	Yes	No
Coating / printing rules	Point	0.00	0.00	Yes	No
Portable fuel containers	Area	0.00	0.00	Yes	No
Federal Motor Vehicle Control Program (FMVCP)	OR	796.66	290.23	Yes	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	54.23	15.17	Yes	Yes
Inspection and Maintenance (I/M)	OR	6.87	8.14	Yes	Yes
On-road TxLED	OR	2.65	0.00	Yes	Yes
Tier I and II locomotive NOX standards	NR	19.15	0.74	Yes	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-3.88	33.19	Yes	No
Heavy duty non-road engines	NR	37.44	14.79	Yes	No
Tiers 2 and 3 non-road diesel engines	NR	38.06	3.15	Yes	No
Small non-road SI engines (Phase II)	NR	2.71	32.19	Yes	No
Large non-road SI & recreational marine	NR	36.77	16.48	Yes	No
Non-road TxLED	NR	3.89	0.00	Yes	No
Non-road RFG	NR	0.01	0.49	Yes	No
Tier 4 non-road diesel engines	NR	25.93	1.14	Yes	No
Diesel recreational marine	NR	0.00	0.00	Yes	No
Small SI (Phase III)	NR	2.47	16.99	Yes	No
Chapter 117 NOX area source engine controls	Area	0.00	0.00	Yes	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission	NR	0.31	0.11	Yes	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
Total 2020 10 DFW RFP Control Reductions		1023.27	432.82		

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05 Calc 10 DFW 2021 AD Cont

06 Calc 2020 RFP MVEB

09 Calc Targets 9 PDC

10 Calc Targets 1 NDC

Appendix 1 - Sheet 40

Calculations: 9 PDC 2020 to 2021 Contingency Control Measures Reductions
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
Nine Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "34 Enter Reductions 9 DFW 2021." The reduction is the reduction that is creditable from each control between 2020 and 2021. If the control has been turned off by inputting a "No" in the "Use this control for 2021 RFP contingency demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Reductions 9 DFW 2021 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Reductions 9 DFW 2021 Sheet and change the No to a Yes indicating that the control will be used for RFP contingency demonstration.

RFP Control Strategy Description	**Source Category**	**Total 2020 to 2021 NO_X Emissions Reductions (tpd)**	**Total 2020 to 2021 VOC Emissions Reductions (tpd)**	**Use this control for 2019 RFP contingency demonstration? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	No
Coating / printing rules	Point	0.00	0.00	No
Portable fuel containers	Area	0.00	0.00	No
Federal Motor Vehicle Control Program (FMVCP)	OR	29.29	10.12	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	-4.21	-0.74	Yes
Inspection and Maintenance (I/M)	OR	-0.84	-0.43	Yes
On-road TxLED	OR	-0.22	0.00	Yes
Tier I and II locomotive NOX standards	NR	0.00	0.00	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-0.06	0.53	Yes
Heavy duty non-road engines	NR	0.74	0.30	Yes
Tiers 2 and 3 non-road diesel engines	NR	1.17	0.11	Yes
Small non-road SI engines (Phase II)	NR	0.04	0.49	Yes
Large non-road SI & recreational marine	NR	1.03	0.50	Yes
Non-road TxLED	NR	-0.12	0.00	Yes
Non-road RFG	NR	0.00	0.00	Yes
Tier 4 non-road diesel engines	NR	1.98	0.07	Yes
Diesel recreational marine	NR	0.00	0.00	Yes
Small SI (Phase III)	NR	0.07	0.44	Yes
Chapter 117 NOX area source engine controls	Area	0.00	0.00	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission D	NR	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
Total 9 PDC RFP Control Reductions		28.88	11.39	

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06 Calc 2020 RFP MVEB
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Appendix 1 - Sheet 41

Calculations: 1 NDC 2020 to 2021 Contingency Control Measures Reductions
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
One Newly Designated Nonattainment County: Wise

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "34 Enter Reductions 9 DFW 2021." The reduction is the reduction that is creditable from each control between 2020 and 2021. If the control has been turned off by inputting a "No" in the "Use this control for 2021 RFP contingency demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Reductions 1 DFW 2021 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Reductions 9 DFW 2021 Sheet and change the No to a Yes indicating that the control will be used for RFP contingency demonstration.

RFP Control Strategy Description	**Source Category**	**Total 2020 to 2021 NO_X Emissions Reductions (tpd)**	**Total 2020 to 2021 VOC Emissions Reductions (tpd)**	**Use this control for 2019 RFP contingency demonstration? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	No
Coating / printing rules	Point	0.00	0.00	No
Portable fuel containers	Area	0.00	0.00	No
Federal Motor Vehicle Control Program (FMVCP)	OR	0.76	0.18	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	-0.08	-0.01	Yes
Inspection and Maintenance (I/M)	OR	0.00	0.00	Yes
On-road TxLED	OR	-0.01	0.00	Yes
Tier I and II locomotive NOX standards	NR	0.00	0.00	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-0.33	0.00	Yes
Heavy duty non-road engines	NR	0.01	0.01	Yes
Tiers 2 and 3 non-road diesel engines	NR	0.03	0.00	Yes
Small non-road SI engines (Phase II)	NR	0.00	0.00	Yes
Large non-road SI & recreational marine	NR	0.00	0.01	Yes
Non-road TxLED	NR	-1.90	0.00	Yes
Non-road RFG	NR	0.00	0.00	Yes
Tier 4 non-road diesel engines	NR	0.07	0.00	Yes
Diesel recreational marine	NR	0.00	0.00	Yes
Small SI (Phase III)	NR	0.00	0.01	Yes
Chapter 117 NOX area source engine controls	Area	0.00	0.00	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
Total 1 NDC RFP Control Reductions		-1.44	0.21	

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06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC

Appendix 1 - Sheet 42

Calculations: Combined 9 DFW and 1 DFW 2020 to 2021 Contingency Control Measures Reductions
DFW Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
All Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "34 Enter Reductions 9 DFW 2021." The reduction is the reduction that is creditable from each control between 2020 and 2021. If the control has been turned off by inputting a "No" in the "Use this control for 2021 RFP contingency demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Reductions 9 DFW 2021 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Reductions 9 DFW 2021 Sheet and change the No to a Yes indicating that the control will be used for RFP contingency demonstration.

RFP Control Strategy Description	**Source Category**	**Total 2020 to 2021 NOx Emissions Reductions (tpd)**	**Total 2020 to 2021 VOC Emissions Reductions (tpd)**	**Use this control for 2021 RFP contingency demonstration? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	No
Coating / printing rules	Point	0.00	0.00	No
Portable fuel containers	Area	0.00	0.00	No
Federal Motor Vehicle Control Program (FMVCP)	OR	30.05	10.30	Yes
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	-4.29	-0.75	Yes
Inspection and Maintenance (I/M)	OR	-0.84	-0.43	Yes
On-road TxLED	OR	-0.23	0.00	Yes
Tier I and II locomotive NOX standards	NR	0.00	0.00	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-0.40	0.53	Yes
Heavy duty non-road engines	NR	0.76	0.31	Yes
Tiers 2 and 3 non-road diesel engines	NR	1.20	0.11	Yes
Small non-road SI engines (Phase II)	NR	0.05	0.50	Yes
Large non-road SI & recreational marine	NR	1.03	0.51	Yes
Non-road TxLED	NR	-2.01	0.00	Yes
Non-road RFG	NR	0.00	0.00	Yes
Tier 4 non-road diesel engines	NR	2.05	0.07	Yes
Diesel recreational marine	NR	0.00	0.00	Yes
Small SI (Phase III)	NR	0.07	0.45	Yes
Chapter 117 NOX area source engine controls	Area	0.00	0.00	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission	NR	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
Total 2021 10 DFW RFP Control Reductions		27.44	11.60	

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06 Calc 2020 RFP MVEB
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10 Calc Targets 1 NDC

Appendix 1 - Sheet 43

Calculations: 2011 to 2020 On-road Control Measures Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NOX

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

Creditable Reductions Control Strategy	**Control Used for RFP Demonstration?**	**On-road Mobile Source Control?**	**Total 2011 to 2020 'On-road Mobile NO_X Emissions Reductions (tpd)**	**Total 2011 to 2020 'On-road Mobile VOC Emissions Reductions (tpd)**
Chapter 117 NOX controls	Yes	No	0	0
Chapter 115 Storage Tank Rule	Yes	No	0	0
Coating / printing rules	Yes	No	0	0
Portable fuel containers	Yes	No	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	Yes	Yes	778.79	285.62
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	Yes	Yes	53.32	15
Inspection and Maintenance (I/M)	Yes	Yes	6.87	8.14
On-road TxLED	Yes	Yes	2.52	0
Tier I and II locomotive NOX standards	Yes	No	0	0
Small non-road spark ignition (SI) engines (Phase I)	Yes	No	0	0
Heavy duty non-road engines	Yes	No	0	0
Tiers 2 and 3 non-road diesel engines	Yes	No	0	0
Small non-road SI engines (Phase II)	Yes	No	0	0
Large non-road SI & recreational marine	Yes	No	0	0
Non-road TxLED	Yes	No	0	0
Non-road RFG	Yes	No	0	0
Tier 4 non-road diesel engines	Yes	No	0	0
Diesel recreational marine	Yes	No	0	0
Small SI (Phase III)	Yes	No	0	0
Chapter 117 NOX area source engine controls	Yes	No	0	0
Drilling Rigs: Federal Engine Standards and Texas Low Emission Dies	Yes	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
Total 9 PDC On-road Mobile Source RFP Control Reductions			**841.50**	**308.76**

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont

Appendix 1 - Sheet 44

Calculations: 2011 to 2020 On-road Control Measures Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NOX

One Newly Designated Nonattainment County: Wise

Creditable Reductions Control Strategy	Control Used for RFP Demonstration?	On-road Mobile Source Control?	Total 2011to 2020 'On-road Mobile NO_X Emissions Reductions (tpd)	Total 2011 to 2020 'On-road Mobile VOC Emissions Reductions (tpd)
Chapter 117 NOX controls	Yes	No	0	0
Chapter 115 Storage Tank Rule	Yes	No	0	0
Coating / printing rules	Yes	No	0	0
Portable fuel containers	Yes	No	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	Yes	Yes	17.87	4.61
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	Yes	Yes	0.91	0.17
Inspection and Maintenance (I/M)	Yes	Yes	0	0
On-road TxLED	Yes	Yes	0.13	0
Tier I and II locomotive NOX standards	Yes	No	0	0
Small non-road spark ignition (SI) engines (Phase I)	Yes	No	0	0
Heavy duty non-road engines	Yes	No	0	0
Tiers 2 and 3 non-road diesel engines	Yes	No	0	0
Small non-road SI engines (Phase II)	Yes	No	0	0
Large non-road SI & recreational marine	Yes	No	0	0
Non-road TxLED	Yes	No	0	0
Non-road RFG	Yes	No	0	0
Tier 4 non-road diesel engines	Yes	No	0	0
Diesel recreational marine	Yes	No	0	0
Small SI (Phase III)	Yes	No	0	0
Chapter 117 NOX area source engine controls	Yes	No	0	0
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	Yes	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
Total 1 NDC On-road Mobile Source RFP Control Reductions			**18.91**	**4.78**

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05 Calc 10 DFW 2021 AD Cont
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09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont

Appendix 1 - Sheet 45

Calculations: 2011 to 2020 On-road Control Measures Reductions

DFW Nonattainment Area Eight-Hour Ozone Season VOC and NOX

All Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Creditable Reductions Control Strategy	Control Used for RFP Demonstration?	On-road Mobile Source Control?	Total 2011 to 2020 On-road Mobile NO$_X$ Emissions Reductions (tpd)	Total 2011 to 2020 On-road Mobile VOC Emissions Reductions (tpd)
Chapter 117 NOX controls	Yes	No	0	0
Chapter 115 Storage Tank Rule	Yes	No	0	0
Coating / printing rules	Yes	No	0	0
Portable fuel containers	Yes	No	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	Yes	Yes	796.66	290.23
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	Yes	Yes	54.23	15.17
Inspection and Maintenance (I/M)	Yes	Yes	6.87	8.14
On-road TxLED	Yes	Yes	2.65	0
Tier I and II locomotive NOX standards	Yes	No	0	0
Small non-road spark ignition (SI) engines (Phase I)	Yes	No	0	0
Heavy duty non-road engines	Yes	No	0	0
Tiers 2 and 3 non-road diesel engines	Yes	No	0	0
Small non-road SI engines (Phase II)	Yes	No	0	0
Large non-road SI & recreational marine	Yes	No	0	0
Non-road TxLED	Yes	No	0	0
Non-road RFG	Yes	No	0	0
Tier 4 non-road diesel engines	Yes	No	0	0
Diesel recreational marine	Yes	No	0	0
Small SI (Phase III)	Yes	No	0	0
Chapter 117 NOX area source engine controls	Yes	No	0	0
Drilling Rigs: Federal Engine Standards and Texas Low Emission Di	Yes	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
This row not used for current RFP	No	No	0	0
Total 9 PDC On-road Mobile Source RFP Control Reductions			**860.41**	**313.54**

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont

Appendix 1 - Sheet 46

Summary Sheet: Uncontrolled or Existing Control NOx Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

2011 Uncontrolled or Existing Control NOX (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	37.69	13.29	50.98
Non-Road Mobile Sources	231.95	13.74	245.69
On-Road Mobile Sources	749.37	18.39	767.76
Point Sources	31.34	8.61	39.95
Total	1050.35	54.03	1104.38

2020 Uncontrolled or Existing Control NOX (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	33.87	4.82	38.69
Non-Road Mobile Sources	254.20	10.31	264.51
On-Road Mobile Sources	935.61	22.29	957.90
Point Sources	40.39	6.44	46.83
Total	1,264.07	43.86	1,307.93

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06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

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Summary Sheet: Controlled or Post-2011 Controlled NOx Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Controlled or Post-2011 Controlled NOX for 2011 (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	37.69	13.29	50.98
Non-Road Mobile Sources	86.08	5.96	92.04
On-Road Mobile Sources	231.83	7.24	239.07
Point Sources	31.34	8.61	39.95
Total	386.94	35.10	422.04

Controlled or Post-2011 Controlled NOX for 2020 (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	33.87	4.82	38.69
Non-Road Mobile Sources	68.01	2.02	70.03
On-Road Mobile Sources	94.10	3.39	97.49
Point Sources	40.39	6.44	46.83
Total	236.37	16.67	253.04

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

Appendix 1 - Sheet 48

Summary Sheet: Uncontrolled or Existing Control VOC Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

2011 Uncontrolled or Existing Control VOC (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	262.35	28.95	291.30
Non-Road Mobile Sources	141.05	4.35	145.40
On-Road Mobile Sources	296.35	4.80	301.15
Point Sources	27.54	2.35	29.89
Total	727.29	40.45	767.74

2020 Uncontrolled or Existing Control VOC (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	281.00	18.22	299.22
Non-Road Mobile Sources	159.14	2.98	162.12
On-Road Mobile Sources	364.37	5.90	370.27
Point Sources	21.53	2.82	24.35
Total	826.04	29.92	855.96

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06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

Appendix 1 - Sheet 49

Summary Sheet: Controlled or Post-2011 Controlled VOC Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Controlled or Post-2011 Controlled VOC for 2011 (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	262.35	28.95	291.30
Non-Road Mobile Sources	40.28	1.21	41.49
On-Road Mobile Sources	100.19	2.05	102.24
Point Sources	27.54	2.35	29.89
Total	430.36	34.56	464.92

Controlled or Post-2011 Controlled VOC for 2020 (tons per day)

RFP Analysis Year	9 PDC	1 NDC	10 NAC Total
Area Sources	281.00	18.22	299.22
Non-Road Mobile Sources	35.93	0.65	36.58
On-Road Mobile Sources	55.61	1.12	56.73
Point Sources	21.53	2.82	24.35
Total	394.07	22.81	416.88

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

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Summary Sheet: 2011 Emissions Inventory By Category
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

2011 9 PDC (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	37.69	37.69	262.35	262.35
Non-Road Mobile Sources	231.95	86.08	141.05	40.28
On-Road Mobile Sources	749.37	231.83	296.35	100.19
Point Sources	31.34	31.34	27.54	27.54
Total	1050.35	386.94	727.29	430.36

2011 1 NDC (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	13.29	13.29	28.95	28.95
Non-Road Mobile Sources	13.74	5.96	4.35	1.21
On-Road Mobile Sources	18.39	7.24	4.80	2.05
Point Sources	8.61	8.61	2.35	2.35
Total	54.03	35.10	40.45	34.56

2011 10 NAC Total (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	50.98	50.98	291.30	291.30
Non-Road Mobile Sources	245.69	92.04	145.40	41.49
On-Road Mobile Sources	767.76	239.07	301.15	102.24
Point Sources	39.95	39.95	29.89	29.89
Total	1104.38	422.04	767.74	464.92

Tables for Chapter of the SIP Narrative

Table 2-5: Nine County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NOX a

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	231.95	86.08	141.05	40.28
On-Road Mobile Sources	749.37	231.83	296.35	100.19
Emissions Inventory Source	**Existing Controlled NO_X**	**Post-2011 Controlled NO_X**	**Uncontrolled VOC**	**Post-2011 Controlled VOC**

Area Sources	37.69	37.69	262.35	262.35
Point Sources	31.34	31.34	27.54	27.54
Total of All Sources	1050.35	386.94	727.29	430.36
QA	1050.35	386.94	727.29	430.36

Table 2-6: One County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NOX an

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	13.74	5.96	4.35	1.21
On-Road Mobile Sources	18.39	7.24	4.80	2.05
Emissions Inventory Source	**Existing Controlled NO_X**	**Post-2011 Controlled NO_X**	**Uncontrolled VOC**	**Post-2011 Controlled VOC**
Area Sources	13.29	13.29	28.95	28.95
Point Sources	8.61	8.61	2.35	2.35
Total of All Sources	54.03	35.10	40.45	34.56
QA	54.03	35.10	40.45	34.56

Table 2-7: Ten County DFW RFP Summary of the 2011 Base Year Average Summer Weekday NOX an

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	245.69	92.04	145.40	41.49
On-Road Mobile Sources	767.76	239.07	301.15	102.24
Emissions Inventory Source	**Existing Controlled NO_X**	**Post-2011 Controlled NO_X**	**Uncontrolled VOC**	**Post-2011 Controlled VOC**
Area Sources	50.98	50.98	291.30	291.30
Point Sources	39.95	39.95	29.89	29.89
Total of All Sources	1104.38	422.04	767.74	464.92
QA	1104.38	422.04	767.74	464.92

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

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Summary Sheet: 2020 Emissions Inventory By Category
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

2020 9 PDC (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	33.87	33.87	281.00	281.00
Non-Road Mobile Sources	254.20	68.01	159.14	35.93
On-Road Mobile Sources	935.61	94.10	364.37	55.61
Point Sources	40.39	40.39	21.53	21.53
Total	1264.07	236.37	826.04	394.07

2020 1 NDC (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	4.82	4.82	18.22	18.22
Non-Road Mobile Sources	10.31	2.02	2.98	0.65
On-Road Mobile Sources	22.29	3.39	5.90	1.12
Point Sources	6.44	6.44	2.82	2.82
Total	43.86	16.67	29.92	22.81

2020 10 NAC Total (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	38.69	38.69	299.22	299.22
Non-Road Mobile Sources	264.51	70.03	162.12	36.58
On-Road Mobile Sources	957.90	97.49	370.27	56.73
Point Sources	46.83	46.83	24.35	24.35
Total	1307.93	253.04	855.96	416.88

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

Table 2-8: DFW RFP Summary of the 2020 Base Year Average Summer Weekday NOX and VOC Emissions (tons

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	264.51	70.03	162.12	36.58
On-Road Mobile Sources	957.90	97.49	370.27	56.73
Emissions Inventory Source	**Existing Controlled NO_X**	**Post-2011 Controlled NO_X**	**Uncontrolled VOC**	**Post-2011 Controlled VOC**
Area Sources	38.69	38.69	299.22	299.22
Point Sources	46.83	46.83	24.35	24.35
Total of All Sources	1307.93	253.04	855.96	416.88

QA	1307.93	253.04	855.96	416.88

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

Appendix 1 - Sheet 52

Summary Total Non-Road Emissions Inventory
DFW Eight-Hour Ozone Nonattainment Area

Nine Previously Designated Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
9 PDC 2011	231.95	86.08	145.87	62.89	141.05	40.28	100.77	71.44
9 PDC 2020	254.20	68.01	186.19	73.24	159.14	35.93	123.21	77.42

One Newly Designated Nonattainment County: Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
1 NDC 2011	13.74	5.96	7.78	56.61	4.35	1.21	3.14	72.17
1 NDC 2020	10.31	2.02	8.29	80.39	2.98	0.65	2.34	78.35

Total Ten Ozone Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
10 County Total 2011	245.69	92.04	153.65	62.54	145.40	41.49	103.91	71.46
10 County total 2020	264.52	70.04	194.48	73.52	162.12	36.58	125.54	77.44

Notes:

1) 1 NDC means the one newly designated county and indicates values are for the one county in the DFW ozone nonattainment area that was newly designated under the2008 eight-hour ozone standard. Includes: Wise County.

2) 9 PDC means the nine existing nonattainment counties and indicates values are for the nine counties that had an existing designation under the one-hour ozone standard and/or under the 1997 eight-hour ozone standard. Includes: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant Counties.

3) 10 County Total means the values include the ten DFW area nonattainment counties designated under the 2008 eight-hour ozone standard.

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05 Calc 10 DFW 2021 AD Cont
06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC

Appendix 1 - Sheet 53

Summary Sheet: 2011 Non-Road Summary by Category
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

2011 9 PDC (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	14.63	14.63	5.56	5.56
Locomotive	36.71	15.12	1.12	0.90
Marine	0.00	0.00	0.00	0.00
NONROAD Model	155.45	43.00	130.06	33.18
Drilling Rigs	25.16	13.33	4.32	0.64
Total All	231.95	86.08	141.05	40.28
Total ALM	51.34	29.75	6.68	6.46
ALM Plus Drilling Rigs (Off-road)	76.50	43.08	11.00	7.10

2011 1 NDC (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	0.01	0.01	0.03	0.03
Locomotive	2.81	1.48	1.12	0.09
Marine	0.00	0.00	0.00	0.00
NONROAD Model	6.90	2.34	2.51	0.99
Drilling Rigs	4.02	2.13	0.69	0.10
Total All	13.74	5.96	4.35	1.21
Total ALM	2.82	1.49	1.15	0.12
ALM Plus Drilling Rigs (Off-road)	6.84	3.62	1.84	0.22

2011 10 NAC Total (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	14.64	14.64	5.59	5.59
Locomotive	39.52	16.60	2.23	0.99
Marine	0.00	0.00	0.00	0.00
NONROAD Model	162.35	45.34	132.57	34.17
Drilling Rigs	29.18	15.46	5.01	0.74
Total All	245.69	92.04	145.40	41.49
Total ALM	54.16	31.24	7.82	6.58
ALM Plus Drilling Rigs (Off-road)	83.34	46.70	12.83	7.32

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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06 Calc 2020 RFP MVEB
09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

Appendix 1 - Sheet 54

Summary Sheet: 2020 Non-Road Summary by Category
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

2020 9 PDC (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	19.21	19.21	3.35	3.35
Locomotive	28.50	11.31	1.19	0.53
Marine	0.00	0.00	0.00	0.00
NONROAD Model	206.17	37.39	154.55	32.05
Drilling Rigs	0.32	0.10	0.05	0.00
Total All	254.20	68.01	159.14	35.93
Total ALM	47.71	30.52	4.54	3.88
ALM Plus Drilling Rigs (Off-road)	48.03	30.62	4.59	3.88

2020 1 NDC (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	0.00	0.00	0.01	0.01
Locomotive	3.04	1.07	0.12	0.05
Marine	0.00	0.00	0.00	0.00
NONROAD Model	7.14	0.91	2.83	0.59
Drilling Rigs	0.13	0.04	0.02	0.00
Total All	10.31	2.02	2.98	0.65
Total ALM	3.04	1.07	0.13	0.06
ALM Plus Drilling Rigs (Off-road)	3.17	1.11	0.15	0.06

2020 10 NAC Total (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	19.21	19.21	3.36	3.36
Locomotive	31.54	12.38	1.31	0.58
Marine	0.00	0.00	0.00	0.00
NONROAD Model	213.31	38.31	157.38	32.64
Drilling Rigs	0.45	0.14	0.07	0.00
Total All	264.52	70.04	162.12	36.58
Total ALM	50.75	31.59	4.67	3.94
ALM Plus Drilling Rigs (Off-road)	51.20	31.73	4.74	3.94

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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09 Calc Targets 9 PDC
10 Calc Targets 1 NDC
11 Calc 9 PDC RFP MS Cont
12 Calc 1 NDC RFP MS Cont
13 Enter % RFP Cont & Conf SM
14 Enter Airport EI
20 Enter On-road EI

Appendix 1 - Sheet 55

Summary Sheet: 2011 and 2020 On-Road Summaries
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

DFW 10 County RFP Ozone Season Weekday On-Road Mobile Source NO_X Emissions

RFP Analysis Year Inventory	Uncontrolled NO_X (tons per day)	Controlled NO_X (tons per day)
2011 Base Year	767.76	239.07
2020 Attainment Year	957.90	97.49

DFW 10 County RFP Ozone Season Weekday On-Road Mobile Source VOC Emissions

RFP Analysis Year Inventory	Uncontrolled VOC (tons per day)	Controlled VOC (tons per day)
2011 Base Year	301.15	102.24
2020 Attainment Year	370.27	56.73

2020 DFW 10 County RFP Ozone Season Weekday On-Road Mobile Source NO_X and VOC Emissions and Control Strategy Reductions

RFP Analysis Year and Inventory of On-Road Mobile Emissions Inventory Strategies	NO_X (tons per day)	VOC (tons per day)
2020 Uncontrolled Inventory	957.90	370.27
Federal Motor Vehicle Control Program (FMVCP)	796.66	290.23
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	54.23	15.17
Inspection and Maintenance (I/M)	6.87	8.14
On-road TxLED	2.65	0.00
2020 Controlled Inventory	97.49	56.73
QA Check	97.49	56.73

Note:NOx FMVCP minus 0.01 program benefit to correct for rounding error. (Enter Reductions 2020)

Note:VOC FMVCP plus 0.01 program benefit to correct for rounding error. (Enter Reductions 2020)

Note: NOx Fuel minus 0.01 program benefit to correct for rounding error. (Enter Reductions 2020)

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12 Calc 1 NDC RFP MS Cont
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20 Enter On-road EI
22 Enter Point EI
23 Enter Reductions 9 PDC 2020
24 Enter Reductions 1 NDC 2020
25 Enter ContReductions 9 2021
26 Enter ContReductions 1 2021
27 Calc 9DFW 2011 Base Year EI
28 Calc 1DFW 2011 Base Year EI
29 Calc 9DFW Uncontrol 2020 EI
30 Calc 1DFW Uncontrol 2020
39 Calc Control DFW10 2020
42 Calc Control 10 DFW 2021
45 Calc OR Control 10 DFW 2020
50 EI 2011 Summary
51 EI 2020 Summary
56 TargetProcess Summary

Appendix 1 - Sheet 56

Summary Sheet: Calculation Process for 2020 Target Levels of Emissions
DFW Eight-Hour Ozone Nonattainment Area
Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Table 3-1: Summary of the Calculation Process for 2020 DFW RFP Target Levels

Line	Description	NO$_X$	VOC
Line 1	Step 1A: 2011 base year (BY) emissions inventory for 1 DFW newly designated county (See Table 2-6)	35.10	34.56
Line 2	15% VOC to meet 15% VOC reduction requirement for newly designated county	N/A	15%
Line 3	Step 1B: 2011 BY emissions inventory for 9 DFW previously designated counties (See Table 2-5)	386.94	430.36
Line 4	Percent of NO$_X$ (PN) and VOC (PV) to meet 15% reduction requirement for 9 previously designated counties, PN + PV = 15	14%	1%
Line 5	Step 1C: 2011 BY emissions inventory for 10 DFW counties (Equals Line 1 plus Line 3, See Table 2-7)	422.04	464.92
Line 6	PN and PV to meet 9% reduction requirement, PN + PV = 9	8%	1%
Line 7	Step 2A: Calculate the 2011-to-2017 15% VOC reduction requirement for 1 newly designated counties **(set to zero for NOx, and equal Line 1 x Line 2 for VOC)**	0.00	5.18
Line 8	Step 2B: Calculate the 2011-to-2017 15% NO$_X$ and VOC reduction requirement for 9 previously designated counties **(Line 3 x Line 4)**	54.17	4.30
Line 9	Step 2C: Calculate the 2017-to-2020 9% reduction requirement for 10 counties **(Line 5 x Line 6)**	33.77	4.65
Line 10	Step 2D: Calculate the total 2011-to-2020 percent reduction requirement **(Line 7+Line 8+Line 9)**	87.94	14.13
Line 11	Step 3: Calculate the 2020 target level of emissions **(Line 5 minus 10)**	334.10	450.79

Q/A Check 334.10 450.79

Notes:

1) No emissions from outside the nonattainment area being used in the RFP analysis.

2) The final implementation rule for the 2008 ozone standard does not require adjustment for non-creditable on-road reductions. The reductions from the non-creditable reductions have been determined to be deminimus.

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Appendix 1 - Sheet 57

Summary Sheet: Non-Road Source RFP Emissions Reductions

DFW Eight-Hour Ozone Nonattainment Area

Ten Nonattainment Counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise

Emissions	NO_X	VOC
Uncontrolled	264.52	162.12
RFP Non-Road Source Reductions	162.86	119.28
RFP Post-2011 Controlled Emissions	101.66	42.84

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APPENDIX 2

HGB REASONABLE FURTHER PROGRESS DEMONSTRATION SPREADSHEET

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-
BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER
PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE
2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY
STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Appendix 2 - Sheet 1

Houston-Galveston-Brazoria Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Reasonable Further Progress Demonstration with MOVES2014a Calculation Spreadsheet

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3	03 Calc NOx Sub 2020	2020 RFP NOX Substitution Analysis with MOVES2014a
4	04 Calc 2021 RFP Cont	2021 Attainment Year RFP Contingency Demonstration with MOVES2014a for the 8 Non-attainment Counties
5	05 Calc 2021 AD Cont	2021 Attainment Demonstration Contingency Demonstration with MOVES2014a for 8 Nonattainment Counties
6	06 Calc 2020 RFP MVEB	2020 RFP Motor Vehicle Emissions Budgets with MOVES2014a
7	07 Calc NonCred Red	Calculation of RFP Non-Creditable Reductions from Pre-1990 FMVCP with MOVES2014a
8	08 Calc Red for % Red	Calculate the Reductions to Meet the 3% Per Year And 3% Contingency Requirements with MOVES2014a
9	09 Calc Targets	Calculation of Post-2011 Target Levels of VOC and NOX Emissions for the 8 Non-attainment Counties with MOVES2014a
10	10 Calc RFP MS Cont Value	Calculation of RFP Milestone Year Required Contingency Reductions for the 8 Non-attainment Counties
11	11 Enter % RFP Cont & Conf SM	Enter: Percent Reductions for 3% RFP, 3% Contingency, Conformity Safety Margins and VOC Transfer
12	12 Enter Airport EI	Enter Aircraft EI, All Years, Controlled and Uncontrolled
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16	16 Enter Drilling Rigs DE EI1	Enter Oil and Gas Production, Drilling Rigs, Diesel Engines EI, All Years, Controlled and Uncontrolled
17	17 Enter Locomotive EI	Enter Locomotive EI, All Years, Controlled and Uncontrolled
18	18 Enter NONROAD Categories EI	Enter NONROAD Model Categories EI, All Years, Controlled and Uncontrolled
19	19 Enter On-road EI	Enter On-road EI, All Years, Controlled and Uncontrolled
20	20 Enter ABY On-road EI	Enter Adjusted Base Year (ABY) On-road EI, All Years
21	21 Enter Point EI	Enter Point Source EI, All Years, Controlled and Uncontrolled
22	22 Enter Reductions 2020	Enter All Source Control Reductions for RFP Analysis Year 2020 for the 8 Non-attainment Counties
23	23 Enter Cont Reductions 2021	Enter All Source Control Reductions for RFP Contingency Year 2020 to 2021 for the 8 Non-attainment Counties
24	24 Calc 2011 Base Year EI	Calculation of 2011 RFP Base Year Emission Inventory for the 8 Non-attainment Counties
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Appendix 2 - Sheet 2

2020 RFP Demonstration Analysis with MOVES2014a
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

2020 RFP Demonstration Analysis with MOVES2014a: To determine if the 2020 RFP requirements are met, the 2020 target level of emissions is compared to the 2020 controlled forecast inventory. The 2020 forecast inventory includes growth between the 2011 base year and the 2020 attainment year. The controlled forecast inventory has been reduced by subtracting the RFP control reductions from 2011 to 2020. If the 2020 controlled forecasted RFP EI is less than the 2020 RFP target level of emissions the 2020 RFP requirement is satisfied.

Line #	**Description**	**NO_X (tpd)**	**VOC (tpd)**
Line 1	Uncontrolled or existing controlled 2020 emissions forecast with growth	1165.66	854.65
Line 2	Creditable RFP control reductions between 2011 and 2020	821.70	370.04
Line 3	Controlled 2020, RFP emissions forecast (Line 1 minus Line 2)	343.96	484.61
Line 4	Amount of creditable reductions reserved for RFP milestone contingency	13.29	0.00
Line 5	Controlled 2020, RFP emission forecast with milestone contingency (Line 3 plus Line 4)	357.25	484.61
Line 6	Amount of NO_X reduction substitution (see Sheet 3)	0.00	0.00
Line 7	Controlled 2020, RFP forecast without reductions reserved for contingency, and accounting for NOx substitution (Line 5 plus Line 6)	357.25	484.61
Line 8	2020 HGB RFP target level of emissions	371.17	493.33
Line 9	Excess (+) / Shortfall (-) (Line 8 minus Line 7)	13.92	8.72
Line 10	**Is controlled RFP EI less than target level of emissions?**	**Yes**	**Yes**

Notes:

1) To calculate the RFP controlled forecast for each milestone/attainment year, the total RFP creditable control strategy reductions to date (total RFP reductions from 2011 to the current RFP milestone year) are subtracted from the total uncontrolled RFP EI.

2) To calculate the final excess or shortfall for each milestone/attainment year, the controlled RFP emissions forecast is subtracted from the RFP target level of emissions. The RFP target level of emissions for all milestone years is calculated on the "Calc Targets" page.

3) Excess emissions reductions (Line 9) may be used to provide a transportation conformity safety margin. The safety margin must be less than or equal to the excess emissions reductions.

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Appendix 2 - Sheet 3

2020 RFP NOX Substitution Analysis with MOVES2014a

HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

The NO_X substitution calculation includes six steps. First, calculate the percent target reduction for both VOC and NO_X by comparing the base year and target inventories. Second, calculate the percent actual reduction by comparing the base year and the actual inventory. Third, compare the percent required reduction to the percent actual reduction. If the percent actual reduction is greater than the percent required, then there are surplus reductions. If the percent actual reduction is less than the percent target, then there is a shortfall of reductions. The difference between the percent actual and the percent target reduction (when there are surplus reductions) is the amount that is available for substitution. For the fourth step, determine the percent NO_X needed for substitution. The minimum base year VOC percentage needed is equal to the percent base year shortfall in VOC plus the smallest increment possible, or 0.01. The respective NO_X percent is calculated using the NO_X base year inventory. The percent base year NO_X transfer should not exceed the percent base year NO_X surplus. The percent NO_X available to transfer is based upon the base year because the base year is the basis for the required reduction calculations. Fifth, convert the percent base year NO_X to a percent target NO_X using the percent base year NO_X from step 5 and the relative values of the base year and target NO_X inventory. The percent NO_X transfer is derived from milestone year target values because those are the values modified by NO_X transfer. The percent NO_X transfer is a percentage of the milestone year target NO_X value that is added back into the NO_X inventory and a percentage of the milestone year target VOC that is subtracted from the VOC inventory. For the sixth step, calculate the resulting tons per day (tpd) associated with the percent NO_X transfer. For NO_X, multiply the NO_X percent transfer and the NO_X milestone year target value. For VOC, multiply the percent NO_X transfer (which is the same as the percentage of the milestone year target VOC that is subtracted from the VOC inventory) and the VOC milestone year target value. The NO_X transfer amount (in tpd) is added to the NO_X actual (in tpd) inventory in the RFP demonstration calculation, and the VOC transfer amount (in tpd) is subtracted from the VOC actual (in tpd) inventory.

Line #	Description	NO_X	VOC
Line 1	2011 base year emissions (tpd)	442.92	535.06
Line 2	2020 controlled RFP EI (tpd)	357.25	484.61
Line 3	Total actual reductions for 2011 to 2020 (Line 1 minus Line 2) (tpd)	85.67	50.45
Line 4	Percent actual reductions for 2011 to 2020 (percent Line 3 is of Line 1) (%)	19.34	9.43
Line 5	2020 target RFP EI (tpd)	371.17	493.33
Line 6	2020 total target reductions for 2011 to 2020 (Line 1 minus Line 5) (tpd)	71.75	41.73
Line 7	Percent target reductions for 2011 to 2020 (percent Line 6 is of Line 1) (%)	16.20	7.80
Line 8	Percent surplus or shortfall (percent actual minus percent target, Line 4 minus Line 7) (%)	3.14	1.63
Line 9	Percent surplus to transfer (NO_X percentage should be less than Line 8) (%)	0.00	0.00
Line 10	Convert the percent surplus to transfer to tons per day (tpd)	0.00	Only NOx Value Needed
Line 11	Calculate what percentage Line 10 is of target (this is the percentage to transfer) (%)	0.00	0.00
Line 12	**Tons equivalent to percent for transfer [Line 5 times (Line 10 divided by 100)] (tpd)**	**0.00**	**0.00**
Line 13	NO_X substitution amount okay? (Check to assure NO_X substitution does not exceed maximum available: Sheet 02, Line 9 must be greater than zero)	Okay to Substitute	Okay to Substitute

Notes:

Line 7: The percent target reduction includes the 15% required reductions from 2011 through 2017, the 3% required reductions for each year after 2017, and accounts for noncreditable reductions betweeen 2011 and the RFP milestone year; therefore, the total percent reduction may not be exaclty 15 plus 3.

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Appendix 2 - Sheet 4

2021 Contingency Demonstration with MOVES2014a for RFP
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Summary 2021 Contingency for 2020 RFP

Contingency Element Description	NO_X	VOC
HGB 2011 Base Year EI	442.92	535.06
Percent for contingency calculation (total of 3%)	3.00	0.00
2020 to 2021 required contingency reductions (ABY EI x (contingency percent))	**13.29**	**0.00**
Control reductions to meet contingency requirements		
Excess reductions from 2020 RFP demonstration	13.92	8.72
Subtract 2020 RFP demonstration motor vehicle emissions budget (MVEB) safety margin from excess reductions from 2020 RFP demonstration	-8.21	-5.49
Federal Motor Vehicle Control Program (FMVCP), inspection and maintenance (I/M), reformulated gasoline (RFG), 2017 Low Sulfur Gasoline Standard and on-road TxLED	24.19	13.05
Federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	4.59	2.29
Total RFP demonstration contingency reductions	**34.49**	**18.57**
Contingency Excess (+) or Shortfall (-)	**21.20**	**18.57**

If changes are made to the enter reductions page, please assure the control reduction summary values above are consistent with the table below. The enter reductions page allows for the control reduction for a row to change. The table above adds particular rows from below.

Contingency Element Description	NO_X	VOC
HGB 2011 Base Year EI	442.92	535.06
Percent for contingency calculation (total of 3%)	3.00	0.00
2020 to 2021 RFP required contingency reductions (ABY EI x (contingency percent))	**13.29**	**0.00**
Calculate available reductions to meet contingency requirements: add excess 2020 control reductions; subtract MVEB safety margin adjustment; and add each 2020 to 2021 control reduction		
Excess reductions from 2020 RFP demonstration	13.92	8.72
Subtract 2020 RFP MVEB safety margin from excess reductions from 2020 RFP demonstration	-8.21	-5.49
Chapter 117 NOX controls	0.00	0.00
Chapter 115 Storage Tank Rule	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	22.30	12.63
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	2.67	0.68
Inspection and Maintenance (I/M)	-0.58	-0.26
On-road TxLED	-0.20	0.00
Tier I and II locomotive NOX standards	0.79	0.03
Small non-road spark ignition (SI) engines (Phase I)	-0.06	0.42
Heavy duty non-road engines	0.48	0.28
Tiers 2 and 3 non-road diesel engines	0.84	0.09
Small non-road SI engines (Phase II)	0.04	0.37
Large non-road SI & recreational marine	1.06	0.58
Non-road TxLED	-0.09	0.00
Non-road RFG	0.00	0.00
Tier 4 non-road diesel engines	1.46	0.05

Diesel recreational marine	0.00	0.00
Small SI (Phase III)	0.07	0.47
Chapter 117 NOX area source engine controls	0.00	0.00
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	0.00	0.00
Commercial marine vessel engine certification standards and fuel programs	0.00	0.00
This row not used for current RFP	0.00	0.00
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This row not used for current RFP	0.00	0.00
This row not used for current RFP	0.00	0.00
Total 2021 RFP contingency reductions	**34.49**	**18.57**
Contingency Excess (+) or Shortfall (-)	**21.20**	**18.57**
Are contingency reductions equal to or greater than required contingency reduction?	**Yes**	**Yes**

Note 1: Inspection and Maintenance Program is only modeled for the five counties covered by the program: The five I/M counties include: Brazoria, Fort Bend, Galveston, Harris, and Montgomery.

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Appendix 2 - Sheet 5

2021 Contingency Demonstration with MOVES2014a for 2020 Attainment

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Summary 2021 Contingency for 2020 Attainment Demonstration

Contingency Element Description	NO_X	VOC
HGB 2011 base year (BY) emissions inventory (EI)	442.92	535.06
Percent for contingency calculation (total of 3%)	3.00	0.00
2020 to 2021 AD required contingency reductions (ABY EI x (contingency percent))	**13.29**	**0.00**
Control reductions to meet contingency requirements		
Excess reductions from 2020 attainment demonstration	0.00	0.00
Subtract reductions reserved for 2020 attainment demonstration MVEB safety margin	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP), inspection and maintenance (I/M), reformulated gasoline (RFG), 2017 Low Sulfur Gasoline Standard and on-road TxLED	24.19	13.05
Federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	4.59	2.29
Total attainment demonstration contingency reductions	**28.78**	**15.34**
Contingency Excess (+) or Shortfall (-)	**15.49**	**15.34**

If changes are made to the enter reductions page please assure the control reduction summary values above are consistent with the table below. The enter reductions page allows for the control reductio for a row to change. The table above adds particular rows from below.

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Contingency Element Description	NO_X	VOC
2020 ABY EI	442.92	535.06
Percent for AD contingency calculation (total of 3%)	3.00	0.00
2020 to 2021 required AD contingency reductions (ABY EI x (contingency percent))	**13.29**	**0.00**
Control reductions to meet contingency requirements		
Add excess reductions from 2020 attainment demonstration	0.00	0.00
Subtract 2020 attainment demonstration MVEB safety margin	0.00	0.00
Chapter 117 NOX controls	0.00	0.00
Chapter 115 Storage Tank Rule	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	22.30	12.63
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	2.67	0.68
Inspection and Maintenance (I/M)	-0.58	-0.26
On-road TxLED	-0.20	0.00
Tier I and II locomotive NOX standards	0.79	0.03
Small non-road spark ignition (SI) engines (Phase I)	-0.06	0.42
Heavy duty non-road engines	0.48	0.28
Tiers 2 and 3 non-road diesel engines	0.84	0.09
Small non-road SI engines (Phase II)	0.04	0.37

Large non-road SI & recreational marine	1.06	0.58
Non-road TxLED	-0.09	0.00
Non-road RFG	0.00	0.00
Tier 4 non-road diesel engines	1.46	0.05
Diesel recreational marine	0.00	0.00
Small SI (Phase III)	0.07	0.47
Chapter 117 NOX area source engine controls	0.00	0.00
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	0.00	0.00
Commercial marine vessel engine certification standards and fuel programs	0.00	0.00
This row not used for current RFP	0.00	0.00
This row not used for current RFP	0.00	0.00
This row not used for current RFP	0.00	0.00
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This row not used for current RFP	0.00	0.00
This row not used for current RFP	0.00	0.00
This row not used for current RFP	0.00	0.00
Total attainment demonstration contingency reductions	**28.78**	**15.34**
Contingency Excess (+) or Shortfall (-)	**15.49**	**15.34**

Note: Row 60 is for Q/A

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Appendix 2 - Sheet 6

Calculations: 2020 RFP MVEBs with MOVES2014a

HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X (tons per day)

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Summary 2020 MVEB

Description	**NO_X**	**VOC**
2020 on-road emissions projection without post-1990 FCAA controls	750.39	322.18
2020 on-road mobile source RFP control reductions	670.91	269.97
2020 On-road mobile controlled inventory	79.48	52.21
Transportation conformity safety margin	8.21	5.49
Excess emissions reduction for 2020	13.92	8.72
Is excess emissions enough for safety margin?	yes	yes
2020 MVEB with safety margin	**87.69**	**57.70**

Note: If safety margin is > than excess emission reductions modify percent safety margin input on the "Enter % for RFP Cont & Conf SM" page.

Notes:

1) If there are excess RFP control reductions, a transportation conformity safety margin is allowed. The transportation conformity safety margin for this SIP revision is calculated based upon a percentage of excess emissions. Control of the safety margin options and calculation of the NOx and VOC values is done on Sheet 11 of this spreadsheet. If changes are needed for the Safety Margin, go to Sheet 11.

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Appendix 2 - Sheet 07

RFP Non-creditable Reductions Calculations
HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Calculation of Non-creditable NO_X and VOC Reductions

RFP Analysis Year	On-Road Mobile ABY EI NO_X	On-Road Mobile ABY EI VOC	Non-Creditable Fleet Turn Over Reductions NO_X	Non-Creditable Fleet Turn Over Reductions VOC	Non-Creditable Reduction Description
2011	536.68	239.63	N/A	N/A	
2017	536.32	242.85	0.36	-3.22	Pre-1990 CAA fleet turnover reduction baseline 2011 through 2017 milestone
2020	536.11	242.46	0.21	0.39	Pre-1990 CAA fleet turnover reduction 2017 milestone through 2020 attainment

Notes:

1) Non-creditable fleet turnover corrections: The reductions due to the the 1992 low RVP rule and the pre-1990 FMVCP are not creditable toward the RFP requirements. Both non-creditable rules only affect on-road mobile sources. The non-creditable reductions for each RFP milestone year are the difference between the on-road mobile ABY EI for each RFP milestone year and the on-road mobile 2011 RFP ABY EI. Since the pre-1990 FMVCP fleet turnover corrections are cumulative in the MOVES model, the noncreditable reductions from previous milestone years must be subtracted from the current milestone year to obtain the non-creditable reductions between milestone years. The FMVCP non-creditable reductions are used to calculate the target value for each RFP milestone year.

2) ABY inventories: The on-road mobile ABY inventories for each milestone/attainment year are calculated using 2011 vehicle miles traveled (VMT) and MOVES emission factors for each RFP analysis year with only the effects of pre-1990 FCAA controls turned on. The pre-1990 FCAA controls include the 1992 Reid Vapor Pressure control and the pre-1990 on-road mobile source FMVCP controls.

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Appendix 2 - Sheet 08

Quantify the Reductions to Meet the Initial 15%, the 3% per Year and Contingency Requirements with MOVES2014a

HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

The Initial 15%, the 3% per Year and Contingency Requirements: The FCAA mandates that an initial 15%, plus a 3% per year starting in year seven, VOC reduction, net of growth, occur from the baseline year 2011 through the attainment year. The reductions must be demonstrated for the six-year period from baseline 2011 through 2017, and every three years after 2017 through the attainment year, 2020. NO_X may be substituted for VOC for the counties designated nonattainment under both the one-hour and 1997 eight-hour standards from the baseline 2011 through 2020. An additional 3% reduction must be demonstrated as a contingency measure for the one-year period following the attainment year, 2020. The division of the percent reductions between VOC and NO_X are entered in the data entry sheet with tab name "Enter % for RFP Cont & Conf SM."

Calculation of Required 15% VOC Reductions and 3% per Year NO_X and VOC Reductions

RFP Analysis Year	Total Percent Reduction Requirement	Percent NO_X	Percent VOC	RFP ABY EI NO_X (tpd)	RFP ABY EI VOC (tpd)	Required Reductions NO_X (tpd)	Required Reductions VOC (tpd)
2011	N/A	N/A	N/A	442.92	535.06	N/A	N/A
2017	15.0	10.0	5.0	442.92	535.06	44.29	26.75
2020	9.0	6.2	2.8	442.92	535.06	27.46	14.98
2021 Contingency	3.0	3.0	0.0	442.92	535.06	13.29	0.00

Notes:

1) The ABY EI is the base year (BY) emissions minus the non-creditable on-road mobile reductions. It is calculated by adding the BY EI for point, area and non-road to the ABY for on-road. When the ABY EI is multiplied by the required percent reduction, the result is the reductions required.

2) On-road mobile ABY inventories: The on-road mobile ABY inventories for each milestone/attainment year are calculated using 2011 VMT and MOVES emission factors for each RFP analysis year with only the effects of pre-1990 FCAA controls turned on. The pre-1990 FCAA controls include the 1992 Reid Vapor Pressure control and the pre-1990 on-road mobile source FMVCP controls. The on-road mobile ABY EI is equal to the on-road mobile BY EI minus the non-creditable FMVCP reductions.

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Appendix 2 - Sheet 9

Target Calculations with MOVES2014a: 2020 RFP Target Level of NOX and VOC Emissions

HGB 2008 Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Post-2011 target level of NO_X emissions: The NO_X target level is calculated by subtracting the reductions necessary to meet: the initial 15% from the bseline 2011 through 2017; the post-2017 3% per year; and the non-creditable fleet (FMVCP/RVP) reductions from the previous milestone/attainment year target level.

RFP Post-2011 Target Level of NO_X Emissions

RFP Milestone Year	Previous Target	FMVCP Non-creditable Reduction	Post-2011 Percent Reduction Requirement NO_X (tpd)	NO_X Target (tpd)
2011 Base Year	N/A	N/A	N/A	442.92
2017	442.92	0.00	44.29	398.63
2020	398.63	0.00	27.46	371.17

Post-2011 target level of VOC emissions: The VOC target level is calculated by subtracting the reductions necessary to meet: the initial 15% from the bseline 2011 through 2017; the post-2017 3% per year; and the non-creditable fleet (FMVCP/RVP) reductions from the previous milestone/attainment year target level.

RFP Post-2011 Target Level of VOC Emissions

RFP Milestone Year	Previous Target	FMVCP Non-creditable Reduction	Post-2011 Percent Reduction Requirement VOC (tpd)	VOC Target (tpd)
2011 Base Year	N/A	N/A	N/A	535.06
2017	535.06	0.00	26.75	508.31
2020	508.31	0.00	14.98	493.33

1)The EPA published the final implementation rule for the 2008 ozone NAAQS (SIP requirements rule) in the Federal Register (FR) on March 6, 2015 (80 FR 12263). The final rule removed the requirement for states to account for non-creditable reductions when determining compliance with Reasonable Further Progress (RFP) emission reduction requirements. There is a toggle on Sheet 1 of this spreadsheet to turn the effects of non-creditable reductions either off or on. The default togg is “No,” which turns off the calculated effects of pre-1990 control measures. The non-creditable reductions are calculated on Sheet 07 for use in the calculation of RFP Targets above. If the effects of non-creditable reductions are turned off on Sheet 11, the values for the non-creditable reductions will still be calculated on Sheet 07, however, zeros will automatically be substituted in the target calculations above. Should there be a need to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle on Sheet 11 can be set to “Yes” and the values above will automatically be used in the calculation of the RFP targets.

2) A result of removing the non-creditable reductions from the RFP calculations is the RFP adjusted base year inventory (ABY) becomes equal to the RFP base year inventory. The ABY inventory is used to calculate the Post-2011 Percent Reductions used above. There is a toggle on Sheet 11 of this spreadsheet to turn the effects of non-creditable reductions either off or on. The default toggle is “No,” which turns off the calculated effects of pre-1990 control measures. Should there be a need to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle on Sheet 11 can be set to “Yes.”

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Appendix 2 - Sheet 10

Calculate RFP Milestone Year Contingency Values to be Reserved for Post 2017 Demonstrations

HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Contingency Element Description	NO_X	VOC
HGB 2011 Base Year (BY) EI	442.92	535.06
Percent for 2017 milestone contingency calculation (total of 3%)	3.00	0.00
2017 to 2018 required contingency reductions (BY EI x (contingency percent))	**13.29**	**0.00**

Note: 1.) The 2017 to 2018 contingency reductions are held in reserve for all RFP milestone years in this RFP demonstration.

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Appendix 2 - Sheet 11

Enter RFP NO_X and VOC Percentage Reductions, Contingency Percents and Safety Margin

HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

A 15% reduction is required for HGB for the period from the bseline 2011 through 2017, with an additional 3% per year until the attainment year 2020. The total reduction for 2017 includes an initial 15% reduction (NO_X may be substituted for VOC). The total reduction for 2020 is 9% (3% times 3). Input percentage of NO_X and VOC reductions to be used to demonstrate RFP for 2017 and 2020. Only a NOx value needs to input. The VOC percent will be calculated automatically based upon the total required and the percent NO_X to be used.

RFP NO_X and VOC Percent Reductions for Milestone and Attainment Years

RFP Milestone Year	NO_X %	VOC %	Total Percent
2017	10	5	15
2020	6.2	2.8	9

A total of 3% RFP contingency measures reductions are required between 2017 to 2018. A 3% contingency is also required for the RFP attainment contingency for 2020 to 2021. A 3% contingency is also required for the attainment demonstration for 2020 to 2021. The contingency reductions can be from NOx or VOC. Input only the percent of the contingency reductions that will be from NOx. The VOC value will be calculated automatically as 3 minus the NOx percent.

'RFP and Attainment Demonstration NO_X and VOC Percent Reductions for 2018 and 2021 Contingency

Contingency Year	NO_X %	VOC %	Total Percent
RFP 2018 Milestone Contingency	3	0	3
RFP 2021 Milestone Contingency	3	0	3
AD 2020 to 2021	3	0	3

If there are excess RFP control reductions, a transportation conformity safety margin is allowed. The safety margin for this SIP revision is calculated based upon a percentage of excess emissions. If a safety margin will be used, enter the percentage of excess VOC and NOx emissions to be used below. The safety margin amount must be less than or equal to the excess reductions after demonstrating RFP. The percentage entered must be between 0 and 100. An error message will appear if a value over 100 is entered. Adjusting the safety margin below will automatically update the MVEB calculation to include the percent of excess emissions entered. For reference, the corresponding percent of the MVEB and tons per day are provided.

RFP Milestone Year	Pollutant	Conformity Safety Margin % of Excess RFP Reductions	Percent of On-road EI (For Reference)	Tons Per Day Change to On-road EI (For Reference)
2020	NOx	59	10.33	8.21
	VOC	63	10.52	5.49

The EPA published the final implementation rule for the 2008 ozone NAAQS (SIP requirements rule) in the *Federal Register* (FR) on March 6, 2015 (80 FR 12263). The final rule removed the requirement for states to account for non-creditable reductions when determining compliance with Reasonable Further Progress (RFP) emission reduction requirements. The Federal Clean Air Act (FCAA) §182(b)(1)(D) specifies four categories of control measures that are not creditable toward the 15% RFP requirement under FCAA §182(b)(1)(A). The EPA stated that for three of the categories, reductions from the measures were achieved many years ago, so the question of creditability is moot for RFP credits for the 2008 eight-hour ozone standard. For the one remaining category, measures related to motor vehicle exhaust or evaporative emissions promulgated by January 1, 1990, citing an assessment that at this point in history the ongoing emission reductions from pre-1990 control measures in this category are *de minimis*, the EPA finalized an approach that eliminates any obligation for states to continue to perform emission reduction calculations for the pre-1990 control measures listed under FCAA §182(b)(1)(D)(i). The “Yes/No” drop-down list in the table below allows non-creditable emission reductions to be turned on or off for this SIP revision. The default toggle is “No,” which turns off the calculated effects of pre-1990 control measures. Should there be a need to perform the RFP calculations accounting for the effects of pre-1990 control reductions, the toggle can be set to “Yes.”

Non-creditable Calculation	Include Non-creditable Reductions in RFP Target Calculation?
Applies to 2017 and 2020, VOC and Nox	No

Enter the percent of the NO_X milestone year target that will be transferred to VOC. Only the NO_X percent is entered. The VOC percent is automatically equal to the NO_X percent transfer. These vales are used on Sheet 03 in the NO_X transfer calculations.

NOx Substitution	**Percent of NO_X Reductions to Transfer to Percent VOC Reductions**	**Percent of VOC Reductions Transferred from Percent NO_X Reductions**
2017	0.00	0.00
2020	0.00	0.00

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Appendix 2 - Sheet 12

Enter Airport Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	9.10	8.88	0.22	2.42	2.53	2.50	0.03	1.19
2020	9.24	8.99	0.25	2.71	1.57	1.55	0.02	1.27

Notes:

1) The airport emissions inventory includes emissions from: airctraft; aircraft auxiliary power units (APU); and, airport ground support equipment (GSE).

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Appendix 2 - Sheet 13

Enter Area Source Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_x (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	21.15	21.15	0.00	0.00	308.53	308.53	0.00	0.00
2020	30.04	30.04	0.00	0.00	310.98	310.98	0.00	0.00

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Appendix 2 - Sheet 14

Enter Biogenic Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	See Note 1	N/A	N/A	N/A	See Note 1	N/A	N/A	N/A

Notes:

1) Beginning with the Air Emissions Reporting Requirements (December 2008), the emissions required to be reported no longer include emissions from biogenic sources. Therefore, as of the 2011 reporting year, the comprehensive triennial emissions inventory no longer includes emissions from biogenic sources. The RFP demonstrations are based upon the emissions from anthropogenic sources. The guidance for RFP calculations shows the first step is to subtract the emissions from biogenic sources from the total base year emissions to obtain the total anthropogenic emission inventory. As of 2011, under the AERR, the base year emissions do not include biogenic sources and already represent the total anthropogenic emissions. In this case, step one of the RFP process is not needed, and the emissions from biogenic sources is unnecessary. This RFP SIP revision: uses a base year of 2011; does not require subtraction of the biogenic emissions in Step One of the RFP calculation process; and does not include quantification of emissions from biogenic sources.

2) 8 HGB means the eight nonattainment counties and indicates values are for the eight counties that had an existing designation under the one-hour ozone standard and under the 1997 eight-hour ozone standard. Includes: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties.

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Appendix 2 - Sheet 15

Enter Commercial Marine Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	68.95	61.61	7.35	10.65	1.59	1.59	0.00	0.10
2020	40.84	26.08	14.76	36.14	1.31	1.19	0.12	9.09

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Appendix 2 - Sheet 16

Enter Oil and Gas Production, Drilling Rigs, Diesel Engines Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	0.91	0.58	0.33	36.26	0.15	0.04	0.11	73.33
2020	0.64	0.21	0.43	67.19	0.10	0.01	0.09	90.00

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Appendix 2 - Sheet 17

Enter Locomotive Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	32.51	18.20	14.31	44.02	1.35	1.09	0.26	19.26
2020	34.52	13.50	21.02	60.89	1.44	0.63	0.81	56.25

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Appendix 2 - Sheet 18

Enter NONROAD Categories Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	131.26	55.57	75.69	57.67	111.32	44.89	66.43	59.67
2020	168.93	28.66	140.26	83.03	131.84	28.11	103.73	78.68

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Appendix 2 - Sheet 19

Enter On-road Mobile Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	536.68	168.60	368.08	68.58	239.63	80.45	159.18	66.43
2020	750.39	79.48	670.91	89.41	322.18	52.21	269.97	83.79

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Appendix 2 - Sheet 20

Enter ABY On-Road Mobile Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

RFP Analysis Year	ABY NO_X (tpd)	ABY VOC (tpd)
2011	536.68	239.63
2017	536.32	242.85
2020	536.11	242.46

Notes:
1) The ABY inventories are based upon the 2011 inventory adjusted for pre-1990 FMVCP controls projected to future years. The activity levels for all ABY inventories are equal to the 2011 base year activity levels. The emission rates are fully uncontrolled with alalysis years 2011, 2017, and 2020.

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Appendix 2 - Sheet 21

Enter Point Source Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Existing Controlled Emissions (as of 2011) NOX (tpd)	Post-2011 Controlled NOX (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Existing Controlled Emissions (as of 2011) VOC (tpd)	Post-2011 Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	108.33	108.33	0.00	0.00	95.97	95.97	0.00	0.00
2020	131.06	131.06	0.00	0.00	85.23	85.23	0.00	0.00

Notes:

1) The difference between existing post-2011 Controlled emissions (as of 2011) and Post-2011 Controlled VOC emissions represents noncreditable as well as creditable reductions.

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Appendix 2 - Sheet 22

Enter 2020 Control Measure Reductions
HGB Nonattainment Area Eight-hour Ozone Season VOC and NO_X
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

RFP Control Strategy Description	Source Category	Total 2011 to 2020 NO_X Emissions Reductions (tpd)	Total 2011 to 2020 VOC Emissions Reductions (tpd)	Use this control for RFP demonstration? (Yes or No)	Is this an on-road mobile control that will change the MVEB? (Yes or No)
Chapter 117 NO_X controls	Point	0.00	0.00	Yes	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	Yes	No
Coating / printing rules	Point	0.00	0.00	Yes	No
Portable fuel containers	Area	0.00	0.00	Yes	No
Federal Motor Vehicle Control Program (FMVCP)	OR	561.84	245.62	Yes	Yes
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	101.55	16.96	Yes	Yes
Inspection and Maintenance (I/M)	OR	5.13	7.39	Yes	Yes
On-road TxLED	OR	2.39	0.00	Yes	Yes
Tier I and II locomotive NO_X standards	NR	21.02	0.81	Yes	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-3.17	25.60	Yes	No
Heavy duty non-road engines	NR	26.71	13.71	Yes	No
Tiers 2 and 3 non-road diesel engines	NR	30.22	2.62	Yes	No
Small non-road SI engines (Phase II)	NR	2.22	23.67	Yes	No
Large non-road SI & recreational marine	NR	37.37	16.51	Yes	No
Non-road TxLED	NR	1.36	0.00	Yes	No
Non-road RFG	NR	0.01	0.73	Yes	No
Tier 4 non-road diesel engines	NR	17.70	0.78	Yes	No
Diesel recreational marine	NR	0.00	0.00	Yes	No
Small SI (Phase III)	NR	2.16	15.43	Yes	No
Chapter 117 NO_X area source engine controls	Area	0.00	0.00	Yes	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.43	0.09	Yes	No
Commercial marine vessel engine certification standards and fuel programs	NR	14.76	0.12	Yes	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
Total		821.70	370.03		

Notes

1) Point source Chapter 117 NOX controls in the HGB area had compliance deadlines before 2011. The 2011 EI includes the effects of the control. No additional control beyond 2011 are claimed.

2) Area source Chapter 117 NOX controls in the HGB area had compliance deadlines before 2011. The 2011 EI includes the effects of the control. No additional control beyond 2011 are claimed.

3) Area source Portable fuel containers controls in the HGB area had compliance deadlines before 2011. The 2011 EI includes the effects of the control. No additional control beyond 2011 are claimed.

4) All eight counies in the HGB area are covered by the federal RFG requirement.

5) Inspection and Maintenance Program is only modeled for the five counties covered by the program: The five I/M counties include: Brazoria, Fort Bend, Galveston, Harris, and Montgomery.

6)"This row not used for current RFP" control rows were created only to allow for planners to easily add controls for alternative scenario analyses.

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Appendix 2 - Sheet 23

Enter 2021 Contingency Measure Control Measure Reductions
HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO$_X$
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

RFP Control Strategy Description	Source Category	Total 2011 to 2021 NO$_X$ Emissions Reductions (tpd)	Total 2011 to 2021 VOC Emissions Reductions (tpd)	Use this control for 2021 RFP contingency? (Yes or No)
Chapter 117 NOX controls	Point	0.00	0.00	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	No
Coating / printing rules	Point	0.00	0.00	No
Portable fuel containers	Area	0.00	0.00	No
Federal Motor Vehicle Control Program (FMVCP)	OR	584.14	258.25	Yes
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	104.22	17.64	Yes
Inspection and Maintenance (I/M)	OR	4.55	7.13	Yes
On-road TxLED	OR	2.19	0.00	Yes
Tier I and II locomotive NOX standards	NR	21.81	0.84	Yes
Small non-road spark ignition (SI) engines (Phase I)	NR	-3.23	26.02	Yes
Heavy duty non-road engines	NR	27.19	13.99	Yes
Tiers 2 and 3 non-road diesel engines	NR	31.06	2.71	Yes
Small non-road SI engines (Phase II)	NR	2.26	24.04	Yes
Large non-road SI & recreational marine	NR	38.43	17.09	Yes
Non-road TxLED	NR	1.27	0.00	Yes
Non-road RFG	NR	0.01	0.73	Yes
Tier 4 non-road diesel engines	NR	19.16	0.83	Yes
Diesel recreational marine	NR	0.00	0.00	Yes
Small SI (Phase III)	NR	2.23	15.90	Yes
Chapter 117 NOX area source engine controls	Area	0.00	0.00	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.43	0.09	No
Commercial marine vessel engine certification standards and fuel programs	NR	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
Total		835.72	385.26	

Note: Unspecified control rows were created only to allow for planners to easily add controls for alternative scenario analyses.

Notes

Please see notes for the control reductions on:
22 Enter Reductions 2020

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Appendix 2 - Sheet 24

Calculate 2011 RFP Base Year Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

The 2011 Base Year Inventory	**NO_x (tons/day)**	**VOC (tons/day)**
Point Source 2011 EI	108.33	95.97
Area Source 2011 EI	21.15	308.53
On-road mobile 2011 EI	168.60	80.45
Non-road mobile 2011 EI	144.84	50.11
Biogenic 2011 EI (see Note 1)	See Note 1	See Note 1
Total 2011 Base Year Inventory	442.92	535.06

Notes:

1) Beginning with the Air Emissions Reporting Requirements (December 2008), the emissions required to be reported no longer include emissions from biogenic sources. Therefore, as of the 2011 reporting year, the comprehensive triennial emissions inventory no longer includes emissions from biogenic sources. The RFP demonstrations are based upon the emissions from anthropogenic sources. The guidance for RFP calculations shows the first step is to subtract the emissions from biogenic sources from the total base year emissions to obtain the total anthropogenic emission inventory. As of 2011, under the AERR, the base year emissions do not include biogenic sources and already represent the total anthropogenic emissions. In this case, step one of the RFP process is not needed, and the emissions from biogenic sources is unnecessary. This RFP SIP revision: uses a base year of 2011; does not require subtraction of the biogenic emissions in Step One of the RFP calculation process; and does not include quantification of emissions from biogenic sources.

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Appendix 2 - Sheet 25

2020 Forecasted Uncontrolled or Existing Control Emissions Inventory with pre-2011 Controls
HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Uncontrolled or Existing Control EI with pre-2011 controls: These calculations add up to the total Uncontrolled or Existing Control NOX and VOC emissions (tpd) for the 2020 RFP milestone year. The totals for each source category used in these calculations were entered on enter EI sheets.

Forecasted 2020 Uncontrolled or Existing Control Emissions Inventory with pre-2011 Controls

Emissions Description	NO_X (tpd)	VOC (tpd)
Point Source	131.06	85.23
Area Source	30.04	310.98
On-Road Mobile Source	750.39	322.18
Non-Road Mobile Source	254.17	136.26
Total	1165.66	854.65

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Calculations: 2011 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

ABY EI with pre-1990 controls: These calculations add up to the total ABY NO_X and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

2011 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	**NO_X (tpd)**	**VOC (tpd)**
Point Source 2011 BY EI	108.33	95.97
Area Source 2011 BY EI	21.15	308.53
On-Road Mobile Source 2011 ABY EI	168.60	80.45
Non-Road Mobile Source 2011 BY EI	144.84	50.11
2011 RFP Adjusted Base Year Emissions Inventory	442.92	535.06

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Calculations: 2017 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

ABY EI with pre-1990 controls: These calculations add up to the total ABY NOX and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

2017 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	**NO_X (tpd)**	**VOC (tpd)**
Point Source 2011 BY EI	108.33	95.97
Area Source 2011 BY EI	21.15	308.53
On-Road Mobile Source 2017 ABY EI	168.60	80.45
Non-Road Mobile Source 2011 BY EI	144.84	50.11
2017 RFP Adjusted Base Year Emissions Inventory	442.92	535.06

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Calculations: 2020 Adjusted Base Year Emissions Inventory with Pre-1990 Controls
HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

ABY EI with pre-1990 controls: These calculations add up to the total ABY NOX and VOC emissions (tpd) for the 2011 RFP BY. The totals for each source category used in these calculations were entered on enter EI sheets. For on-road mobile sources, there are separate data entry sheets for the ABY inventory for each milestone year. For all other source categories, the 2011 ABY is equal to the BY because there are no non-creditable controls for point, area or non-road sources after 2011.

2020 RFP Adjusted Base Year Emissions Inventory with Pre-1990 Controls

Emissions Description	**NO_X (tpd)**	**VOC (tpd)**
Point Source 2011 BY EI	108.33	95.97
Area Source 2011 BY EI	21.15	308.53
On-Road Mobile Source 2020 ABY EI	168.60	80.45
Non-Road Mobile Source 2011 BY EI	144.84	50.11
2020 RFP Adjusted Base Year Emissions Inventory	442.92	535.06

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Appendix 2 - Sheet 29

Calculations: 2011 to 2020 Control Measures Reductions

HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "22 Enter Reductions 2020." The reduction is the reduction that is creditable from each control between 2011 and 2020. If the control has been turned off by inputting a "No" in the "Use this control for 2020 RFP demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Reductions 2020 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Reductions 2020 Sheet and change the No to a Yes indicating that the control will be used for RFP demonstration.

Creditable Reductions Control Strategy	**Source Category**	**Total 2011 to 2020 NOX Emissions Reductions (tpd)**	**Total 2011 to 2020 VOC Emissions Reductions (tpd)**	**Use this control for RFP demonstration? (Yes or No)**	**Is this an on-road mobile control that will change the MVEB? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	Yes	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	Yes	No
Coating / printing rules	Point	0.00	0.00	Yes	No
Portable fuel containers	Area	0.00	0.00	Yes	No
Federal Motor Vehicle Control Program (FMVCP)	OR	561.84	245.62	Yes	Yes
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	101.55	16.96	Yes	Yes
Inspection and Maintenance (I/M)	OR	5.13	7.39	Yes	Yes
On-road TxLED	OR	2.39	0.00	Yes	Yes
Tier I and II locomotive NOX standards	NR	21.02	0.81	Yes	No
Small non-road spark ignition (SI) engines (Phase I)	NR	-3.17	25.60	Yes	No
Heavy duty non-road engines	NR	26.71	13.71	Yes	No
Tiers 2 and 3 non-road diesel engines	NR	30.22	2.62	Yes	No
Small non-road SI engines (Phase II)	NR	2.22	23.67	Yes	No
Large non-road SI & recreational marine	NR	37.37	16.51	Yes	No
Non-road TxLED	NR	1.36	0.00	Yes	No
Non-road RFG	NR	0.01	0.73	Yes	No
Tier 4 non-road diesel engines	NR	17.70	0.78	Yes	No
Diesel recreational marine	NR	0.00	0.00	Yes	No
Small SI (Phase III)	NR	2.16	15.43	Yes	No
Chapter 117 NOX area source engine controls	Area	0.00	0.00	Yes	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.43	0.09	Yes	No
Commercial marine vessel engine certification standards and fuel programs	NR	14.76	0.12	Yes	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
This row not used for current RFP	N/A	0.00	0.00	No	No
Total 2020 RFP Control Reductions		821.70	370.04		

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Calculations: 2020-2021 Contingency Control Measures Reductions
HGB Nonattainment Area Eight-Hour Ozone Season VOC and NO_X
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Explanation: The control strategy name, control reduction amount, status of inclusion of the control in the RFP calculations, and whether or not the control is for on-road mobile sources were all input in sheet "23 Enter Cont Reductions 2021." The reduction is the reduction that is creditable from each control between 2020 and 2021. If the control has been turned off by inputting a "No" in the "Use this control for 2021 RFP contingency demonstration?" column, the spreadsheet will put a zero in for the reduction for that control on this sheet, even if a positive value for the control was input into the Enter Cont Reductions 2021 sheet. If it was intended to have a positive reduction for the control but there is a zero, go back to the Enter Cont Reductions 2021 Sheet and change the No to a Yes indicating that the control will be used for RFP contingency demonstration.

RFP Control Strategy Description	**Source Category**	**Total 2020 to 2021 NO_X Emissions Reductions (tpd)**	**Total 2020 to 2021 VOC Emissions Reductions (tpd)**	**Use this control for 2021 RFP contingency demonstration? (Yes or No)**
Chapter 117 NOX controls	Point	0.00	0.00	No
Chapter 115 Storage Tank Rule	Point	0.00	0.00	No
Coating / printing rules	Point	0.00	0.00	No
Portable fuel containers	Area	0.00	0.00	No
Federal Motor Vehicle Control Program (FMVCP)	OR	22.30	12.63	Yes
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	OR	2.67	0.68	Yes
Inspection and Maintenance (I/M)	OR	-0.58	-0.26	Yes
On-road TxLED	OR	-0.20	0.00	Yes
Tier I and II locomotive NOX standards	NR	0.79	0.03	Yes
Small non-road spark ignition (SI) engines (Phase I)	NR	-0.06	0.42	Yes
Heavy duty non-road engines	NR	0.48	0.28	Yes
Tiers 2 and 3 non-road diesel engines	NR	0.84	0.09	Yes
Small non-road SI engines (Phase II)	NR	0.04	0.37	Yes
Large non-road SI & recreational marine	NR	1.06	0.58	Yes
Non-road TxLED	NR	-0.09	0.00	Yes
Non-road RFG	NR	0.00	0.00	Yes
Tier 4 non-road diesel engines	NR	1.46	0.05	Yes
Diesel recreational marine	NR	0.00	0.00	Yes
Small SI (Phase III)	NR	0.07	0.47	Yes
Chapter 117 NOX area source engine controls	Area	0.00	0.00	No
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	NR	0.00	0.00	No
Commercial marine vessel engine certification standards and fuel programs	NR	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
This row not used for current RFP	N/A	0.00	0.00	No
Total 2021 RFP Control Reductions		28.78	15.34	

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Calculations: 2011 to 2020 On-road Control Measures Reductions

HGB Nonattainment Area Eight-Hour Ozone Season VOC and NOX

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Creditable Reductions Control Strategy	**Control Used for RFP Demonstration?**	**On-road Mobile Source Control?**	**Total 2011 - 2020 'On-road Mobile NO$_X$ Emissions Reductions (tpd)**	**Total 2011 - 2020 'On-road Mobile VOC Emissions Reductions (tpd)**
Chapter 117 NOX controls	Yes	No	0.00	0.00
Chapter 115 Storage Tank Rule	Yes	No	0.00	0.00
Coating / printing rules	Yes	No	0.00	0.00
Portable fuel containers	Yes	No	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	Yes	Yes	561.84	245.62
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	Yes	Yes	101.55	16.96
Inspection and Maintenance (I/M)	Yes	Yes	5.13	7.39
On-road TxLED	Yes	Yes	2.39	0.00
Tier I and II locomotive NOX standards	Yes	No	0.00	0.00
Small non-road spark ignition (SI) engines (Phase I)	Yes	No	0.00	0.00
Heavy duty non-road engines	Yes	No	0.00	0.00
Tiers 2 and 3 non-road diesel engines	Yes	No	0.00	0.00
Small non-road SI engines (Phase II)	Yes	No	0.00	0.00
Large non-road SI & recreational marine	Yes	No	0.00	0.00
Non-road TxLED	Yes	No	0.00	0.00
Non-road RFG	Yes	No	0.00	0.00
Tier 4 non-road diesel engines	Yes	No	0.00	0.00
Diesel recreational marine	Yes	No	0.00	0.00
Small SI (Phase III)	Yes	No	0.00	0.00
Chapter 117 NOX area source engine controls	Yes	No	0.00	0.00
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	Yes	No	0.00	0.00
Commercial marine vessel engine certification standards and fuel programs	Yes	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
This row not used for current RFP	No	No	0.00	0.00
Total On-road Mobile Source RFP Control Reductions			**670.91**	**269.97**

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Summary Sheet: Uncontrolled or Existing Control NOX Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

2011 Uncontrolled or Existing Control NOX (tons per day)

RFP Analysis Year	HGB
Area Sources	21.15
Non-Road Mobile Sources	242.73
On-Road Mobile Sources	536.68
Point Sources	108.33
Total	908.89

2020 Uncontrolled or Existing Control NOX (tons per day)

RFP Analysis Year	HGB
Area Sources	30.04
Non-Road Mobile Sources	254.17
On-Road Mobile Sources	750.39
Point Sources	131.06
Total	1,165.66

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Summary Sheet: Controlled or Post-2011 Controlled NOX Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Controlled or Post-2011 Controlled NOX for 2011 (tons per day)

RFP Analysis Year	HGB
Area Sources	21.15
Non-Road Mobile Sources	144.84
On-Road Mobile Sources	168.60
Point Sources	108.33
Total	442.92

Controlled or Post-2011 Controlled NOX for 2020 (tons per day)

RFP Analysis Year	HGB
Area Sources	30.04
Non-Road Mobile Sources	77.44
On-Road Mobile Sources	79.48
Point Sources	131.06
Total	318.02

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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Summary Sheet: Uncontrolled or Existing Control VOC Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

2011 Uncontrolled or Existing Control VOC (tons per day)

RFP Analysis Year	HGB
Area Sources	308.53
Non-Road Mobile Sources	116.94
On-Road Mobile Sources	239.63
Point Sources	95.97
Total	761.07

2020 Uncontrolled or Existing Control VOC (tons per day)

RFP Analysis Year	HGB
Area Sources	310.98
Non-Road Mobile Sources	136.26
On-Road Mobile Sources	322.18
Point Sources	85.23
Total	854.65

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Summary Sheet: Controlled or Post-2011 Controlled VOC Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Controlled or Post-2011 Controlled VOC for 2011 (tons per day)

RFP Analysis Year	HGB
Area Sources	308.53
Non-Road Mobile Sources	50.11
On-Road Mobile Sources	80.45
Point Sources	95.97
Total	535.06

Controlled or Post-2011 Controlled VOC for 2020 (tons per day)

RFP Analysis Year	HGB
Area Sources	310.98
Non-Road Mobile Sources	31.49
On-Road Mobile Sources	52.21
Point Sources	85.23
Total	479.91

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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Summary Sheet: 2011 Emissions Inventory By Category
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

2011 (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	21.15	21.15	308.53	308.53
Non-Road Mobile Sources	242.73	144.84	116.94	50.11
On-Road Mobile Sources	536.68	168.60	239.63	80.45
Point Sources	108.33	108.33	95.97	95.97
Total	908.89	442.92	761.07	535.06

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

Table 2-8: DFW RFP Summary of the 2011 Base Year Average Summer Weekday NOX and VO

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	242.73	144.84	116.94	50.11
On-Road Mobile Sources	536.68	168.60	239.63	80.45
Emissions Inventory Source	**Existing Controlled NO_X**	**Post-2011 Controlled NO_X**	**Uncontrolled VOC**	**Post-2011 Controlled VOC**
Area Sources	21.15	21.15	308.53	308.53
Point Sources	108.33	108.33	95.97	95.97
Total of All Sources	908.89	442.92	761.07	535.06
QA	908.89	442.92	761.07	535.06

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Summary Sheet: 2020 Emissions Inventory By Category
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

2020 (tons per day)

Emissons Inventory Source	Uncontrolled or Existing Control NOx	Controlled or Post-2011 Controlled NOx	Uncontrolled or Existing Control VOC	Controlled or Post-2011 Controlled VOC
Area Sources	30.04	30.04	310.98	310.98
Non-Road Mobile Sources	254.17	77.44	136.26	31.49
On-Road Mobile Sources	750.39	79.48	322.18	52.21
Point Sources	131.06	131.06	85.23	85.23
Total	1165.66	318.02	854.65	479.91

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

Table 2-5: DFW RFP Summary of the 2011 Base Year Average Summer Weekday NOX and VOC Emis

Emissions Inventory Source	Uncontrolled NO_X	Controlled NO_X	Uncontrolled VOC	Controlled VOC
Non-Road Mobile Sources	254.17	77.44	136.26	31.49
On-Road Mobile Sources	750.39	79.48	322.18	52.21
Emissions Inventory Source	**Existing Controlled NO_X**	**Post-2011 Controlled NO_X**	**Uncontrolled VOC**	**Post-2011 Controlled VOC**
Area Sources	30.04	30.04	310.98	310.98
Point Sources	131.06	131.06	85.23	85.23
Total of All Sources	1165.66	318.02	854.65	479.91
QA	1165.66	318.02	854.65	479.91

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Summary Total Non-Road Emissions Inventory
HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

'RFP Analysis Year	Uncontrolled NO_X (tpd)	Controlled NO_X (tpd)	Total Reduction NO_X (tpd)	Percent Reduction	Uncontrolled VOC (tpd)	Controlled VOC (tpd)	Total Reduction VOC (tpd)	Percent Reduction
2011	242.73	144.84	97.89	40.33	116.94	50.11	66.83	57.15
2020	254.17	77.44	176.73	69.53	136.26	31.49	104.77	76.89

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Summary Sheet: 2011 Non-Road Summary by Category
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

2011 (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	9.10	8.88	2.53	2.50
Locomotive	32.51	18.20	1.35	1.09
Marine	68.95	61.61	1.59	1.59
NONROAD Model	131.26	55.57	111.32	44.89
Drilling Rigs	0.91	0.58	0.15	0.04
Total All	242.73	144.84	116.94	50.11
Total ALM	110.56	88.69	5.47	5.18
ALM Plus Drilling Rigs (Off-road)	111.47	89.27	5.62	5.22

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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Summary Sheet: 2020 Non-Road Summary by Category
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

2020 (tons per day)

Emissons Inventory Source	Uncontrolled NOx	Controlled NOx	Uncontrolled VOC	Controlled VOC
Airport	9.24	8.99	1.57	1.55
Locomotive	34.52	13.50	1.44	0.63
Marine	40.84	26.08	1.31	1.19
NONROAD Model	168.93	28.66	131.84	28.11
Drilling Rigs	0.64	0.21	0.10	0.01
Total All	254.17	77.44	136.26	31.49
Total ALM	84.60	48.57	4.32	3.37
ALM Plus Drilling Rigs (Off-road)	85.24	48.78	4.42	3.38

Note: The controlled inventory shown here includes all controls. The controlled RFP inventory may not include all controls and may therefore be a higher value than shown here.

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Summary Sheet: 2011, 2017 and 2020 On-Road Summaries

HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

HGB Eight County RFP Ozone Season Weekday On-Road Mobile Source NOX Emissions

RFP Analysis Year Inventory	Uncontrolled NOX (tons per day)	Controlled NOX (tons per day)
2011 Base Year	536.68	168.60
2020 Attainment Year	750.39	79.48

HGB EightCounty RFP Ozone Season Weekday On-Road Mobile Source VOC Emissions

RFP Analysis Year Inventory	Uncontrolled VOC (tons per day)	Controlled VOC (tons per day)
2011 Base Year	239.63	80.45
2020 Attainment Year	322.18	52.21

2020 HGB Eight County RFP Ozone Season Weekday On-Road Mobile Source NOX and VOC Emissions and Control Strategy Reductions

RFP Analysis Year and Inventory of On-Road Mobile Emissions Inventory Strategies	NOX (tons per day)	VOC (tons per day)
2020 Uncontrolled Inventory	750.39	322.18
Federal Motor Vehicle Control Program (FMVCP)	561.84	245.62
Reformulated Gasoline (RFG)/East Texas Regional Low RVP/Low Sulfur	101.55	16.96
Inspection and Maintenance (I/M)	5.13	7.39
On-road TxLED	2.39	0.00
2020 Controlled Inventory	79.48	52.21
QA Check	79.4800000000000	52.2100000000000

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Summary Sheet: Calculation Process for 2020 Target Levels of Emissions

HGB Eight-Hour Ozone Nonattainment Area

Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Table 3-1: Summary of the Calculation Process for 2020 HGB RFP Target Levels

Line	Description	NO_X	VOC
Line 1	Step 1: 2011 base year emissions inventory (see Table 2-13)	442.92	535.06
Line 2	Percent of NO_X (PN) and VOC (PV) to meet 15% reduction requirement (PN plus PV = 15)	10.00%	5.00%
Line 3	Percent of NO_X (PN) and VOC (PV) to meet 9% reduction requirement (PN plus PV = 9)	6.2%	2.8%
Line 4	Step 2A: Calculate the 15% NOX and VOC reduction requirement between 2011 and 2017 (Line 1 multiplied by Line 2)	44.29	26.75
Line 5	Step 2B: Calculate the 9% NOX and VOC reduction requirement between 2017 and 2020 (Line 1 multiplied by Line 3)	27.46	14.98
Line 6	Step 2C: Calculate the total NO_X and VOC reduction requirement between 2011 and 2020 **(Line 4 plus Line 5)**	71.75	41.73
Line 7	Step 3: Calculate the 2020 target level of emissions **(Line 1 minus Line 6)**	371.17	493.33

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Summary Sheet: Total RFP Emissions Reductions
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller

Control Strategy Description	NO_X Reductions	VOC Reductions
Chapter 117 NOX controls	0.00	0.00
Chapter 115 Storage Tank Rule	0.00	0.00
Coating / printing rules	0.00	0.00
Portable fuel containers	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP)	561.84	245.62
Reformulated Gasoline (RFG)/Low Sulfur Gasoline/Ultra Low Sulfur Diesel	101.55	16.96
Inspection and Maintenance (I/M)	5.13	7.39
On-road TxLED	2.39	0.00
Tier I and II locomotive NOX standards	21.02	0.81
Small non-road spark ignition (SI) engines (Phase I)	-3.17	25.60
Heavy duty non-road engines	26.71	13.71
Tiers 2 and 3 non-road diesel engines	30.22	2.62
Small non-road SI engines (Phase II)	2.22	23.67
Large non-road SI & recreational marine	37.37	16.51
Non-road TxLED	1.36	0.00
Non-road RFG	0.01	0.73
Tier 4 non-road diesel engines	17.70	0.78
Diesel recreational marine	0.00	0.00
Small SI (Phase III)	2.16	15.43
Chapter 117 NOX area source engine controls	0.00	0.00
Drilling Rigs: Federal Engine Standards and Texas Low Emission Diesel	0.43	0.09
Commercial marine vessel engine certification standards and fuel programs	14.76	0.12
Total:	821.70	370.04

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Summary Sheet: Point Source RFP Emissions Reductions
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty,

Emissions	NO_X	VOC
Existing Controlled Emissions (as of 2011)	131.06	85.23
RFP Point Source Reductions	0.00	0.00
RFP Post-2011 Controlled Emissions	131.06	85.23

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Summary Sheet: Area Source RFP Emissions Reductions
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty,

Emissions	NO_X	VOC
Existing Controlled Emissions (as of 2011)	30.04	310.98
RFP Area Source Reductions	0.00	0.00
RFP Post-2011 Controlled Emissions	30.04	310.98

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Summary Sheet: Non-Road Source RFP Emissions Reductions
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty,

Emissions	NO_X	VOC
Uncontrolled	254.17	136.26
RFP Non-Road Source Reductions	150.79	100.07
RFP Post-2011 Controlled Emissions	103.38	36.19

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Summary Sheet: On-Road Source RFP Emissions Reductions
HGB Eight-Hour Ozone Nonattainment Area
Eight Nonattainment Counties: Brazoria, Chambers, Fort Bend, Galveston, Harris,

Emissions	NO_X	VOC
Uncontrolled	750.39	322.18
RFP On-Road Source Reductions	670.91	269.97
RFP Post-2011 Controlled Emissions	79.48	52.21

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APPENDIX 3

DEVELOPMENT OF REASONABLE FURTHER PROGRESS POINT SOURCE EMISSIONS INVENTORIES FOR THE DFW AND HGB NONATTAINMENT AREAS

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

APPENDIX 3: DEVELOPMENT OF REASONABLE FURTHER PROGRESS POINT SOURCE EMISSIONS INVENTORIES FOR THE DFW AND HGB NONATTAINMENT AREAS

1.1 EMISSIONS INVENTORY DEVELOPMENT

Stationary point source emissions data are collected annually from sites that meet the reporting requirements of 30 TAC §101.10. This rule, referred to as the TCEQ emissions inventory (EI) reporting rule, establishes point source EI reporting thresholds in ozone nonattainment areas that are currently at or less than major source thresholds in the DFW and HGB ozone nonattainment areas. Therefore, some minor sources in the DFW and HGB ozone nonattainment areas report to the point source EI.

To collect the data, the TCEQ sends notices to all sites identified as potentially meeting the reporting requirements. Companies are required to report emissions data and to provide sample calculations used to determine the emissions. Information characterizing the process equipment, the abatement units, and the emission points is also required. Per FCAA §182(a)(3)(B), company representatives certify that reported emissions are true, accurate, and fully represent emissions that occurred during the calendar year to the best of the representative's knowledge.

All data submitted in the EI are reviewed for quality-assurance purposes and then stored in the State of Texas Air Reporting System (STARS) database. EI guidance documents and historical point source emissions of criteria pollutants are available on the TCEQ's Point Source Emissions Inventory webpage (https://www.tceq.texas.gov/airquality/point-source-ei/psei.html). Additional information is available upon request from the TCEQ's Air Quality Division.

1.1.1 Updated 2011 Base Year Inventories

The TCEQ extracted the 2011 point source inventory data from STARS on March 1, 2019. The extracted data includes reported annual and ozone season daily emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOC) for each site in the DFW or HGB area that submitted a 2011 EI and reflects revisions made on or before the extract date.

1.1.2 Updated Attainment Year Inventories

In the development of the 2020 attainment year inventories, the TCEQ projected future emissions from the 2016 emissions inventories and added unused emissions reductions credits to the inventories as described in the following sections. 2016 was chosen as the projection base year for point sources because it was more representative of typical point source operations than 2017, when Hurricane Harvey occurred. The TCEQ extracted the 2016 point source inventory data from STARS on March 1, 2019. The extracted data includes reported annual and ozone season daily emissions of NO_x and VOC for each site in the DFW or HGB area that submitted a 2016 EI and reflects revisions made on or before the extract date.

1.1.2.1 DFW 2020 Attainment Year Inventory

Cement Kilns

NO_x emissions from cement kilns were projected using 2016 emissions and adding site- or source-specific adjustments based upon corresponding directly enforceable limits from consent decrees and agreed orders. These limits were compared to the 30 TAC §117.3123 cap ("Chapter 117 cap"), which also limits future emissions growth to specified levels. Using the Chapter 117 cap to project emissions growth provides growth estimates that exceed current federally enforceable limits. Therefore, the limits from EPA-approved consent decrees, and agreed orders were used to project emissions, since this is a more representative but still conservative approach to emissions growth.

Other (Non-Cement Kiln) Major Stationary Sources of Ozone Precursor Emissions

Other major stationary sources of NO_x emissions and all major stationary sources of VOC emissions were projected by adding emissions growth allowed under the major modification thresholds to each site's 2016 emissions. Title V operating permit data were reviewed to identify sites that were major stationary sources of ozone precursors. Ozone precursors emissions from these sites were projected by adding emissions growth allowed under the major modification thresholds. The serious nonattainment major modification thresholds for ozone precursors of 25 tons per year (tpy) was applied. A daily average of this growth was calculated for each site by multiplying the 25-tpy threshold by the ratio of the ozone season daily emissions to the annual emissions for the site. This value was then added to each site's 2016 emissions to develop the 2020 attainment year emissions for the site.

Other Point Sources

For sources not identified as major stationary sources of ozone precursor emissions, future emissions were projected by using growth factors. Growth factors for sites associated with oil and gas exploration were derived from area source growth factors for the Barnett Shale. These growth factors reflect recent oil and gas activity in the DFW area and are consistent with area source oil and gas inventory development methods. Growth factors for other sources were derived from the 2016 Eastern Research Group (ERG) factor set. Documentation for the development of these emissions growth factors can be found in Appendix 4: *Growth Factors for Area and Point Sources*.

Emissions Credits

Finally, the attainment year inventory was adjusted to account for available (unused) emissions credits. Emissions credits are banked emissions reductions that may return to the air shed in the future when these emissions credits are used either to modify existing facilities, construct new facilities, or demonstrate compliance with source-specific emissions limit obligations where provided for in commission rules. To account for the possible use of the banked emissions, available emissions reduction credit (ERC) and discrete emissions reduction credit (DERC) data were also used to forecast growth.

Projected ERC use was determined by assuming that all banked ERCs listed in the emissions banking and trading database as of March 5, 2019 would be used for offsets in permitting new or modified sources. In ozone nonattainment areas, ERCs used to permit new or modified sources must be reduced by a factor called the offset ratio to assist with ensuring progress towards attaining air quality standards. Therefore, all banked ERCs were divided by an offset ratio of 1.2 before being added to the attainment year inventory to account for the nonattainment New Source Review (NSR) permitting offset ratio for serious nonattainment areas.

Recently used ERCs (ERCs used between 2012 and 2018) were reviewed to determine whether adjustments were needed to the attainment year inventory. All ERCs used between 2012 and 2018 were used for compliance with 30 TAC Chapter 115 and Chapter 117 rules. Actual project data was used to determine the emissions that were added to the 2020 attainment year inventory.

In summary, all banked ERCs listed in the emissions banking and trading database as of March 5, 2019 were adjusted by the offset ratio, and the resulting emissions were added to the 2020 attainment year inventory to account for growth. Including recently used ERCs in growth projections ensures that equipment that may not have been operated in the 2016 projection base year emissions inventory is accounted in future growth.

Projected DERC use was determined by assuming that all banked credits would be used over a 10-year period, from 2019 through 2028. The resulting credits were averaged over the 2019 through 2028 projected timespan to obtain a daily contribution. This daily contribution was added to each of the years from 2019 to 2028, including the 2020 attainment year.

The 2019 through 2028 future year timespan was used for several reasons. First, the total amount of available DERCs was calculated on March 5, 2019; it was assumed the majority of these available credits would be used beginning in 2019. Additionally, the longer timespan also provides a more realistic, although conservatively high, daily DERC use rate. Averaging the use of all available DERCs over the projection years for this SIP revision (2018, 2019, and 2020) would artificially inflate projected DERC use; historical use has been considerably less (less than 10% of the projected rate)[1] and this is not anticipated to change significantly. The DERC transactions for 2016 were not added as these transactions would be reflected in the 2016 base year inventory.

Applicable Rules

Rules controlling ozone precursor emissions from stationary sources, such 30 TAC Chapter 117 rules, were accounted for in the 2011 base year inventory, the 2016 projection base year inventory, and the attainment year inventories as appropriate (e.g., cement cap). No additional controls were incorporated into the 2020 attainment year inventories.

1.1.2.2 HGB 2020 Attainment Year Inventory

Mass Emissions Cap and Trade (MECT)

NO_X emissions from sites with equipment applicable to the MECT Program were projected using the MECT cap. MECT data were retrieved from the emissions banking

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[1] Texas Commission on Environmental Quality. “Discrete Emission Credit Use Report.” Accessed March 1, 2019. https://www.tceq.texas.gov/assets/public/implementation/air/banking/reports/decusereport.pdf.

and trading database and reviewed to identify sites with applicable units. For all point sources, it was assumed that the majority of NO_X emissions are from MECT-applicable units. Since the MECT cap is an annual value, it was converted to an ozone season daily value using the following approach. First, the reported 2016 ozone season daily emissions for all MECT-applicable sites were summed. Next, the ratio of the summed 2016 ozone season daily emissions to the summed 2016 annual emissions were determined for these sites. Finally, this ratio was applied to the annual MECT cap value to determine future daily emissions for the HGB area. To maintain a conservative approach, the entire cap was applied to develop the 2020 attainment year inventory.

Other Major Stationary Sources of VOC Emissions

Title V operating permit data were reviewed to identify sites that were major stationary sources of VOC emissions. VOC emissions from these sites were projected by adding emissions growth allowed under the major modification thresholds. The serious nonattainment major modification threshold for ozone precursors of 25 tpy was applied. A daily average of this growth was calculated for each site by multiplying the 25-tpy threshold by the ratio of the ozone season daily emissions to the annual emissions for the site. This value was then added to each site's 2016 emissions to develop the 2020 attainment year emissions for the site.

Other Point Sources

NO_X emissions from sites not listed in the MECT Program and VOC emissions from sources not identified as major for VOC were assumed to be minor source emissions and were projected using growth factors. Growth factors were derived from the 2016 ERG factor set. Documentation for the development of these emission growth factors can be found in Appendix 4: *Growth Factors for Area and Point Sources*.

Emissions Credits

Finally, the attainment year inventory was adjusted to account for available (unused) emissions credits. Emissions credits are banked emissions reductions that may return to the air shed in the future when these emissions credits are used to modify existing facilities, construct new facilities, or demonstrate compliance with emissions limit obligations where provided for in commission rules. To account for the possible use of the banked emissions, available ERCs and DERCs data were also used to forecast growth.

Projected ERC use was determined by assuming that all banked and recently used ERCs (ERCs used between 2012 and 2018) listed in the emissions banking and trading database as of March 5, 2019 would be used for offsets in permitting new or modified sources. In ozone nonattainment areas, ERCs used to permit new or modified sources must be reduced by a factor called the offset ratio to assist with ensuring progress towards attaining air quality standards. Therefore, all banked ERCs were divided by an offset ratio of 1.2 before being added to the attainment year to account for the nonattainment NSR permitting offset ratio for serious nonattainment areas. Recently used ERCs (ERCs used between 2012 and 2018) were divided by the appropriate offset based on the nonattainment status at the time of the project and available project information before being added to the attainment year emissions inventory.

In summary, all banked ERCs and recently used ERCs (between 2012 and 2018) listed in the emissions banking and trading database as of March 5, 2019 were adjusted by the offset ratio, and the resulting emissions were added to the 2020 attainment year inventory to account for growth. Including recently used ERCs in growth projections ensures that equipment that may not have been operated in the 2016 projection base year emissions inventory is accounted in future growth.

Projected DERC use was determined by assuming that all banked credits would be used over a 10- year period, from 2019 through 2028. The resulting credits were averaged over the 2019 through 2028 projected timespan to obtain a daily contribution. This daily contribution was added to each of the years from 2019 to 2028, including the 2020 attainment year.

The 2019 through 2028 future year timespan was used for several reasons. First, the total amount of available DERCs was calculated on March 5, 2019; it was assumed the majority of these available credits would be used beginning in 2019. Additionally, the longer timespan also provides a more realistic, although conservatively high, daily DERC use rate. Averaging the use of all available DERCs over the projection years for this SIP revision (2018, 2019, and 2020) would artificially inflate projected DERC use; historical use has been considerably less (less than 10% of the projected rate)[2] and this is not anticipated to change significantly. The DERC transactions for 2016 were not added as these transactions would be reflected in the 2016 base year inventory.

Applicable Rules

The rules detailed below were accounted for in the base year and the attainment year inventories. No additional controls were incorporated into the 2020 attainment year inventory.

Industrial source NO_X controls are reflected in the MECT 2008 NO_X cap. The MECT NO_X emissions allocations account for NO_X controls, including controls applied to electric generating units (EGU) and large stationary engines as defined by 30 Texas Administrative Code (TAC) Chapter 117, Subchapters C: Combustion Control at Major Utility Electric Generation Sources in Ozone Nonattainment Areas and D: Combustion Control at Minor Sources in Ozone Nonattainment Areas.

The VOC controls are reflected in the highly reactive volatile organic compounds emissions cap and trade program (HECT) and 30 TAC Chapter 115 changes that limit tank landings. The HECT cap is an annual cap on sitewide highly reactive volatile organic compounds (HRVOC) emissions from equipment that are subject to the HRVOC control requirements of 30 TAC Chapter 115, Subchapter H, Division 1: Vent Gas Control or Division 2: Cooling Tower Heat Exchange Systems for applicable sites listed in the cap. Other 30 TAC Chapter 115 changes limit convenience landings unless an abatement device is used to control the VOC emissions or landing loss emissions are authorized under an emission limit or cap in a permit issued under 30 TAC Chapter 116.

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[2] Texas Commission on Environmental Quality. “Discrete Emission Credit Use Report.” Accessed March 1, 2019. https://www.tceq.texas.gov/assets/public/implementation/air/banking/reports/decusereport.pdf.

APPENDIX 4

GROWTH FACTORS FOR AREA AND POINT SOURCES

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Eastern Research Group, Inc.

GROWTH FACTORS FOR AREA AND POINT SOURCES

Final

Prepared for:

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GROWTH FACTORS FOR AREA AND POINT SOURCES

Final

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BBL	barrel
BBO	billion (10^9) barrels of oil
BCF	billion (10^9) cubic feet
BTU	British thermal unit
CCTFT	Clean Coal Technology Foundation of Texas
CO	carbon monoxide
CPP	Clean Power Plan
EGAS	Economic Growth Analysis System
EIA	Energy Information Administration
EIIP	Emission Inventory Improvement Program
ERCOT	Electric Reliability Council of Texas
ERG	Eastern Research Group, Inc.
EUR	Estimated Ultimate Recovery
INGAA	Interstate Natural Gas Association of America
MBO	thousand barrels of oil
MCF	thousands cubic feet
mi^2	square miles
NAAQS	National Ambient Air Quality Standard
NAICS	North American Industry Classification System
NGSA	Natural Gas Supply Association
NO_x	nitrogen oxides
RA	Rocky Mountain Power Area
RRC	Railroad Commission of Texas
SERC	Southeastern Electric Reliability Council
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SPE	Society of Petroleum Engineers
SPP	Southwest Power Pool
STARS	State of Texas Air Reporting System
TCC	Texas Chemical Council
TCEQ	Texas Commission on Environmental Quality
TCF	trillion (10^{12}) cubic feet

TexAER	Texas Air Emissions Repository
TIPI	Texas Industrial Production Index
TRR	Technically Recoverable Resources
TSDC	Texas State Data Center
TXOGA	Texas Oil and Gas Association
URR	Ultimately Recoverable Resources
U.S. EPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

ES.0 EXECUTIVE SUMMARY

Eastern Research Group, Inc. (ERG) completed the development of a comprehensive suite of growth factors for point and area sources. The growth factors were based upon a base year of 2014 and were developed for each year between 2015 and 2050. Various demographic and economic data were used to develop the growth factors, including, but not limited to: energy projections from the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook*, economy forecasts from Economy.com, and Texas-specific population projections. In addition, analysis was conducted to investigate growth factor variances.

The developed growth factors were submitted to the Texas Commission on Environmental Quality (TCEQ) along with the final report. The point source growth factors and associated data were provided in Microsoft Excel/Access database format as approved by the TCEQ. The area source growth factors and associated data were provided in text files in Texas Air Emissions Repository (TexAER) loadable format, as well as in a Microsoft Access database. The area source growth factors in TexAER loadable format were uploaded into the TexAER system successfully as a user test.

1.0 INTRODUCTION

Emission inventories are a core component of air quality analyses. Inventories are used to estimate the quantity of emissions generated by a range of source types (i.e., point sources, area sources, on-road motor vehicles, nonroad mobile sources, and natural sources) and pollutants (i.e., criteria air pollutants, hazardous air pollutants, and greenhouse gases). Inventories are used as inputs to air quality models for simulating air quality concentrations based on base case and/or control scenarios for determining future-year compliance with federal National Ambient Air Quality Standards (NAAQS) within State Implementation Plans (SIPs).

The TCEQ uses base year inventories and future year projections to develop SIPs. In general, future year inventory projections are estimated by applying growth and control factors to base year emissions. Over time, growth factors must be reassessed and, if necessary, revised.

This project is the latest of several Texas-specific growth factor development projects that have been conducted. In 2005, ERG developed an initial suite of area source growth factors through 2020 (and backcasting factors for years dating back to 1990) based upon a 2002 base year (ERG, 2006). ERG conducted a follow-up project in 2010 that resulted in the development of point and area source growth factors for 2006 through 2035 based upon a 2005 base year (ERG, 2010). ERG also conducted another related project in 2012 that specifically focused on growth factors for the oil and gas exploration and production sectors (ERG, 2012).

As part of the 2010 project, point source and area source growth factors were primarily developed using data and model inputs from the following sources:

- Output projections from Economy.com;
- Energy projections from *Annual Energy Outlook (AEO)* published by the EIA; and
- Population projections from the Texas State Demographer.

As part of the 2012 oil and gas project, area source growth factors for oil and gas exploration and production were developed using historical oil, gas, and condensate production data and several different projection methodologies. Upon completion of the analysis, a methodology known as the Hubbert's Method was deemed the most appropriate to employ for purposes of growth factor development for the oil and gas sector for areas with hydraulically fractured wells.

The purpose of the current project is the development of growth factors for calendar years 2015 through 2050 based upon a 2014 base year. This project builds upon the methods and data developed for the previous projects.

The remainder of this report describes in detail the steps involved with developing the Texas county-level point and area source growth factors. The report includes the following sections:

- Section 2.0 describes the collection of data used to develop the point and area source growth factors;
- Section 3.0 explains the development of the point source growth factors;
- Section 4.0 explains the development of the area source growth factors;
- Section 5.0 briefly describes the data analysis that was conducted comparing future year inventories, as well as previously estimated growth factors;
- Section 6.0 explains the final growth factor formatting;
- Section 7.0 identifies a number of important caveats associated with the use of growth factors;
- Section 8.0 explains the development of the 2011 area source backcasting factors;
- Section 9.0 lists all references used in the development of the point and area source growth factors;
- Appendix A provides a detailed description of the methodology used to develop oil and gas exploration and production area source growth factors;
- Appendix B presents the point source SIC-to-NAICS crosswalk and growth factor surrogate assignments; and
- Appendix C presents the area source growth factor surrogate assignments.

2.0 COLLECTED DATA

In support of the development of point source and area source category growth factors, data were collected from a number of sources. As indicated in the project work plan, ERG obtained and analyzed data from the following sources: Economy.com economic data and projections, the Texas Industrial Production Index (TIPI), the 2016 *AEO*, and the surrogate assignments from the Economic Growth Analysis System (EGAS) model. For the oil and gas sector, ERG also obtained and analyzed historical oil and gas production data from the Railroad Commission of Texas (RRC) and growth factors from the 2012 oil and gas project.

2.1 Economy.com Economic Data and Projections

Historical economic data and future year economic projections were purchased from Moody's Economy.com in March 2016. The Economy.com future year projections are recalibrated each month based upon the most recent monthly economic indicators. As a result, economic changes are gradually reflected over time in the future year projections. The particular data set purchased from Economy.com was county-level gross product expressed in millions of constant 2009 dollars for 2-, 3-, and 4-digit North American Industry Classification System (NAICS) codes; Economy.com also provided additional gross product data for aggregated NAICS groupings for different types of economic activity that cross over multiple NAICS code (e.g., Office-Using Industries, IT-Using Industries, Manufacturing of Durable Goods) (Economy.com, 2016). Product output data were obtained rather than employment, earnings, or value added data, since both the U.S. Environmental Protection Agency (U.S. EPA) and the Emission Inventory Improvement Program (EIIP) have indicated that the use of product output as a growth indicator is preferable to these other measures of growth (EIIP, 1999).

2.2 Texas Industrial Production Index

The project work plan identified the Texas Industrial Production Index (TIPI) as a potential source of growth data. The TIPI was previously examined in the 2010 projection factor project; however, the TIPI was discontinued soon after that project (in August 2010) by the Federal Reserve Bank of Dallas. Economy.com suggested that the Manufacturing Production Index from the Texas Manufacturing Outlook Survey be used as a replacement information source (Economy.com, 2011). The Texas Manufacturing Outlook Survey maintains monthly historical data dating back to June 2004; however, a brief review of the Texas Manufacturing Outlook Survey confirmed that no projections data are available (FRB, 2016). As a result, no data from TIPI or the Texas Manufacturing Outlook Survey were used to develop growth factors for this project.

2.3 Annual Energy Outlook

The EIA annually publishes the *AEO*. The *AEO* provides sector-specific consumption projections, as well as production projections, at the regional level. The most recent version of the *AEO* was an early release 2016 version (released May 17, 2016) with projections out to 2040 that addressed two different scenarios: a “reference case” (i.e., a baseline trend estimate with given known technology and technological and demographic trends, including implementation of the Clean Power Plan [CPP]), and a “no CPP” case (i.e., a baseline trend estimate, which differs from the reference case by assuming that CPP is not implemented) (EIA, 2016a). The final release of the 2016 *AEO* is scheduled for July 7, 2016. All relevant energy projections were included in the early release 2016 *AEO*; the final release 2016 *AEO* is expected to provide additional detailed documentation. U.S. EPA staff previously working on emission projections have indicated that *AEO* is considered to be a reliable source of projections data for combustion sources (Chappell and Bollman, 2008; Chappell, 2010).

2.4 EGAS Model – Surrogate Assignments

Although the Economic Growth Analysis System (EGAS) model was not directly used to calculate growth factors, the surrogate assignments of the EGAS Version 5.0 model were previously reviewed as part of the 2010 projection factor project. However, it should be noted that the EGAS model was officially retired by U.S. EPA in July 2013 (U.S. EPA, 2016).

2.5 Railroad Commission of Texas

The RRC publishes monthly oil and gas production data for each county in Texas. These product-specific data include production of gas well gas, gas from oil wells (casinghead gas), oil, and condensate. As described in Appendix A, production data for every county in Texas were compiled for 2000 through January 2016 to assist in the development of growth factors for the processes and operations associated with upstream oil and gas exploration and production (RRC, 2016).

2.6 U.S. EPA Projections-Related Research

The project work plan indicated that any U.S. EPA research into the relationship of energy- and non-energy-based emissions and the potential for growth factor development would also be investigated.

During the 2007-2008 time frame, U.S. EPA analyzed a long-held fundamental assumption that economic growth is an appropriate surrogate for emissions growth by conducting a sector-level analysis of energy (i.e., combustion) emissions versus non-energy (i.e., process) emissions for 10 key industries. At the time of the 2010 projection factors project (ERG, 2010), this analysis was reportedly undergoing internal U.S. EPA review. However, it does not appear that the results of this analysis were ever publicly released.

Most recently, U.S. EPA has documented the projections methods used to develop the 2017 and 2025 future year inventories for the 2011 Emissions Modeling Platform (U.S. EPA, 2015). U.S. EPA staff have indicated that the projections methods outlined in the *Technical Support Document for the 2011 Emissions Modeling Platform* should not be considered as official guidance, but may provide useful information related to the projections of emission inventories (Eyth, 2016). Much of the information in the *Technical Support Document for the 2011 Emissions Modeling Platform* addresses controls and is specifically focused on U.S. EPA's future years of 2017 and 2025.

2.7 Other Data Sources

As part of the previous 2010 growth factors project (ERG, 2010), ERG also contacted a number of other sources, including government agencies and industry associations. The contacted industry associations included the following: Texas Energy Group, Texas Alliance of Energy Producers, Society of Petroleum Engineers (SPE), Texas Oil and Gas Association (TXOGA), Texas Chemical Council (TCC), Clean Coal Technology Foundation of Texas (CCTFT), Natural Gas Supply Association (NGSA), and Interstate Natural Gas Association of America (INGAA). Only a few of these sources had any growth factor information. In some cases, the sources were not willing to share their growth factor information citing confidentiality considerations; in other cases, the provided growth factor information had insufficient detail associated with geographic location, time series duration, or coverage of source categories. No useable growth factor information was obtained from these other government agencies and trade associations as part of the 2010 growth factor development project. Additional inquiries conducted under the current project found that it was unlikely that these sources have produced any new growth factor information that could be incorporated into this project's results.

3.0 DEVELOPMENT OF POINT SOURCE GROWTH FACTORS

Based upon previous experience with developing point source growth factors for the 2010 project, ERG developed growth factors for every point source Standard Industrial Classification (SIC) code currently contained in the TCEQ's State of Texas Air Reporting System (STARS).

After analyzing the collected data, the specific growth factor data assignments for point source SICs were developed. These data assignments are presented in Appendix B. Because the Economy.com data were presented in terms of NAICS and the TCEQ requested SIC-level growth factors, a NAICS-to-SIC crosswalk was necessary. ERG reviewed an initial crosswalk provided by TCEQ staff (Muldoon, 2016a). In general, the TCEQ's NAICS-to-SIC assignments in the crosswalk were appropriate and reasonable, but ERG revised a few assignments, which are noted as footnotes in Appendix B.

For each point source SIC, ERG developed county-level growth factors using the Economy.com output data and the following equation:

$$GF_{s,c,y} = \frac{Out_{s,c,y}}{Out_{s,c,2014}}$$

Where:

$GF_{s,c,y}$ = Growth factor for SIC s, county c, and year y;
$Out_{s,c,y}$ = Output for SIC s, county c, and year y; and
$Out_{s,c,2014}$ = Output for SIC s, county c, and year 2014.

4.0 DEVELOPMENT OF AREA SOURCE GROWTH FACTORS

An initial list of the area source Source Classification Codes (SCCs) contained in the TCEQ's TexAER system was obtained from TCEQ staff (Lauderdale, 2016a). The initial SCC list contained 371 unique area source SCCs. Along with the initial SCC list, TCEQ's 2014 area source emissions inventory was also obtained from TCEQ staff (Lauderdale, 2016b). After comparing the SCCs in the initial list with the SCCs in the 2014 area source inventory, ERG identified a single SCC (i.e., 2501055120 – Total evaporative losses from gasoline bulk plants) from the 2014 inventory that was not included in the initial area source SCC list. In addition, ERG identified 15 SCCs (all related to onshore oil and gas activities) that were included in the 2012 project to develop growth factors for oil and gas sources but were not included in the initial area source SCC list. ERG added these 16 additional SCCs to the initial SCC list to develop a comprehensive area source SCC list for TCEQ, containing a total of 387 SCCs.

A comprehensive listing of all area source categories included in the TCEQ's area source inventory is presented in Appendix C. ERG's assignment of growth factor surrogates to specific area source categories was initially based upon the assignments previously developed for the 2010 growth factor development project; however, all assignments were reviewed for appropriateness. Some notes regarding the data used for area source growth factor surrogates are provided below.

4.1 Economy.com Data

Economy.com gross product data were obtained at the 2-, 3-, and 4-digit NAICS level (Economy.com, 2016). Wherever possible, 4-digit NAICS data were used, but if unavailable, then 2- or 3-digit NAICS data were used.

4.2 Annual Energy Outlook Data

The consumption data from *AEO* were not available at the state-level; instead, consumption data for the West South Central census division (i.e., Arkansas, Louisiana, Oklahoma, and Texas) were used (EIA, 2016a). Given the relative size of Texas consumption activity compared to the other three states, the application of data from the West South Central census division to Texas is reasonable.

Offshore production data were available from *AEO* for crude oil production (in units of million barrels per day) and natural gas production (in units of trillion dry cubic feet). Combined crude oil and natural gas production data were calculated by converting both crude oil production and natural gas production to a common British thermal unit (BTU) basis using representative heat contents. In addition, *AEO* onshore crude production data and offshore crude production data were combined to develop total crude production estimates for 2014 to 2040.

4.3 Texas-Specific Population Projections

The most recent Texas-specific population projections were obtained from the Texas State Demographer at the Texas State Data Center (TSDC) (TSDC, 2014). Compared to other types of activity data used for area source projections, population projections are considered to be among the most accurate. This accuracy is due to birth and death rates being fairly well quantified. In addition, birth and death rates usually have considerable demographic inertia and do not change significantly from year to year. The uncertainty of population projections is primarily due to immigration. The population projections used in this study represent the "One-Half 2000-2010 Migration (0.5) Scenario" which is prepared as an approximate average of the "Zero Migration (0.0) Scenario" (i.e., net migration is zero) and the "2000-2010 Migration (1.0) Scenario" (i.e., continuation of the 2000 to 2010 migration rates into the future). The Texas State Demographer has indicated that the "0.5 scenario continues to be the most appropriate scenario for most counties for use in long-term planning."

4.4 Constant/No Growth Factors

For some source categories, a constant/no growth factor (i.e., 1.0000) was assigned. These included a number of categories that either were not expected to vary significantly from year to year or where appropriate activity data could not be reasonably assigned. Some examples included forest wildfires, catastrophic/accidental releases, and ammonia emissions from wild animals. A constant/no growth factor was also assigned to all of the agricultural source categories (SCC 2801xxxxxx) and livestock ammonia categories (SCC 2805xxxxxx). This assignment was made because total agricultural acreage does not significantly change over time. In addition, various types of livestock vary from year to year, but these variations are often cyclical in nature and are in response to market forces. As a result, a flat factor was also assigned to the livestock ammonia categories.

4.5 Development of Growth Factors

After analyzing the collected data, specific data assignments for each area source category were developed. These data assignments are presented in Table 4-1.

ERG used data from Economy.com, *AEO*, and population estimates to develop the area source growth factors. The equation used to develop point source growth factors (presented in

Section 3.0) incorporated output projections from Economy.com, energy projections from *AEO*, and population projections to develop area source growth factors for sectors other than onshore oil and gas. A detailed discussion of the methodology used to develop onshore oil and gas exploration and production area source growth factors is provided in Appendix A.

4.6 Adjustments

The area source growth factors were reviewed and a number of adjustments were made, including but not limited to:

- Economy.com gross product data for some categories in certain counties for the base year 2014 were zero. This resulted in a "#DIV/0!" error in the calculation of future year growth factors. In these cases, ERG set the growth factor value to 1.00 (i.e., no growth scenario).

- Population projections data were available through 2050, but Economy.com gross product data were only available through the year 2045. Similarly, *AEO* consumption data (by fuel, by sector) and production data (onshore and offshore oil and gas) were only available through 2040. In these cases, ERG extrapolated data to 2050 (from 2046 to 2050 in case of Economy.com data and from 2041 to 2050 in case of *AEO* data) using linear extrapolation based on data from the later years of the time-series. ERG reviewed the time series data from Economy.com (2014-2045) and from *AEO* (2014-2040). In both cases, the 2014-2020 data exhibited variability, while the data from 2025 onwards were approximately linear with comparably less variability year to year. Therefore, ERG used 2025-2045 data to linearly extrapolate Economy.com data up to year 2050 and similarly used 2025-2040 data to linearly extrapolate *AEO* data to year 2050.

- Economy.com gross product data resulted in very high growth factors (i.e., greater than 4.00) for some categories in certain counties (mainly small rural counties). The highest calculated growth factor was 83. In most of these cases, the base year 2014 gross product value was very low. In the case of growth factor value of 83, the 2014 gross product value was 0.01 (i.e., $10,000) and the 2045 gross product value was 0.83 (i.e., $830,000) and the resulting growth factor for 2045 was 83. In such cases where the 2014 gross product data was less than $1 million, ERG used county-level "Total GDP" data as a surrogate. Economy.com data consisted of a "Total GDP" category for each county which is a summation of all gross product value for each county (i.e., NAICS 1XX thru NAICS 9XX).

- For NAICS 2211 (Electricity Generating Units), data were available from both Economy.com and from *AEO*. Economy.com data consists of gross product for the electric power generation, transmission, and distribution segments. The *AEO* data consisted of power generation projections by fuel type for coal, petroleum, and natural gas. The *AEO* data were projected for individual electricity market module regions – the primary region covering most counties is the Electric Reliability Council of Texas (ERCOT); however, the Southwest Power Pool (SPP) covers portions of the Panhandle and northeast Texas, the Southeastern Electric Reliability Council (SERC) covers portions of east Texas, and the Rocky Mountain Power Area (RA) includes far west Texas. ERG could not use the fuel-based *AEO* data for developing annual growth factors at the SIC level, since SIC codes do not contain information on fuel types. After consultation with TCEQ, it was decided to develop three different profiles for each of the four electricity market module regions, based on fuel type (i.e., coal, petroleum fuels, and natural gas). The preliminary growth factors developed under Task 2 were initially based upon 2015 *AEO* data (EIA, 2015a); however, the Early Release 2016 *AEO* data were published on May 17, 2016. Based on consultation with TCEQ, it was decided to replace the 2015 *AEO* data with the Early Release 2016 *AEO* data (including both the CPP and no CPP scenarios). ERG then obtained a listing of the Texas counties that are located within each of the four electricity market module regions (ERCOT, SPP, SERC, and RA) (Texas Almanac, 2012). ERG mapped each county to its corresponding electricity market module region, resulting in three different profiles for each county based on fuel type (coal, petroleum fuels, and natural gas).

5.0 DATA ANALYSIS

After developing preliminary growth factors for Texas point and area sources as described in Sections 3.0 and 4.0, ERG conducted two types of data analysis under Task 3 (Data Analysis). Information gained from these analyses were used to quality assure the preliminary growth factors.

The first analysis applied the compiled growth factors to the point source and area source 2014 base year emissions inventories (provided by TCEQ and used "as is" with no changes) to develop future year emissions inventories for 2017, 2026, 2029, 2032, and 2050. ERG analyzed the future emissions inventories by comparing and contrasting differences between the 2014 base year inventory and the five future year inventories. The analysis included comparisons at the following levels of disaggregation: statewide, county, attainment status area (i.e., attainment, ozone nonattainment, and ozone precursor special inventory counties), SIC (for point sources only), and SCC (for area sources only).

Based on conversations with TCEQ project staff, it was decided to limit the analysis to nitrogen oxides (NO_x), volatile organic compounds (VOC), and carbon monoxide (CO). The analysis identified the top five SCC and SIC codes (excluding SIC 4911 [Electric Services]) that had the greatest and least emissions variation expressed in units of tons per day and percent change. ERG calculated the difference between the 2014 base year emissions inventory and the five future year inventories in a spreadsheet and submitted these to TCEQ for review. Tables 5-1 through 5-8 show the source categories with the highest increase in emissions, by pollutant (based on the 2014-2050 difference in emissions, TPD, and % change), at the state-level and attainment status-level for area and point sources.

Based upon TCEQ staff's review of the analysis results, the following revision was made to the point source projection factors:

- For NAICS 4226 (Special Warehousing and Storage) point sources, replacement of Economy.com output data for NAICS 4931 (Warehousing and Storage) with output data for NAICS 4247 (Petroleum and Petroleum Products Merchant Wholesalers).
- For SICs 1311 (Crude Petroleum and Natural Gas) and 1321 (Natural Gas Liquids), the original growth factors were based on Economy.com output data for NAICS 2111 (Oil and Gas Extraction). Based on discussions with TCEQ staff, growth factor profiles developed for area source SCC 2310000000 (Oil and Gas Exploration and production – Total, All Processes) were used to develop the final growth factors (2015-2050) for point source SICs 1311 and 1321.

Since these updates were made after TCEQ staff's review of the Task 3 analysis results, these changes are not reflected in Tables 5-1 through 5-8.

Table 5-1. Area Source SCC Categories – State-level Totals

SCC	Description	Pollutant	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2102005000	Industrial fuel combustion – Residual oil	NO_x	10.5	324.4%
2610000500	Open burning – Land clearing debris, except logging debris	CO	74.1	67.3%
2102005000	Industrial fuel combustion – Residual oil	CO	0.9	324.4%
2401050000	Surface coating – Miscellaneous finished metals, total all solvent types	VOC	83.7	110.9%
2515040000	Organic chemical transport – Pipelines, total all products	VOC	12.7	366.5%

Table 5-2. Point Source SIC Categories – State-level Totals

SIC	Description	Pollutant	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	NO_x	90.5	229.6%
3672	Printed circuit boards	NO_x	0.004	854.1%
3241	Cement, hydraulic	CO	65.9	182.2%
3672	Printed circuit boards	CO	0.004	854.1%
2869	Industrial organic chemicals, NEC	VOC	46.1	117.4%
3672	Printed circuit boards	VOC	0.3	854.1%

Table 5-3. Area Source SCC Categories – Attainment Status-level, NO_x

SCC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2102005000	Industrial fuel combustion – Residual oil	Attainment areas	2.6	324.4%
2102005000	Industrial fuel combustion – Residual oil	Ozone non-attainment areas	5.7	324.4%
2102005000	Industrial fuel combustion – Residual oil	Ozone special inventory counties	2.3	324.4%

Table 5-4. Area Source SCC Categories – Attainment Status-level, CO

SCC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2610000500	Open burning – Land clearing debris, except logging debris	Attainment areas	8.0	29.5%
2102005000	Industrial fuel combustion – Residual oil	Attainment areas	0.2	324.4%
2610000500	Open burning – Land clearing debris, except logging debris	Ozone non-attainment areas	38.8	79.1%
2102005000	Industrial fuel combustion – Residual oil	Ozone non-attainment areas	0.5	324.4%
2610000500	Open burning – Land clearing debris, except logging debris	Ozone special inventory counties	27.4	80.6%
2102005000	Industrial fuel combustion – Residual oil	Ozone special inventory counties	0.2	324.4%

Table 5-5. Area Source SCC Categories – Attainment Status-level, VOC

SCC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
2461850000	Commercial products – Pesticides – Herbicides, all processes	Attainment areas	15.2	29.1%
2401065000	Surface coating – Electronic and other electrical, total all sovent types	Attainment areas	0.2	344.3%
2401050000	Surface coating – Miscellaneous finished metals, total all solvent types	Ozone non-attainment areas	59.2	138.5%
2401065000	Surface coating – Electronic and other electrical, total all sovent types	Ozone non-attainment areas	0.5	454.4%
2401050000	Surface coating – Miscellaneous finished metals, total all solvent types	Ozone special inventory counties	13.7	81.7%
2102005000	Industriall fuel combustion – Residual oil	Ozone special inventory counties	0.01	324.4%

Table 5-6. Point Source SIC Categories – Attainment Status-level, NO_x

SIC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	Attainment areas	74.2	211.5%
3299	Nonmetallic mineral products	Attainment areas	0.2	408.1%
2869	Industrial organic chemicals, NEC	Ozone non-attainment areas	47.0	138.5%
3672	Printed circuit boards	Ozone non-attainment areas	0.004	854.1%
3241	Cement, hydraulic	Ozone special inventory counties	62.9	238.8%
4619	Pipelines, NEC	Ozone special inventory counties	0.7	961.6%

Table 5-7. Point Source SIC Categories – Attainment Status-level, CO

SIC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	Attainment areas	25.3	244.6%
3299	Nonmetalic mineral products	Attainment areas	0.8	408.1%
2869	Industrial organic chemicals, NEC	Ozone non-attainment areas	32.7	144.5%
3672	Printed circuit boards	Ozone non-attainment areas	0.004	854.1%
3241	Cement, hydraulic	Ozone special inventory counties	47.3	212.7%
4619	Pipelines, NEC	Ozone special inventory counties	0.4	961.6%

Table 5-8. Point Source SIC Categories – Attainment Status-level, VOC

SIC	Description	Attainment Status	Increase in Emissions, 2014-2050 (TPD)	Increase in Emissions, 2014-2050 (%)
4922	Natural gas transmission	Attainment areas	13.0	238.0%
3299	Nonmetallic mineral products	Attainment areas	0.2	408.1%
2869	Industrial organic chemicals, NEC	Ozone non-attainment areas	29.3	142.7%
3672	Printed circuit boards	Ozone non-attainment areas	0.3	854.1%
2869	Industrial organic chemicals, NEC	Ozone special inventory counties	15.9	102.7%
4619	Pipelines, NEC	Ozone special inventory counties	0.3	961.6%

The second data analysis compared the growth factors developed in previous projects (ERG, 2010; ERG, 2012). The analysis tested the performance of growth factors developed in these projects against actual historical emission trends. The analysis was limited to VOC and NO_x emissions within the ozone nonattainment and ozone precursor special inventory counties. In addition, the analysis focused on the top five SCC categories for VOC and NO_x for area sources and the top five SIC categories (excluding SIC 4911 [Electric Services]) for VOC and NO_x for point sources.

The current 2014 Texas point and area source inventory, along with the historical 2008 and 2011 Texas point and area source inventories, were provided by TCEQ staff (Muldoon, 2016b; Lauderdale, 2016b). ERG identified the top five area source SCC categories and the top five point source SIC categories by summing up the individual 2014 SCC/SIC VOC and NO_x emission totals for the 16 ozone nonattainment counties (i.e., Brazoria, Chambers, Dallas, Denton, Ellis, Fort Bend, Galveston, Harris, Johnson, Liberty, Montgomery, Parker, Rockwall, Tarrant, Waller, and Wise counties) and the 21 ozone precursor special inventory counties (i.e., Bastrop, Bexar, Caldwell, Comal, El Paso, Gregg, Hardin, Harrison, Hays, Henderson, Hood, Jefferson, McLennan, Nueces, Orange, Rusk, San Patricio, Smith, Upshur, Victoria, and Wilson counties). Based on the screening of the 2014 area source inventories, the top five area source SCC categories are presented in Tables 5-9 through 5-12. Likewise, based on the screening of the 2014 point source inventories, the top five point source SIC categories are presented in Tables 5-13 through 5-16. In Tables 5-9 through 5-16, 2014 actual inventory NO_x and VOC emissions were compared against 2014 projected NO_x and VOC emissions. The 2014 projected emissions were developed using 2008 base year inventories (Lauderdale, 2016b; Muldoon, 2016b) combined with projection factors developed under a previous project (ERG, 2010). Tables 5-9 through 5-16 present both actual and projected emissions for the ozone nonattainment counties and the ozone precursor special inventory counties. The difference of emissions (i.e., projected relative to actual) is also included in terms of tons per year and percentage.

Table 5-9. Top Five Area Source SCC Categories – NO_x in Nonattainment Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2102006000	Industrial Fuel Combustion – Natural Gas	5,113.8	5,412.3	298.5	5.8%
2104006000	Residential Fuel Combustion – Natural Gas	4,644.6	4,236.6	-408.0	-8.8%
2103006000	Commercial/Institutional Fuel Combustion – Natural Gas	3,803.5	3,848.0	44.5	1.2%
2310021302	On-Shore Gas Production – Natural Gas-Fired 4-Cycle Rich Burn Compressor Engines (50 to 499 HP)	3,562.2	38,785.2	35,223.0	988.8%
2102007000	Industrial Fuel Combustion – Liquefied Petroleum Gas (LPG)	999.7	367.2	-632.5	-63.3%

[a] Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-10. Top Five Area Source SCC Categories – NO_x in Special Inventory Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2310021302	On-Shore Gas Production – Natural Gas-Fired 4-Cycle Rich Burn Compressor Engines (50 to 499 HP)	6,607.6	7,760.1	1,152.5	17.4%
2104006000	Residential Fuel Combustion – Natural Gas	2,652.9	2,353.7	-299.2	-11.3%
2310000330	Oil and Gas Exploration and Production – Artificial Lift (Pumpjack)	2,618.7	4,205.8	1,587.2	60.6%
2102006000	Industrial Fuel Combustion – Natural Gas	1,960.7	2,128,4	167.8	8.6%
2103006000	Commercial/Institutional Fuel Combustion – Natural Gas	1,794.2	2,018.9	224.7	12.5%

[a] Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-11. Top Five Area Source SCC Categories – VOC in Nonattainment Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2401050000	Surface Coating – Miscellaneous Finished Metals	15,608.1	15,608.2	0.1	0.0%
2460100000	Consumer/Commercial Products – All Personal Care Products	12,381.7	10,470.6	-1,911.0	-15.4%
2401001000	Surface Coating – Architectural Coatings	12,251.8	16,369.8	4,118.0	33.6%
2460200000	Consumer/Commercial Products – All Household Products	11,730.0	9,920.9	-1,809.1	-15.4%
2460800000	Consumer/Commercial Products – All FIFRA-Related Products	11,599.7	9,810.5	-1,789.2	-15.4%

[a] Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-12. Top Five Area Source SCC Categories – VOC in Special Inventory Counties

SCC	SCC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2310021010	On-Shore Gas Production – Condensate Storage Tanks (including Flash)	18,013.9	110,096.0	92,082.1	511.2%
2310011020	On-Shore Oil Production – Crude Tanks (including Flash)	8,527.2	13,268.0	4,740.8	55.6%
2310011450	On-Shore Oil Production – Wellhead	6,922.5	8,427.0	1,504.5	21.7%
2501060101	Gasoline Service Stations – Stage 2 Displacement Loss (Uncontrolled)	6,897.4	6,897.5	0.1	0.0%
2460100000	Consumer/Commercial Products – All Personal Care Products	6,317.0	5,455.0	-861.9	-13.6%

[a] Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-13. Top Five Point Source SIC Categories – NO_x in Nonattainment Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	12,399.3	16,148.8	3,749.4	30.2%
2911	Petroleum Refining	7,706.6	9,450.5	1,743.8	22.6%
1311	Crude Petroleum and Natural Gas	3,319.5	4,985.8	1,666.3	50.2%
3241	Cement (Hydraulic)	3,210.2	11,855.8	8,654.6	269.3%
1321	Natural Gas Liquids	1,812.2	2,815.9	1,003.7	55.4%

[a] Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-14. Top Five Point Source SIC Categories – NO_x in Special Inventory Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	11,710.7	12,894.7	1,184.0	10.1%
2911	Petroleum Refining	9,901.2	13,079.0	3,177.7	32.1%
3241	Cement (Hydraulic)	9,619.0	14,817.8	5,198.8	54.0%
1321	Natural Gas Liquids	2,853.9	3,447.5	593.6	20.8%
4922	Natural Gas Transmission	1,089.1	1,681.2	592.1	54.4%

[a] Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-15. Top Five Point Source SIC Categories – VOC in Nonattainment Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	7,481.9	11,961.2	4,479.4	59.9%
2911	Petroleum Refining	7,317.8	10,996.6	3,678.9	50.3%
1311	Crude Petroleum and Natural Gas	4,195.3	9,210.9	5,015.6	119.6%
4226	Special Warehousing and Storage (Not Elsewhere Classified)	2,660.4	3,972.6	1,312.2	49.3%
2821	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	2,137.8	3,689.3	1,551.5	72.6%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

Table 5-16. Top Five Point Source SIC Categories – VOC in Special Inventory Counties

SIC	SIC Description	2014 Actual Inventory (tpy)	2014 Projected Inventory (tpy)[a]	Difference (tpy)	Difference (%)
2911	Petroleum Refining	7,650.8	8,632.5	981.8	12.8%
2869	Industrial Organic Chemicals (Not Elsewhere Classified)	5,650.3	6,046.2	395.8	7.0%
2821	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	1,839.7	2,213.6	373.9	20.3%
2822	Synthetic Rubber (Vulcanizable Elastomers)	1,695.0	1,987.8	292.8	17.3%
1311	Crude Petroleum and Natural Gas	886.3	773.2	-113.1	-12.8%

[a]Emissions projected using projection factors from previous project (ERG, 2010).

The area source and point source calculations and results were submitted to TCEQ in Excel spreadsheet format (area_2008-2014_top5_analysis_ 052516.xlsx and point_2008-2014_top5_analysis_052516.xlsx).

In Tables 5-9 through 5-16, a positive difference represents the situation where the projected emissions were greater than the actual emissions. A likely reason for this is that the projection factor simply represents growth, while the actual emissions are subject to control devices, regulatory controls, facility closures, facility maintenance and repairs, etc., which will tend to reduce actual emissions. Conversely, a negative difference in Tables 5-9 through 5-16 represents the situation where the projected emissions were less than the actual emissions; a potential reason for this may include the use of a growth factor surrogate that does not adequately represent growth behavior with a particular source. Finally, a zero or neglible difference in Tables 5-9 through 5-16 most likely represents a situation where the actual inventory was generated using the growth factors developed during the previous project (ERG, 2010).

Another issue that should be noted with the growth factors from the previous project was that the point and area source growth factors were developed in 2010 for the years 2006 through 2035 based upon a 2005 base year. At that time, the growth factor surrogates from Economy.com and *AEO* were likely a bit more uncertain due to the severity of the recession of 2007 through 2009, as well as the subsequent recovery.

6.0 FORMATTED GROWTH FACTORS

The final step of the project was the development of the formatted growth factors under Task 4 (Develop Formatted Growth Factors) of the project scope. The formatted growth factors were submitted to the TCEQ along with the final report. ERG provided the growth factors and associated data in Microsoft Access and Excel format for point sources. For area sources, ERG provided the growth factors in TexAER loadable format input file as well as in Microsoft Access format, with all fields complete and all mandatory fields quality assured.

ERG also conducted an upload test of the area source TexAER input file and corrected all errors identified during the upload. During the upload the TexAER system flagged 15 SCCs as "Not Valid." All 15 SCCs were related to onshore oil and gas operations and were identified as not included in TCEQ's area source SCC list under Task 2 of this project (refer to Section 4.0). These 15 SCCs are:

- 2310000230
- 2310011600
- 2310021011
- 2310021310
- 2310021410
- 2310021411
- 2310021601
- 2310021602
- 2310021604
- 2310021605
- 2310021700
- 2310030230
- 2310030300
- 2310030400
- 2310030401

7.0 CAVEATS ASSOCIATED WITH USE OF GROWTH FACTORS

Although a comprehensive suite of point and area source growth factors were developed under this project, there are a number of caveats that should be considered when using these growth factors to develop projected emission inventories. These caveats include the following:

- Growth factors developed under this project do not account for the effects of future controls (e.g., regulation control, rule effectiveness, rule penetration, fuel switching, technology improvements, etc.). As part of the development of future emissions, the effects of controls should also be considered.
- Growth factors developed under this project are based upon the most recent data projections available (i.e., spring/summer 2016) from Economy.com, *AEO*, Texas state demographics, etc. In the future, these data projections will be updated based upon newly available data and/or revised projections. Therefore, as these growth factors "age" over time, increased care and consideration should be exercised when using them.
- Growth factors developed under this project were developed relative to a 2014 base year. Use of these growth factors for a base year other than 2014 requires the use of growth factor ratioing. For instance, the 2019 growth factor for a 2016 base year inventory would be the ratio of the 2019 growth factor (2014 base year) divided by the 2016 growth factor (2014 base year).
- Growth factors developed under this project were based upon national- or regional-level data that were extrapolated to individual counties. Care should be exercised when applying growth factors to point sectors with a small number of facilities or area source categories in smaller counties. Local conditions (e.g., new construction, expansion, closings, etc.) may not be accurately represented. Information regarding local "on-the-ground" conditions should take precedence over this project's growth factors.
- Growth factors developed under this project may not fully represent short-term and/or regional disruptions, such as economic recessions, natural disasters, commodity price changes, etc. The full effect of these events typically takes time to permeate through the data projections.
- Growth factors developed under this project are intended to be used to project future year emissions estimates at the county- or regional-level. The factors should not be used to project future year emissions estimates for individual sites or sources.

8.0 BACKCASTING FACTORS

An additional task to develop county-level area source backcasting factors for 2011 was added to this project after project initiation (i.e., Task 7). The backcasting factors were developed for all area source categories that were previously identified under Task 2. Under Task 4, growth factors for the future years of 2015 through 2050 were developed for 388 SCCs. ERG's assignment of growth factor surrogates to specific area source categories was based upon the assignments previously developed under Task 2 and revised under Task 3; these assignments are presented in Appendix C. The backcasting factors were developed using similar historical data that were used to develop the future year growth factors (i.e., population, energy consumption, and economic statistics). For each area source SCC, ERG developed county-level backcasting factors using the relevant surrogate data and the following equation:

$$BF_{s,c} = \frac{Out_{s,c,2011}}{Out_{s,c,2014}}$$

Where:

$BF_{s,c}$ = 2011 Back casting factor for SCC *s*, and county *c*;
$Out_{s,c,2011}$ = Output for SCC *s*, county *c*, and year *2011*; and
$Out_{s,c,2014}$ = Output for SCC *s*, county *c*, and year 2014.

Some notes additional notes regarding the data used for area source backcasting factor surrogates are provided below:

- Historical 2011 Economy.com gross product data were obtained at the 2-, 3, and 4-digit NAICS level (Economy.com, 2016). Wherever possible, 4-digit NAICS data were used, but if unavailable, then 2- or 3-digit NAICS data were used.
- Historical state-level energy consumption data were obtained from the EIA (EIA, 2015b; EIA, 2015c; EIA, 2015d; EIA, 2016b; EIA, 2016c; EIA, 2016d; EIA, 2016e; EIA, 2016f; EIA, 2016g; EIA, 2016h).
- Historical population estimates were obtained from the Texas State Demographer at the Texas State Data Center (TSDC) (TSDC, 2014).

Backcasting factors were developed for the nonpoint oil- and gas-related SCCs using the 2011 to 2014 ratio of oil, gas, or condensate production (or well counts as appropriate) for the Barnett Shale, Haynesville Shale, Eagle Ford Shale, and Permian Basin plays. Production and well count data were obtained from the Railroad Commission of Texas (RRC) for the years 2000 through January 2016 (RRC, 2016). The resultant backcasting factors for each play and commodity type were then assigned to each SCC based on the use of oil, gas, or condensate production or well counts as a scaling variable. For example, the ratio of 2011 to 2014 oil production was used as the scaling variable for SCC 2310011020 "On-Shore Oil Production /Storage Tanks: Crude Oil". Table A-24 in Appendix A identified the scaling variable (i.e., oil, gas, or condensate production or well counts) used to assign the backcasting factors to each SCC. Tables 8-1 and 8-2 show the final oil and gas backcasting factors developed using the methodology described above for production and well counts, respectively, for each commodity and play.

Table 8-1. Final Oil, Gas, and Condensate Production Backcasting Factors

	Barnett			Eagle Ford			Haynesville			Permian			Statewide		
Year	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**
2011	1.168	1.110	0.430	0.120	0.440	0.245	0.938	1.048	0.851	0.617	0.781	0.253	0.711	0.845	0.445

Table 8-2. Final Oil and Gas Well Count Backcasting Factors

	Barnett		Eagle Ford		Haynesville		Permian		Statewide	
Year	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**	**Oil**	**Gas**
2011	0.971	0.913	0.576	0.815	1.057	1.010	0.812	1.029	0.854	0.942

Values in Tables 8-1 and 8-2 less than 1 indicate a higher level of activity in 2014 than in 2011, while values greater than 1 indicate a higher level of activity in 2011 than in 2014. As with the growth factors developed for the 2015-2050 period, backcasting factors for counties in Texas outside of the four study areas were estimated by averaging oil, gas, and condensate growth factors across each of the four study areas for each commodity. Note that there are no condensate wells in Table 8-2 as all condensate is produced at gas wells.

After development of the 2011 backcasting factors at the county-level and by SCC, ERG developed and submitted a Microsoft Access database that contains the results. In addition, ERG also developed and submitted to TCEQ an input file in TexAER loadable format. The TexAER input file containing the 2011 backcasting factors was developed in a similar fashion as the 2015-2050 growth factor file was developed under Task 4. Since the format and file structure was tested under Task 4 of this project by conducting a successful test upload with the TexAER system, ERG did not duplicate the test upload for Task 7.

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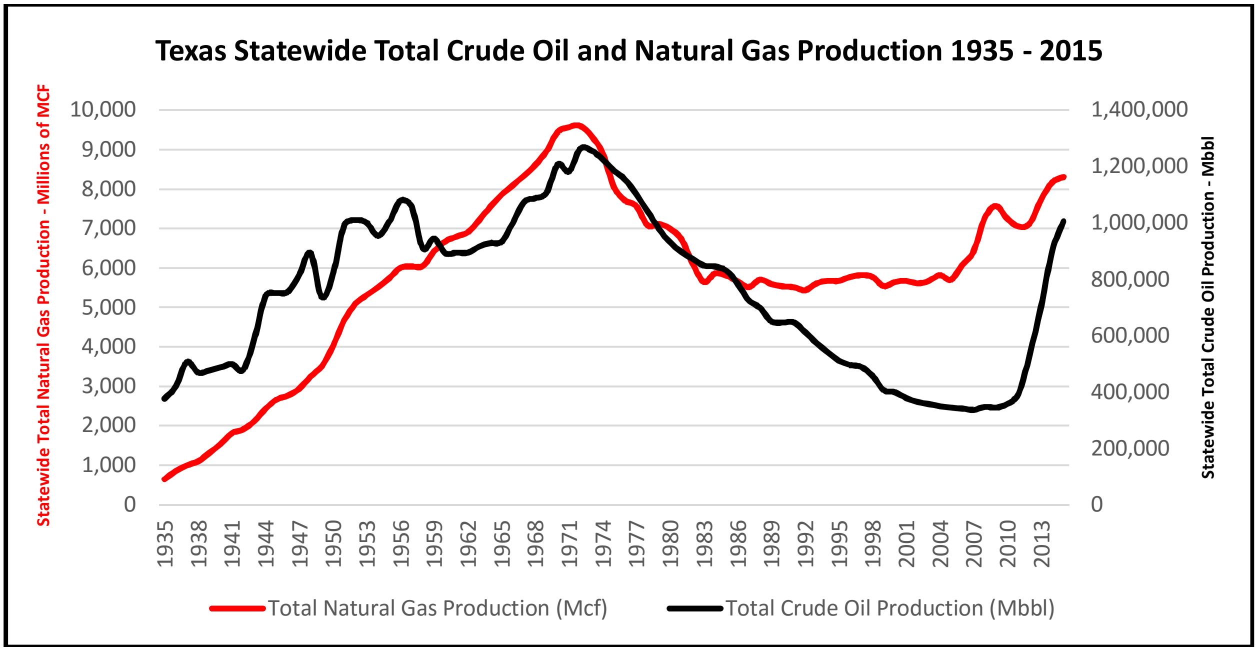
APPENDIX A
DEVELOPMENT OF OIL AND GAS EXPLORATION AND PRODUCTION AREA SOURCE GROWTH FACTORS

A.0 DEVELOPMENT OF OIL AND GAS EXPLORATION AND PRODUCTION AREA SOURCE GROWTH FACTORS

The increasing use of horizontal drilling and hydraulic fracturing in the past 10 years has led to increases in the statewide production of oil and natural gas as shown in Figure A-1.

Figure A-1. Texas Statewide Oil and Gas Production, 1935 – 2015



The most significant production increases in the past ten years have occurred in four regions. These four regions are the Barnett, Haynesville, and Eagle Ford Shales; and the Permian Basin. Initially, the Barnett Shale in north-central Texas was the focal point of shale gas development, followed by an increase in gas development activity in the Haynesville Shale. More recently, horizontal drilling and hydraulic fracturing techniques have been used to develop the liquids-rich areas of the Eagle Ford Shale area in south-central Texas and in the Permian Basin in west Texas. These four areas currently account for approximately 80 to 90 percent of total oil, gas, and condensate production in Texas.

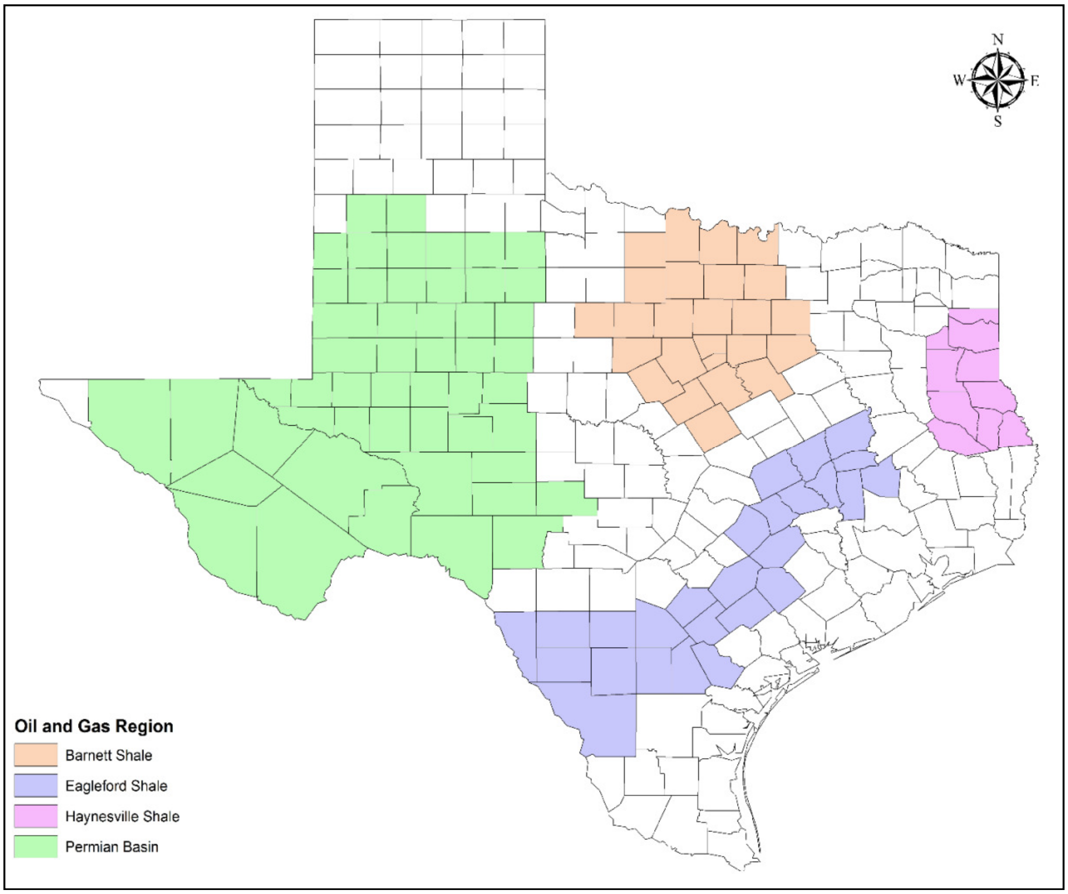
Area-specific growth factors were developed to forecast oil and gas activities for these four regions. Monthly production data were obtained from the Railroad Commission of Texas (RRC) for the years 2000 through January 2016 (RRC, 2016a). These data were obtained at the county level, and included gas well gas production in thousands of cubic feet per month (MCF/month), oil production in barrels per month (BBL/month), casinghead gas production in MCF/month, and condensate production in BBL/month. ERG segregated the monthly production data into four data sets based on the counties that compose the Barnett, Haynesville, Eagle Ford, and Permian regions, and used these data to project future production activity for oil, condensate, and gas based on Hubbert's model. Growth factors for Texas counties outside of the Barnett Shale, Haynesville Shale, Eagle Ford Shale, and Permian Basin plays were estimated using the average of the factors developed for these four areas.

Determining the growth factors depends upon an understanding of the geography, historical production, and estimates of recoverable oil and gas reserves in each of the four regions. Commodity prices also have an impact on oil and gas exploration and production activities. Information on current reserves and production trends are utilized in Hubbert's Model to forecast future production activity.

A.1 Oil and Gas Plays

Development of shale gas and shale (tight) oil across the United States has increased dramatically in the last 15 years due to technological advances in drilling and well completion activities. In particular, horizontal drilling and hydraulic fracturing have allowed for development of shale gas and tight oil deposits. Numerous counties in Texas compose the four oil and gas plays covered under this study as illustrated by Figure A-2. Additional details on each of these areas is provided below.

Figure A-2. Texas Oil and Gas Plays



Barnett Shale Gas Play

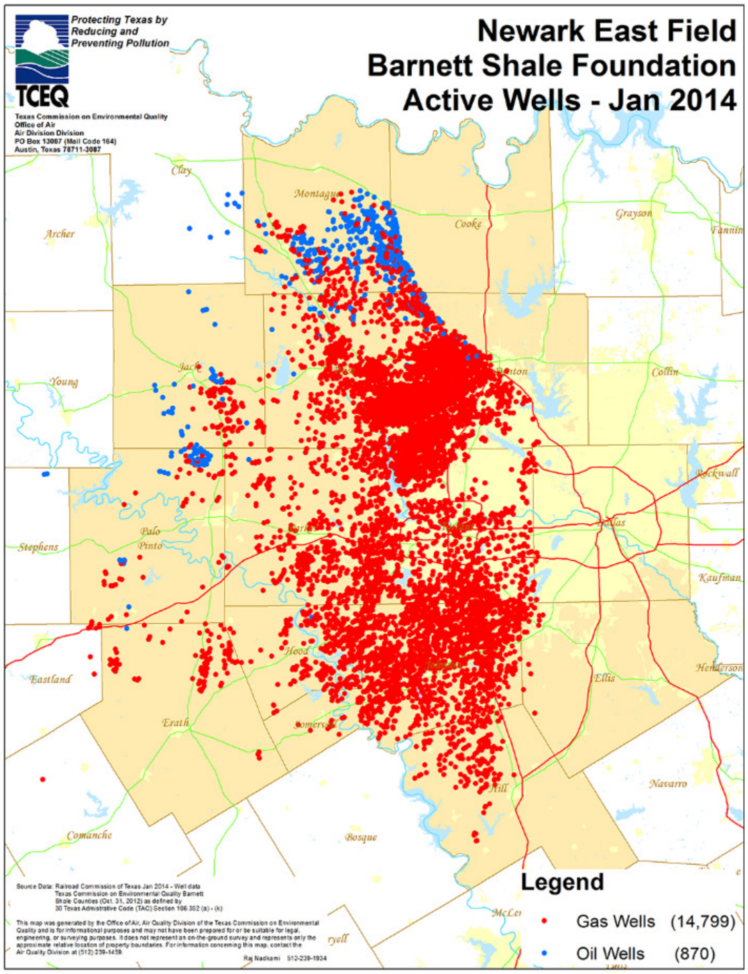
The Barnett Shale gas play is situated around the Dallas-Fort Worth metropolitan area and covers approximately 7,000 square miles (mi^2). Table A-1 identifies the 25 counties in Texas that comprise the Barnett Shale play region.

Table A-1. Texas Counties Comprising the Barnett Shale Gas Play Region

Archer	Denton	Hood	Shackelford
Bosque	Eastland	Jack	Somervell
Clay	Ellis	Johnson	Stephens
Comanche	Erath	Montague	Tarrant
Cooke	Hamilton	Palo Pinto	Wise
Coryell	Hill	Parker	Young
Dallas			

Figure A-3 shows the location of oil and gas wells in the Barnett Shale. The presence of oil wells in the northern and western areas of the Barnett Shale indicate wet gas formations, where hydrocarbon liquids may be found along with natural gas.

Figure A-3. Barnett Shale Gas Play, Fort Worth Basin, Texas



Newark East Field
Barnett Shale Foundation
Active Wells - Jan 2014

Source Data: Railroad Commission of Texas Jan 2014 - Well data
Texas Commission on Environmental Quality Barnett
Shale Counties (Oct. 31, 2012) as defined by
30 Texas Admistrative Code (TAC) Section 106.352 (a) - (k)

This map was generated by the Office of Air, Air Quality Division of the Texas Commission on Environmental Quality and is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries. For information concerning this map, contact the Air Quality Division at (512) 239-1459.

Raj Nadkarni 512-239-1934

Production in the Barnett Shale play region began to increase around 2001 with the advent of horizontal drilling and hydraulic fracturing, with significant production increases seen in the region over the last ten years. The Barnett Shale play was the first area in Texas to experience increased development with these new drilling technologies.

A report by the U.S. Department of Energy, Energy Information Administration (EIA) reviewed key statistics and resource estimates for the Barnett Shale gas play (EIA, 2011; EIA, 2015a), which are listed in Table A-2 below.

Table A-2. Barnett Shale Gas Play Statistics and Resource Estimates

	Active	Undeveloped
Area (square miles)	4,075	2,383
Estimated Ultimate Recovery (BCF/well)	1.6	1.2
Well Spacing (wells/square mile)	5.5	8
Technically Recoverable Resources (TCF)	24.3	

BCF – billion cubic feet
TCF – trillion cubic feet

Eagle Ford Shale Oil and Gas Play

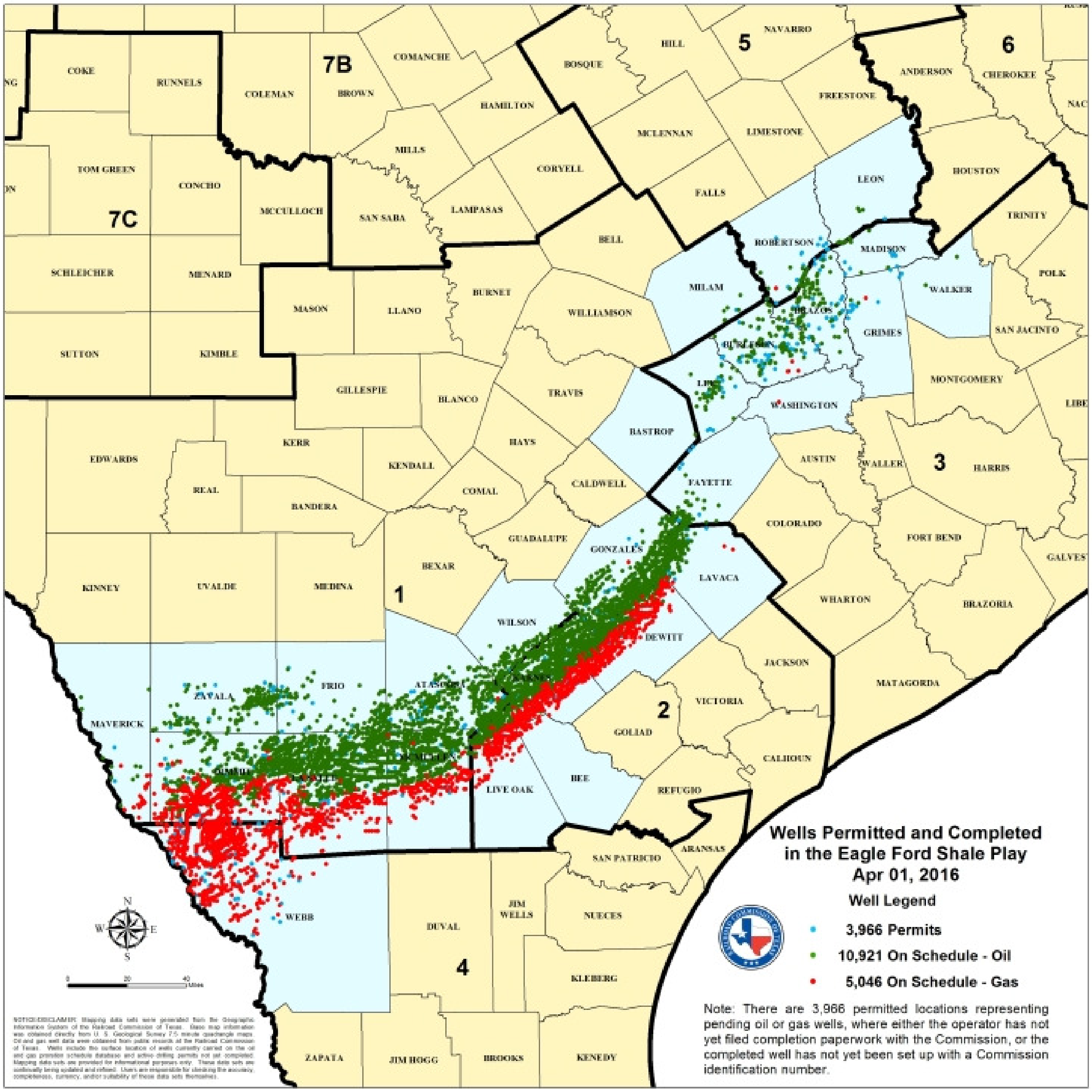
The Eagle Ford Shale is a hydrocarbon producing formation of significant importance due to its capability of producing gas, condensate, and more oil than other traditional shale plays. The Eagle Ford Shale is situated in south Texas and is roughly 50 miles wide and 400 miles long. The area of the dry gas zone is estimated at 200 mi^2; the area of the condensate zone is estimated at 890 mi^2; and the area of the oil zone is estimated at 2,233 mi^2. The Eagle Ford Shale is located in the Western Gulf basin within the RRC Districts 1 through 6. Table A-3 identifies the 26 counties in the Eagle Ford Shale region.

Table A-3. Texas Counties Comprising the Eagle Ford Shale Oil and Gas Play Region

Atascosa	Fayette	Lee	Milam
Bastrop	Frio	Leon	Robertson
Bee	Gonzales	Live Oak	Walker
Brazos	Grimes	Madison	Webb
Burleson	Karnes	Maverick	Wilson
De Witt	La Salle	McMullen	Zavala
Dimmit	Lavaca		

Figure A-4 shows the location of oil and gas wells in the Eagle Ford Shale; note the north to south trend changing from oil wells to gas wells.

Figure A-4. Eagle Ford Shale Oil and Gas Play, South Texas



Source: RRC, 2016a, http://www.rrc.state.tx.us/media/33182/eaglefordshaleplay2016-04-lg.jpg

The first of the Eagle Ford Shale wells was drilled in 2008, using horizontal drilling and multi-stage hydraulic fracturing. The number of wells drilled in this region has increased steadily since then. The number of producing gas wells has increased from 67 in 2009 to over 11,000 in 2016. The number of producing oil wells has increased from 40 in 2009 to over 18,000 in 2016.

A report by the EIA reviewed key statistics and resource estimates for the Eagle Ford Shale play, which are listed in Table A-4 below (EIA, 2011; EIA, 2015a).

Table A-4. Eagle Ford Shale Gas Play Statistics and Resource Estimates

	Dry Gas Zone	Condensate Zone	Oil Zone
Area (square miles)	200	890	2,233
Estimated Ultimate Recovery (BCF/well)	5.5	4.5	
Estimated Ultimate Recovery (MBO/well)			300
Well Spacing (wells/square miles)	4	8	5
Technically Recoverable Resources (BBO)	5.17		
Technically Recoverable Resources (TCF)	23.7		

BBO – billion barrels of oil
MBO – thousand barrels of oil

Haynesville Shale Gas Play

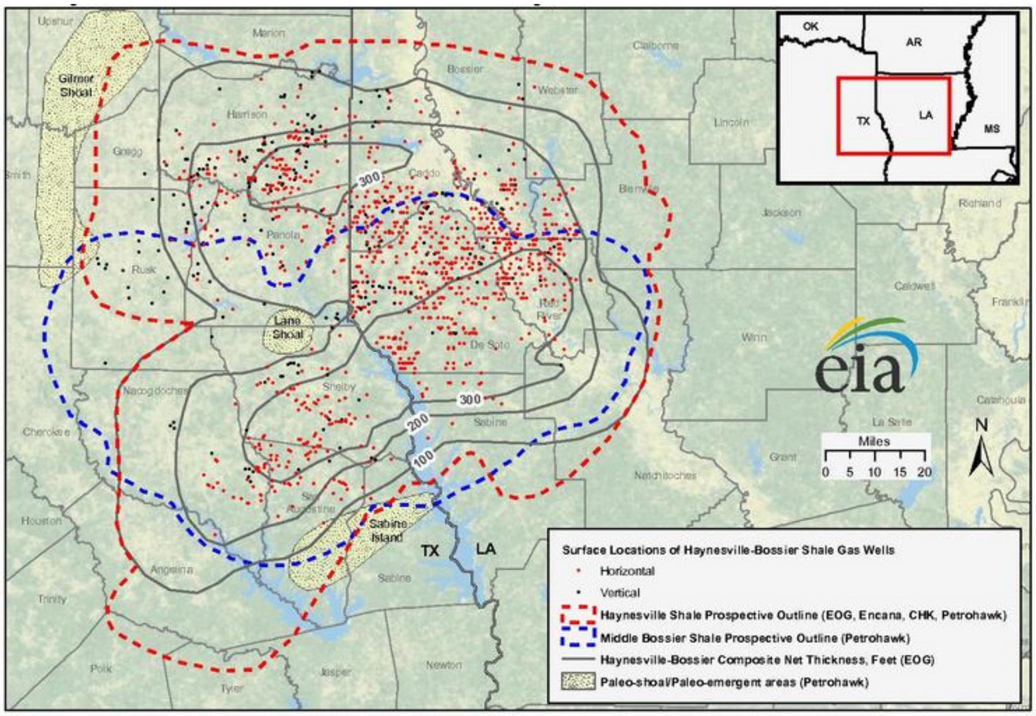
The Haynesville Shale gas play (also known as the Haynesville-Bossier Shale play), is located in east Texas and western Louisiana. The Haynesville Shale has a total area of approximately 9,000 square miles. Table A-5 identifies the 10 counties that compose the Texas portion of the Haynesville Shale play region.

Table A-5. Texas Counties Comprising the Haynesville Shale Gas Play Region

Angelina	Marion	Rusk	Shelby
Gregg	Nacogdoches	Sabine	
Harrison	Panola	San Augustine	

Figure A-5 shows the location of oil and gas wells in the Haynesville Shale.

Figure A-5. Haynesville Shale Gas Play, Eastern Texas



Source: Energy Information Administration based on data from HPDI, TX Railroad Commission, LA Dept. of Natural Resources, Operators.
Updated May 26, 2011

Production in the Haynesville Shale play region has doubled in the past ten years with the introduction of directional drilling and hydraulic fracturing techniques and the higher natural gas prices which occurred from 2005 to 2008 (over $5 per thousand cubic feet [MCF]). The combination of these factors made extraction of the gas economically feasible. With the recent decline in natural gas prices, drilling activity and production have been curtailed. Key statistics and resource estimates from the EIA for the Haynesville Shale gas play are listed in Table A-6 below (EIA, 2011; EIA, 2015a).

Table A-6. Haynesville Shale Gas Play Statistics and Resource Estimates

	Active	Undeveloped
Area (square miles)	3,574	5,426
Estimated Ultimate Recovery (BCF/well)	6.5	1.5
Well Spacing (wells/square miles)	8	8
Technically Recoverable Resources (TCF)	53.30	19.41

Permian Basin Oil Play

The Permian Basin oil play is located in West Texas and Eastern New Mexico and is approximately 250 miles wide and 300 miles long. It is the largest crude oil producing region in the

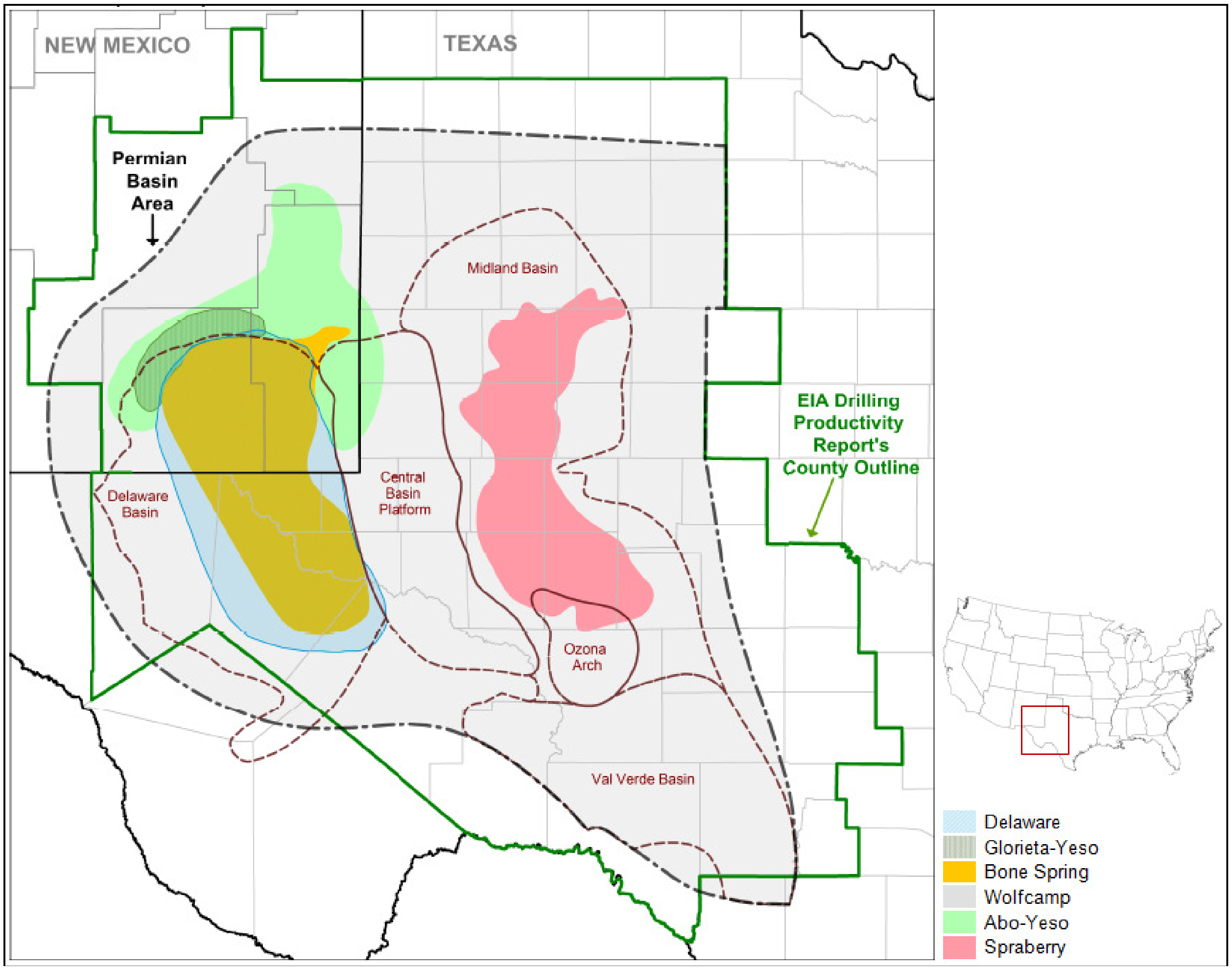
United States with an estimated production of over 1,300,000 barrels per day in 2013. The Permian Basin covers a large geographic area and is comprised of a large number of oil and gas-bearing formations of varying porosity and depth. The majority of the increase in oil production in the Permian Basin since 2007 has come from development of six low-porosity (tight oil) formations (i.e., the Spraberry, Wolfcamp, Bone Spring, Glorieta, Yeso, and Delaware formations) (EIA, 2014a). Table A-7 identifies the 51 counties in Texas that compose the Texas portion of the Permian Basin oil play region.

Table A-7. Texas Counties Comprising the Permian Basin Oil Play Region

Andrews	Hale	Pecos
Borden	Hockley	Presidio
Brewster	Howard	Reagan
Cochran	Hudspeth	Reeves
Coke	Irion	Schleicher
Crane	Jeff Davis	Scurry
Crockett	Kent	Sterling
Crosby	Kimble	Stonewall
Culberson	King	Sutton
Dawson	Lamb	Terrell
Dickens	Loving	Terry
Ector	Lubbock	Tom Green
Edwards	Lynn	Upton
Fisher	Martin	Val Verde
Gaines	Midland	Ward
Garza	Mitchell	Winkler
Glasscock	Nolan	Yoakum

Figure A-6 shows the location of the Permian Basin oil play and the primary producing formations.

Figure A-6. Permian Basin Oil Play, West Texas



Source: U.S. Energy Information Administration, 2014, https://www.eia.gov/todayinenergy/detail.cfm?id=17031

Oil production in the Permian Basin region has doubled in the past six years with the introduction of directional drilling and hydraulic fracturing techniques and spurred on by the higher oil prices which occurred from 2011 to 2014 (with prices over this time period often exceeding $100 per barrel). The combination of these factors made extraction of oil from the six tight oil plays in the Permian Basin economically feasible. With the recent decline in oil prices, drilling activity has been curtailed, while production continues near peak levels as existing wells continue to produce.

Key statistics and resource estimates from the EIA for the Permian Basin oil play are listed in Table A-8 below (EIA, 2014b, RRC, 2016b).

Table A-8. Permian Basin Oil Play Statistics and Resource Estimates

	Active	Undeveloped

Area (square miles)	58,250	
Number of Producing Wells	82,000	
Technically Recoverable Resources (BBO)	7.022	22

BBO – billion barrels of oil

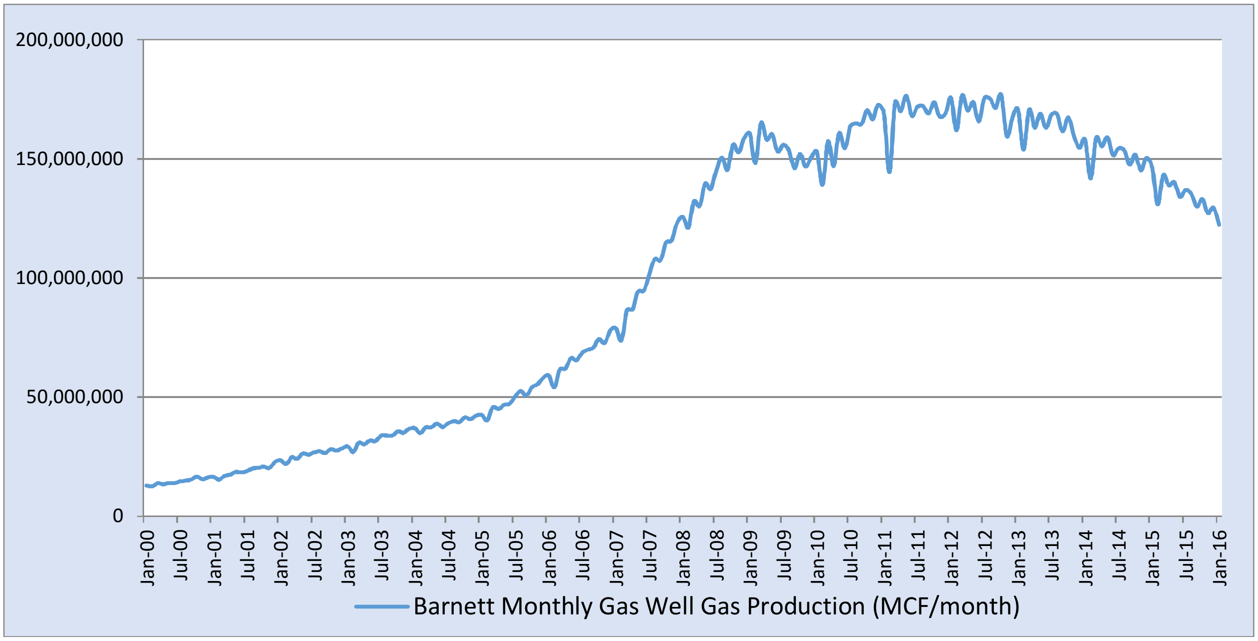
A.2 Historical Production

Historical monthly production data were obtained from the RRC for the years 2000 through January 2016. These data were obtained at the county level, and included gas well gas production (MCF/month), oil production (BBL/month), casinghead gas production (MCF/month), and condensate production (BBL/month). ERG segregated the monthly production data into four parts based on the listing of counties that compose the Barnett, Eagle Ford, and Haynesville Shale play regions and the Permian Basin oil play (see Tables A-1, A-3, A-5, and A-7, above).

Barnett Shale Gas Play

The Barnett Shale play is predominantly a gas well gas play. As shown in Figure A-7, total gas well gas production rates from all counties in the Barnett Shale play generally increased from around 2006 until the play reached its peak production in 2012. The highest gas well gas producing counties remain Tarrant and Johnson counties, but production in both counties is markedly diminished over the last few years, particularly in Johnson County where production is currently less than half what it was during its peak in 2011. The gas produced in the Barnett Shale is dry, so very little condensate is produced relative to the volume of gas.

Figure A-7. Barnett Shale Gas Play, Gas Production 2000 - 2016



Eagle Ford Shale Oil and Gas Play

The Eagle Ford Shale is unique among Texas shale plays in that it contains regions that are rich in oil, condensate, and gas. With the introduction of horizontal drilling and hydraulic fracturing in early 2008, production of both oil and condensate increased by a factor of 40 between 2009 and 2015 (see Figures A-8 and A-9), and as shown in Figure A-10, gas production nearly doubled between 2011 and 2015 when gas production in the Eagle Ford Shale matched the gas production from the Barnett Shale. Liquids production has decreased markedly since March 2015 with current oil and condensate production down over 25 percent in the last year.

Figure A-8. Eagle Ford Shale, Condensate Production 2000 - 2016

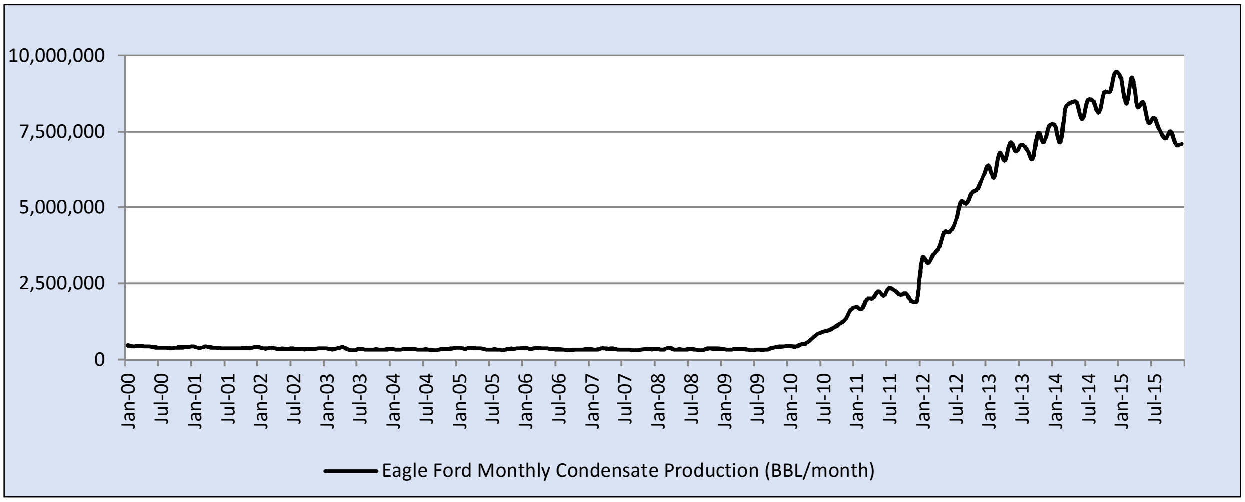


Figure A-9. Eagle Ford Shale, Oil Production 2000 - 2016

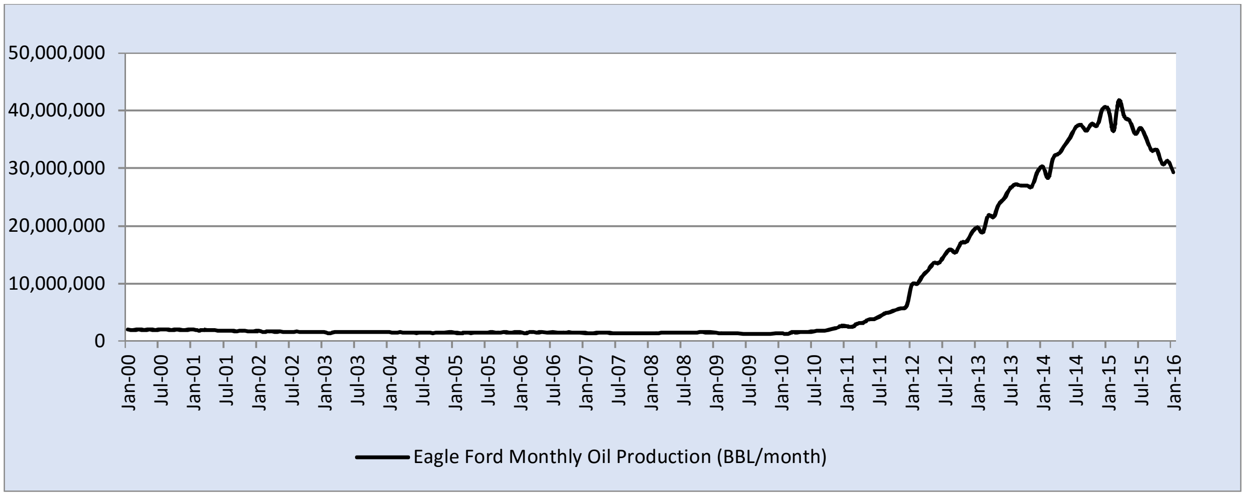
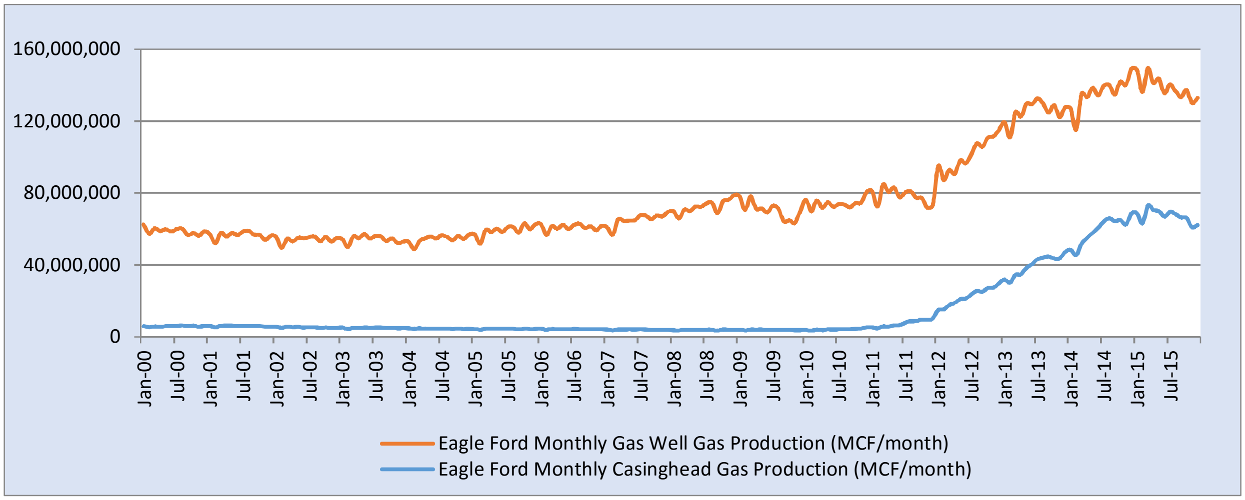


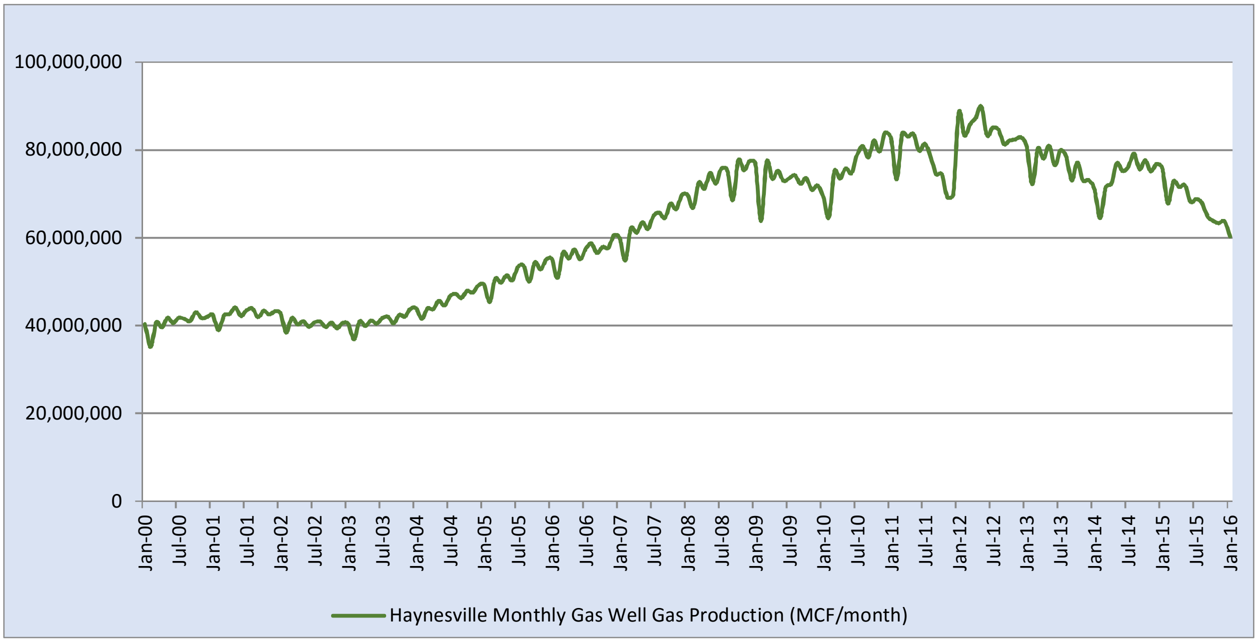
Figure A-10. Eagle Ford Shale, Gas Production From 2000 - 2016



Haynesville Shale Gas Play

There is no oil and very little condensate produced from the Haynesville Shale formation; the play is primarily a gas play. As shown in Figure A-11, production of gas appears to have peaked in 2012, and has steadily decreased since that time by over 25 percent of peak levels. The decline is most likely due to the drop in price of natural gas.

Figure A-11. Haynesville Shale Gas Play, Gas Production 2000 - 2016



Permian Basin Oil Play

While conventional oil development in the Permian Basin was steady at over 20 million barrels per month between 2000 and 2010, oil production in the Permian Basin more than doubled between 2010 and 2015 as more wells were completed using hydraulically fractured stimulation (see Figure A-12). The Permian Basin is known primarily as an oil play, but casinghead gas production in the fall of 2015 was approximately 75 percent of gas well gas production in both the Barnett Shale and Eagle Ford Shale gas plays (see Figure A-13). Production has declined since its peak in early 2015, but the decline has not been as dramatic as in the Eagle Ford Shale, possibly due to the established baseline of conventional production. There is relatively little condensate production in the Permian Basin.

Figure A-12. Permian Basin, Oil Production 2000 - 2016

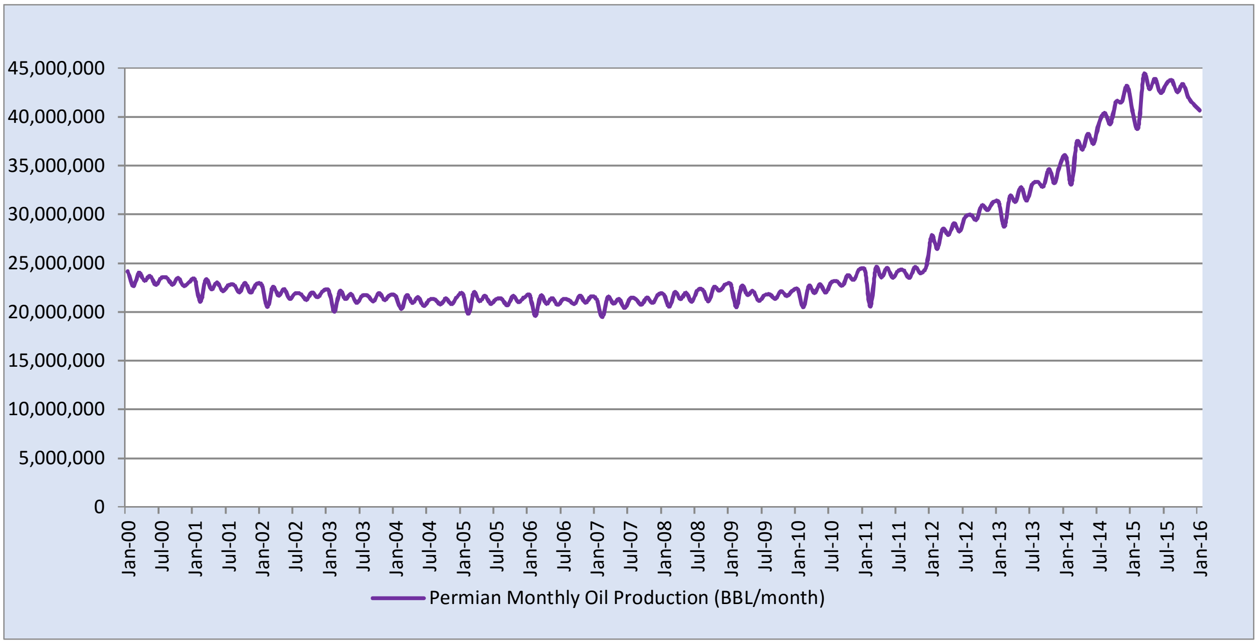
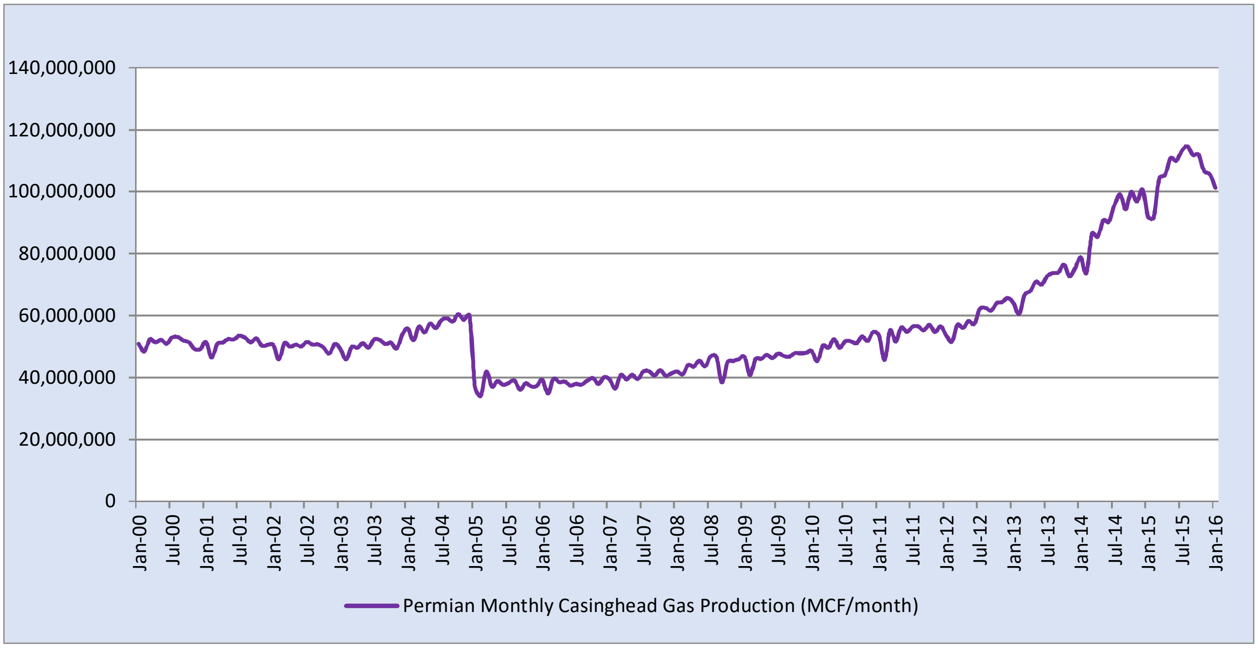


Figure A-13. Permian Basin, Gas Production 2000 - 2016



A.3 Gas and Oil Play Production and Commodity Prices

Natural Gas Prices

The price of natural gas peaked at over $12 per MCF in 2005 and again in 2008, then declined to below $5 per MCF in 2009 and is currently below $2 per MCF. Natural gas production in the Barnett Shale peaked in 2012, but has steadily declined since that time. Although drilling activity is sensitive to commodity prices, wells already in production remain in production which results in a lag between a drop in commodity prices and a drop in production. Natural gas production in the Eagle Ford Shale remained constant through about 2012, but increased rapidly between 2012 and 2015. Many new wells were brought into production during this time due to the high price of oil and the fact that the Eagle Ford Shale produces both oil and gas (see Figures A-14 and A-17). The same scenario occurred with casinghead gas production in the Permian Basin between 2012 and 2015 (see Figure A-15).

Figure A-14. Gas Well Gas Production and Commodity Prices

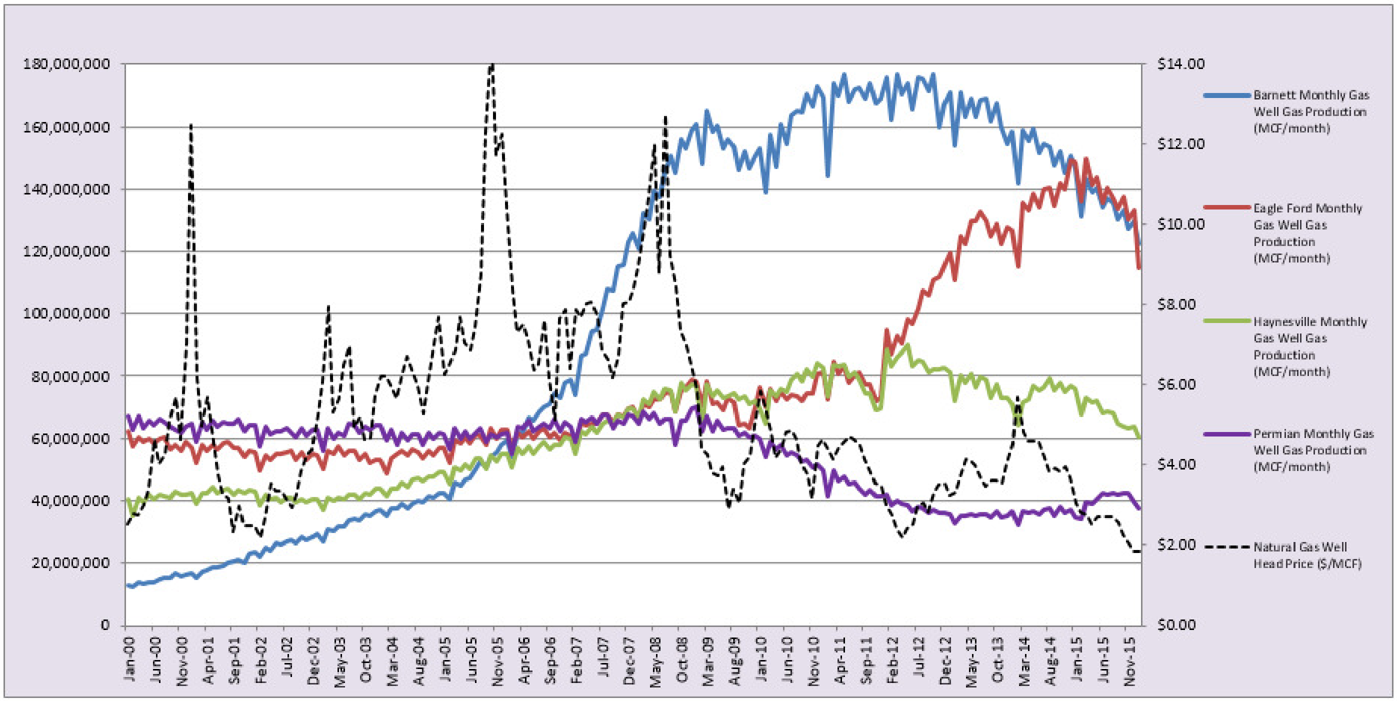
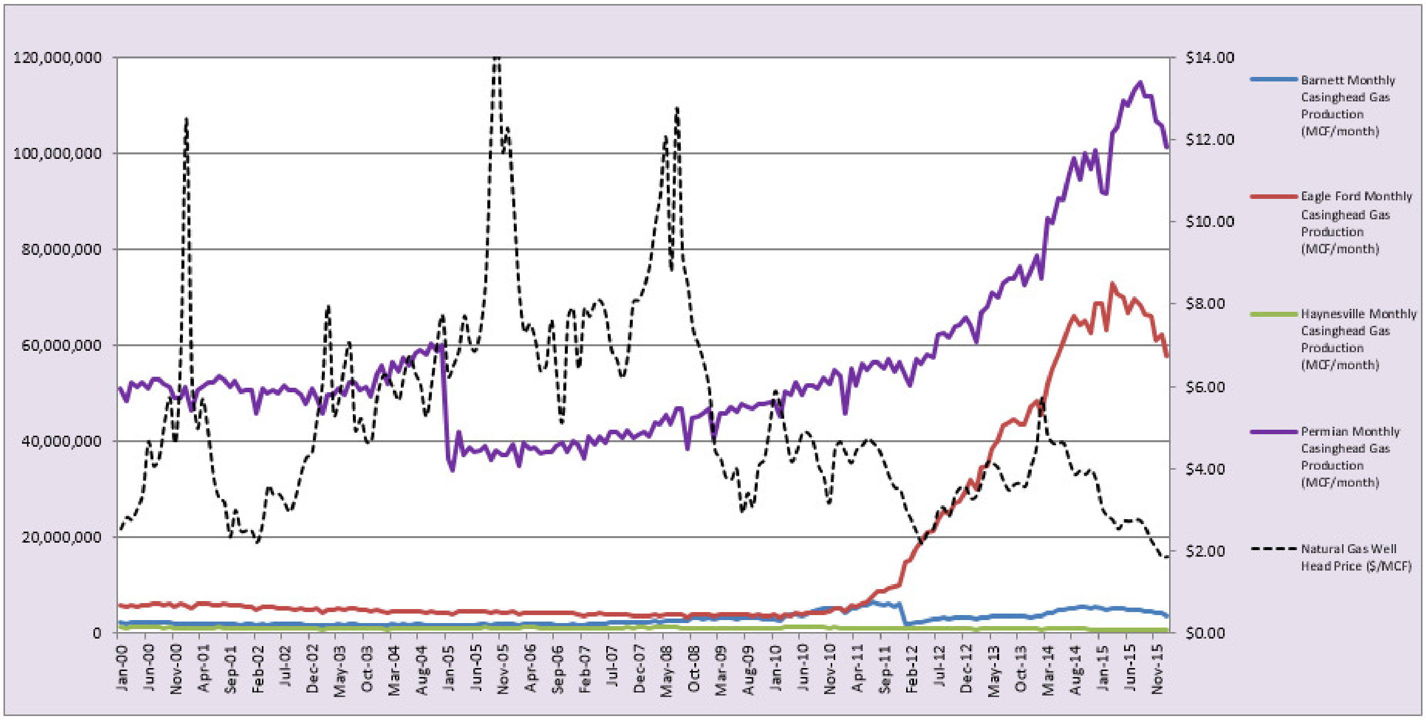


Figure A-15. Casinghead Gas Production and Commodity Prices



Oil Prices

The price of oil peaked in 2008 at over $130 per barrel before falling to approximately $40 per barrel in 2009. From there, the price trend for oil diverged from that for natural gas as prices slowly climbed back to over $100 per barrel in 2011 and remained elevated for several years before beginning to drop dramatically in late 2014 to a low of under $40 per barrel in late 2015. Prices have recently rebounded to nearly $50 per barrel. Oil and condensate production in the Eagle Ford Shale and the Permian Basin began to pick up in early 2011 following the steady price increases in oil, and the introduction of hydraulic fracturing in these areas. As with natural gas, there was a lag between the beginning of a drop in oil prices in 2014 and when peak production occurred in 2015. Liquids production has dropped in the last year, most notably in the Eagle Ford Shale where condensate production has dropped by approximately 25 percent.

See Figures A-16 and A-17 for oil and condensate production over time relative to oil prices.

Figure A-16. Oil Production and Commodity Prices

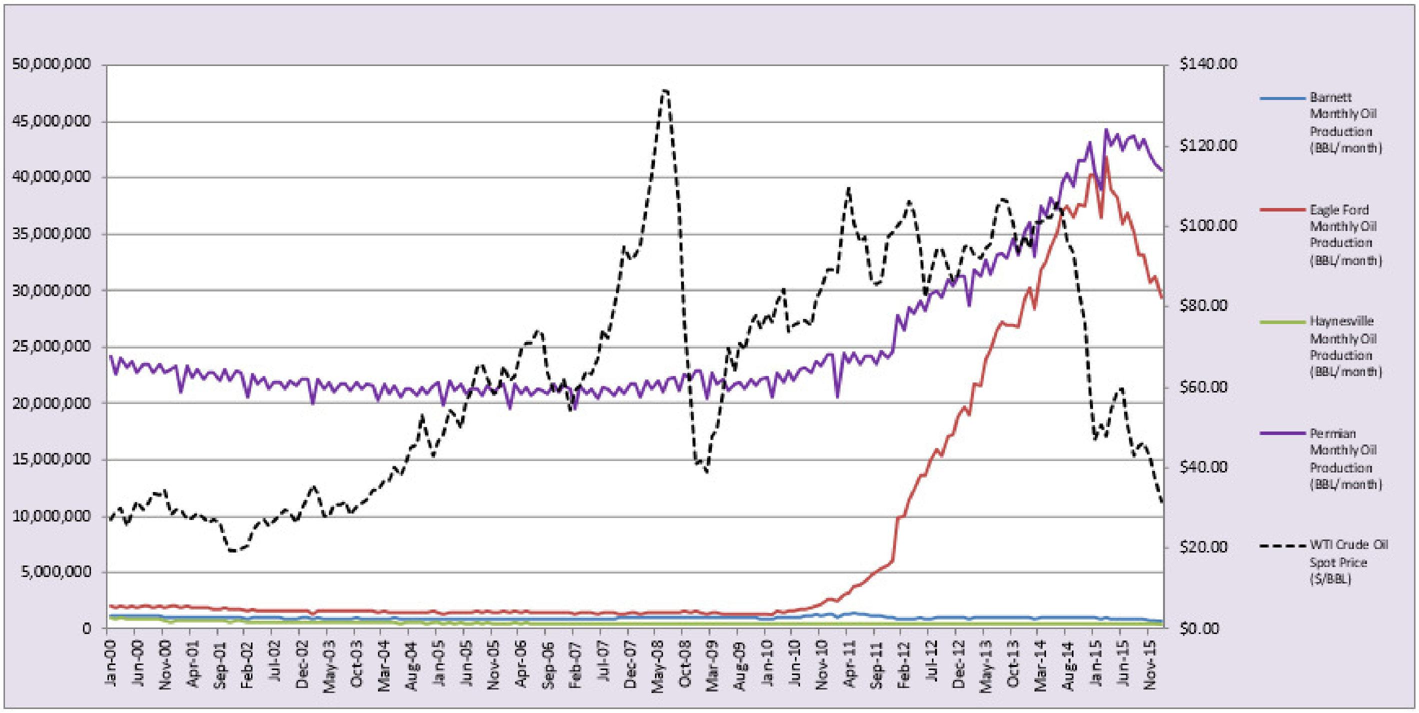
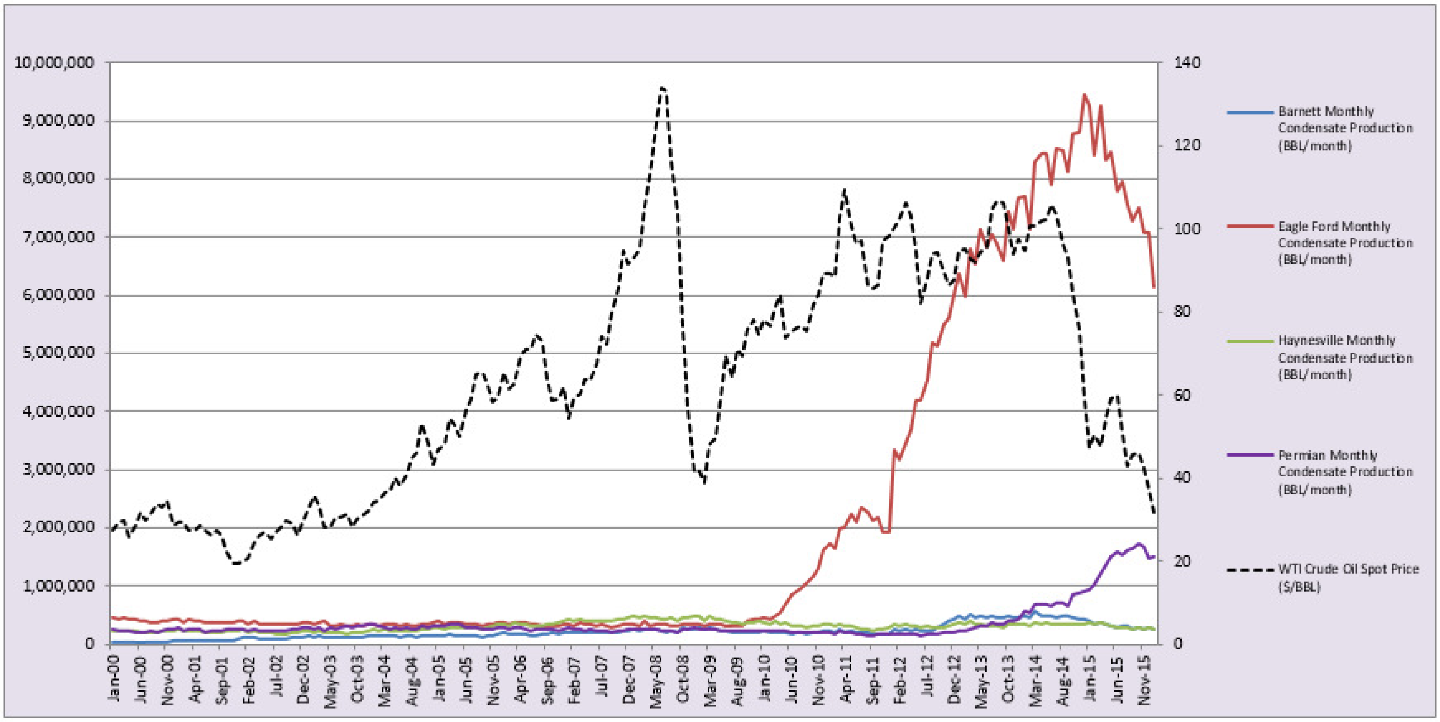


Figure A-17. Condensate Production and Commodity Prices



A.4 Future Production Scenario Methodology

ERG used Hubbert's Method to forecast future production. Cumulative production of oil, natural gas, and condensate were calculated for each play region based on the historical monthly production data from 2000 through 2014 obtained from the RRC. Hubbert's Method was then used to model historic cumulative production and to project cumulative and annual production for oil, natural gas, and condensate from the four Texas oil and gas play regions.

Attempts at calculating depletion times for oil reserves have been made since the early twentieth century (Brandt, 2010). Furthermore, these methods evolved from predicting well or field-level production using exponential or hyperbolic decline curves to predicting production at larger regional and global scales using statistical and curve-fitting methods.

One of the most well-known and simplest curve fitting models is Hubbert's logistic model. Hubbert published his model in 1956 (Hubbert, 1956) but did not provide a full derivation until 1980 (Hubbert, 1980). Brandt classifies Hubbert's model as hypothetical and physically-based and argues that, as a curve-fitting model, it is useful for first order production projections. The model is based on certain simplifying assumptions, as noted by Brandt:

- Yearly production is modeled as the first derivative of the logistic function;

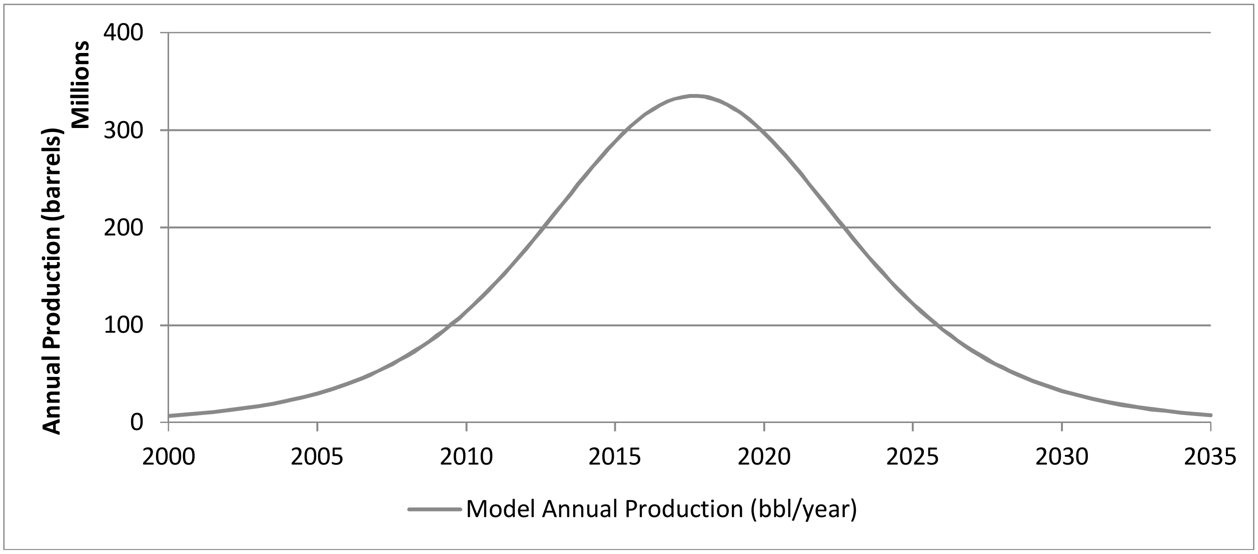
- The production profile is symmetric;
- There is a time lag where production follows discovery; and
- Production follows a single cycle; increasing and decreasing with a single peak.

Despite the assumptions and simple nature of the model, production profiles in various areas have been successfully modeled using the Hubbert logistic model (Clark, 2011). However, the model does not account for various economic, political, or other factors or conditions that may affect production but instead is based on historic cumulative production and estimates of ultimately recoverable resources. Multi-cycle Hubbert models can be used to account for various changes in conditions that affect production, as Clark has demonstrated for the Barnett Shale play by matching historical production in the Barnett Shale to a multi-cycle Hubbert model based on three cycles: one for original production in the region during the first decade, a second beginning in 2004 with the advent of horizontal drilling and an increase in natural gas prices, and a third cycle beginning in 2010 when natural gas prices again achieved another short term peak.

In using Hubbert's model to project future production levels for each of the four regions, ERG used historical production data for the region, changes in production rates due to the size of reserves and estimated ultimate recovery with a capped limit based on an estimate of the size of the reserves. There is a great amount of uncertainty in reserve estimates and published Technically Recoverable Resources (TRR) values. These values continue to change over time due to new discoveries, advances in technology, and changes in estimation methods.

The Hubbert model accounts for estimated maximum cumulative production based on the estimate of reserves. The gradual leveling of total cumulative production as resources near depletion is reflected in the production rate curve when the cumulative production curve is differentiated. The result is a clear peak in the annual production curve indicating when maximum annual production is estimated to occur. For emissions modeling and estimation purposes, this peak would also correspond to the period of peak emissions resulting from production activities. A typical Hubbert's model production rate curve is shown in Figure A-18. The height of the production peak and length of time to depletion are dependent upon the size of the reserve and the rate of extraction.

Figure A-18. Typical Hubbert's Model Production Rate Curve



As shown in Figure A-1, the production of oil and natural gas in Texas can each be imagined as two Hubbert's model production curves separated in time. The sum of the two production curves equals the total statewide production. The first set of curves, with their peaks in 1972, were produced with conventional drilling and extraction technology. The second set of curves represents the oil and gas that are being extracted with advanced drilling and extraction techniques (e.g., horizontal drilling and hydraulic fracturing). The oil and gas reserves that were tapped with conventional techniques are still being extracted, and these wells and formations continue to produce at low levels. The oil and gas reserves that have been tapped since approximately 2001 using advanced drilling and extraction techniques represent new reserves that were not previously recoverable using the older conventional techniques.

In modeling the production growth rates for each of the four regions, it is important to account for both the old and new reserves. Their size is different and their rates of production are different. Since total annual production is aggregated at the county level and production is not distinguished based on formation, drilling technique, or year of first production, the production figures used for modeling represent total production. However, the production growth rate modeling is heavily influenced by the production of new reserves. Data suggest that these reserves are being produced at a faster rate, and that the growth and decline of production will occur in a shorted time period.

The Hubbert model for cumulative production is a logistic growth function:

$$Q(t) = \frac{Q_\infty}{1 + N_o e^{-a(t-t_o)}}$$

Where:
$Q(t)$ = total cumulative production in year t;
Q_∞ = estimated ultimate recovery (EUR) or ultimately recoverable resources (URR);
N_o = $\frac{(Q_\infty - Q_o)}{Q_o}$ (where Q_o = cumulative production in base year 2014);
a = model parameter;
t = year; and
t_o = base year (2014).

Taking the derivative of the above equation results in an equation for the production rate (*P(t)*):

$$P(t) = \frac{dQ}{dt} = \frac{aQ_\infty N_O e^{-a(t-t_o)}}{(1 + N_o e^{-a(t-t_o)})^2}$$

The parameters a and Q_∞ can be determined by plotting the ratio of production rate and cumulative production against cumulative production. Assuming the plot of those data can be fit to a linear function:

$$\frac{\frac{dQ}{dt}}{Q} = \frac{P(t)}{Q(t)} = -\frac{a}{Q_\infty} Q + a$$

The parameter a can be determined from the y-intercept of the line. The slope of the line is $-\frac{a}{Q_\infty}$, where $Q_\infty = slope/-a$. After plotting the above equation and making initial estimates for a and Q_∞, the model cumulative production equation was used to determine the goodness-of-fit to the actual cumulative production data using the initial estimates of a and Q_∞. Published EIA estimates of TRRs for Barnett, Haynesville, and Permian oil and condensate were not available and thus Q_∞ was estimated as a result of using the above linearization approach. Published estimates of TRR from the EIA were available for: Eagle Ford Shale oil, condensate, and natural gas; and Barnett Shale natural gas and are presented in Table A-9 (EIA, 2015a).

Table A-9. EIA Oil and Natural Gas TRR Data for the Texas Shale Plays

	Barnett	**Eagle Ford**
Natural Gas TRR (TCF)	24.3	23.7

Oil TRR (BBO)	Not Available	5.17

For those regions and products where published estimates of TRR were available from the EIA, Q_∞ was calculated using the following equation:

$$Q_\infty = Q(t) + (TRR)\left(1 + \frac{GR_p}{100}\right)$$

Where:

TRR = technically recoverable resources (as of 2014); and
GR_p = overall growth rate (2014 through 2050) of TRR for product p, %.

TRR estimates change over time largely due to advances in technology or resource estimation methods. EIA data on end of year reserves growth rates from 2010 through 2040 for both lower 48 oil reserves and lower 48 natural gas reserves under the high TRR assumption (i.e., 1.6 percent and 0.6 percent for oil and gas, respectively) were used as surrogates for oil and gas TRR growth rates (EIA, 2015a). It was assumed that the overall TRR growth rate for 2010 through 2040 would be the same for 2014 through 2050. The calculated Q_∞ just described was used in the model cumulative production and model annual production equations for Eagle Ford oil, condensate, and natural gas; and Barnett natural gas instead of the estimated Q_∞ determined using the linearization approach.

In all cases, after Q_∞ was estimated (either by linearization or calculated using the published TRR), the a parameters were adjusted such that the modeled annual cumulative production in 2014 matched the actual cumulative production in 2014.

A.5 Results

The results of the growth factor development for the four oil and gas play regions using Hubbert's method are presented in this section.

Barnett Shale Play

Model development using Hubbert's method for the Barnett Shale play region resulted in the models for cumulative production and annual production as shown in Table A-10.

Table A-10. Hubbert's Method Production Models for Barnett Shale Play Region

Product	Cumulative Production	Annual Production

Oil	$Q_{Oil,B}(barrels) = \frac{276{,}824{,}257}{1 + (19.25)e^{-0.2569(t-2014)}}$	$P(t)_{Oil,B}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,B} = \frac{(0.2569)(276{,}824{,}257)(19.25)e^{-0.2569(t-2014)}}{(1 + (19.25)e^{-0.2569(t-2014)})^2}$
Gas	$Q_{G,B}(MCF) = \frac{41{,}929{,}072{,}190}{1 + (239.27)e^{-0.3673(t-2014)}}$	$P(t)_{G,B-3}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,B} = \frac{(0.3673)(41{,}929{,}072{,}190)(239.27)e^{-0.3673(t-2014)}}{(1 + (239.27)e^{-0.3673(t-2014)})^2}$
Condensate	$Q_{C,B}(barrels) = \frac{78{,}159{,}054}{1 + (163.84)e^{-0.3585(t-2014)}}$	$P(t)_{C,B}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,B} = \frac{(0.3585)(78{,}159{,}054)(163.84)e^{-0.3585(t)}}{(1 + (163.84)e^{-0.3585(t-2014)})^2}$

The estimated model parameters for the Barnett Shale play region are summarized in Table A-11.

Table A-11. Summary of Hubbert's Method Production Model Parameters for Barnett Shale Play Region

Product	Q_∞	A	N_o
Oil	276,824,257	0.2569	19.25
Gas	41,929,072,190	0.3673	239.27
Condensate	78,159,054	0.3585	163.84

Figures A-19 and A-20 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-21 and A-22 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-23 and A-24 present actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-19. Hubbert's Model Fit to Historic Oil Production from the Barnett Shale Play Region (2000-2014)

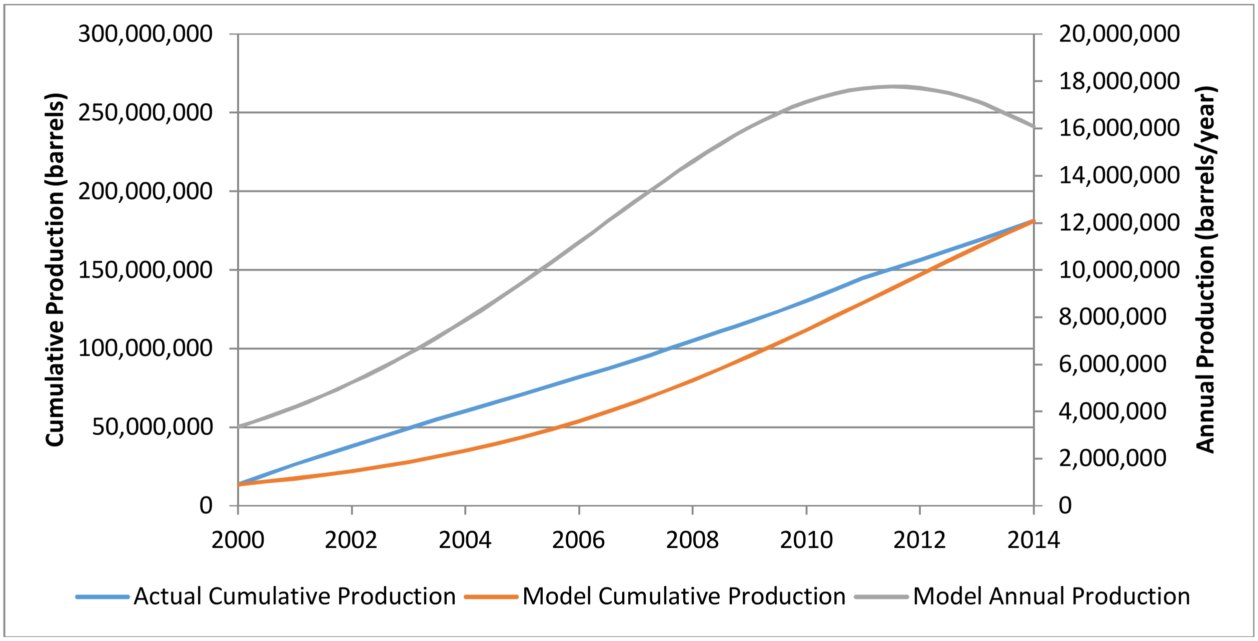


Figure A-20. Hubbert's Model Projected Cumulative and Annual Oil Production from the Barnett Shale Play Region (2015-2050)

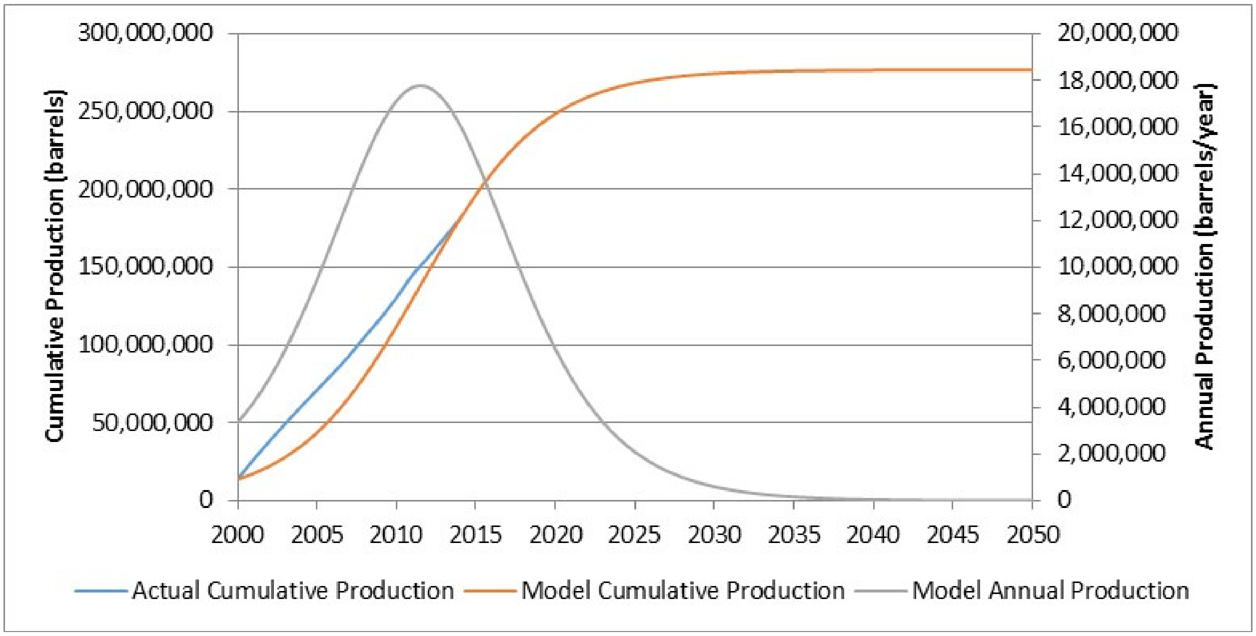


Figure A-21. Hubbert's Model Fit to Historic Natural Gas Production from the Barnett Shale Play Region (2000-2014)

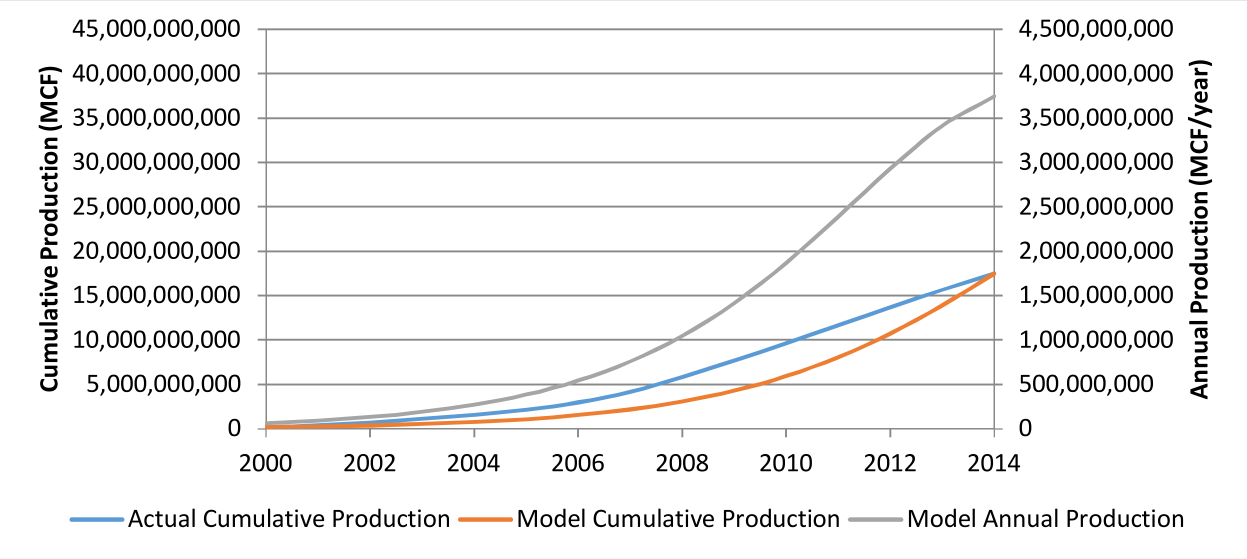


Figure A-22. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Barnett Shale Play Region (2015-2050)

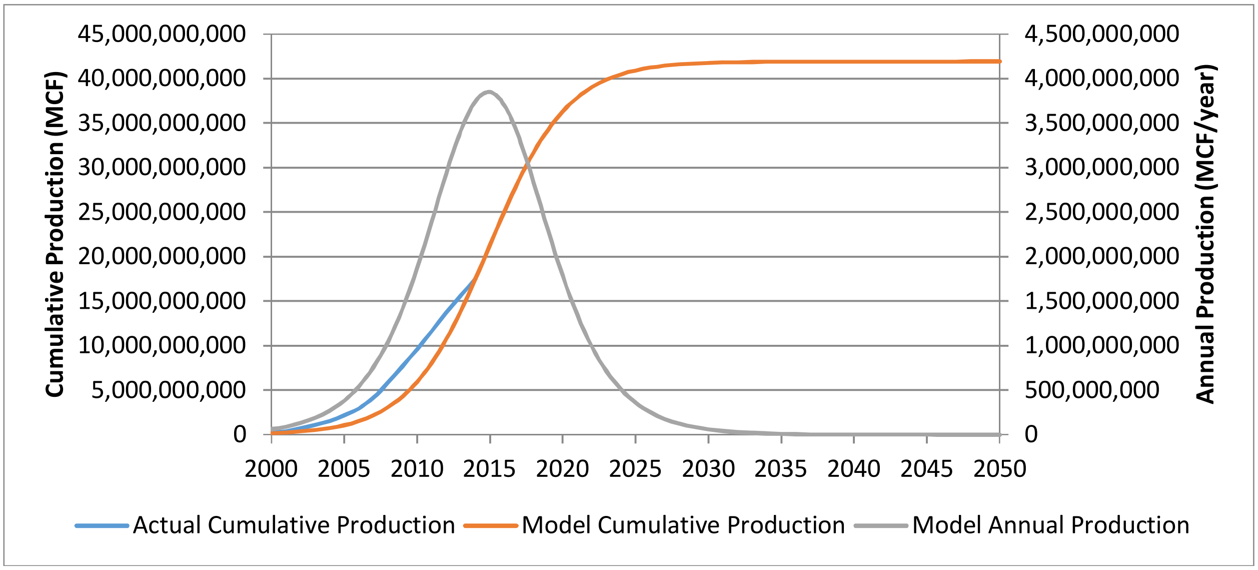


Figure A-23. Hubbert's Model Fit to Historic Condensate Production from the Barnett Shale Play Region (2000-2014)

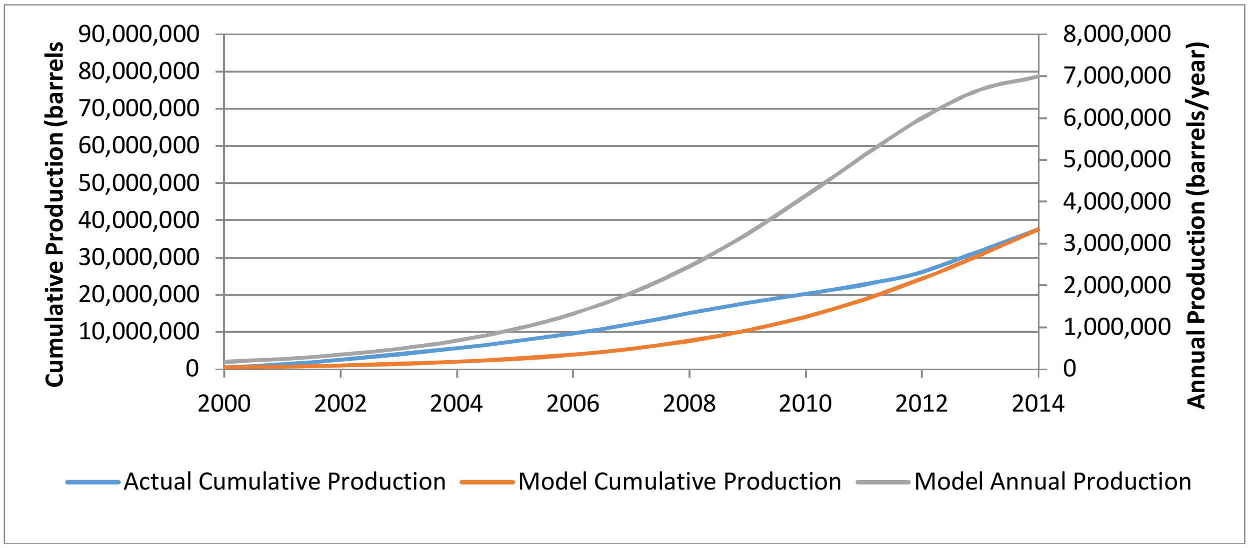
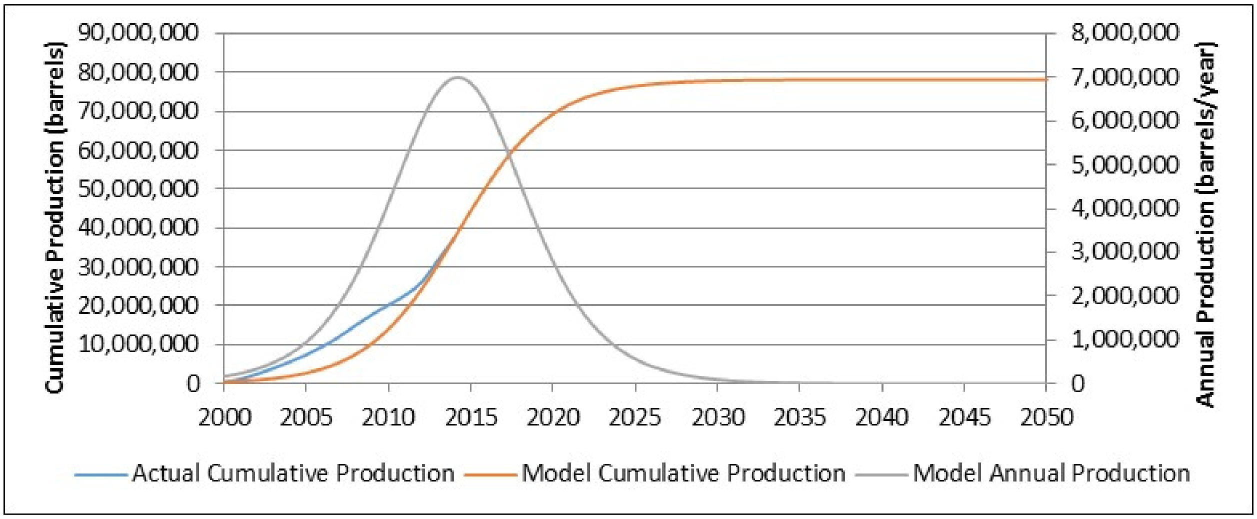


Figure A-24. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Barnett Shale Play Region (2015-2050)



A summary of the annual growth factors calculated for the Barnett Shale play region is presented in Table A-12.

Table A-12. Barnett Shale Growth Factors

Year	Oil	Gas	Condensate
2015	0.910	1.028	0.982
2016	0.806	0.988	0.906
2017	0.698	0.891	0.789
2018	0.591	0.758	0.653
2019	0.492	0.613	0.519
2020	0.403	0.476	0.398
2021	0.327	0.359	0.298
2022	0.262	0.264	0.219
2023	0.209	0.191	0.158
2024	0.165	0.136	0.113
2025	0.130	0.096	0.081
2026	0.102	0.068	0.057
2027	0.080	0.047	0.040
2028	0.062	0.033	0.028
2029	0.048	0.023	0.020
2030	0.038	0.016	0.014
2031	0.029	0.011	0.010
2032	0.023	0.008	0.007
2033	0.018	0.005	0.005
2034	0.014	0.004	0.003

Table A-12. Barnett Shale Growth Factors

Year	Oil	Gas	Condensate
2035	0.011	0.003	0.002
2036	0.008	0.002	0.002
2037	0.006	0.001	0.001
2038	0.005	0.001	0.001
2039	0.004	0.001	0.001
2040	0.00293	0.00041	0.00039
2041	0.00226	0.00028	0.00027
2042	0.00175	0.00020	0.00019
2043	0.00135	0.00014	0.00013
2044	0.00105	0.00009	0.00009
2045	0.00081	0.00007	0.00006
2046	0.00063	0.00005	0.00005
2047	0.00048	0.00003	0.00003
2048	0.00038	0.00002	0.00002
2049	0.00029	0.00002	0.00002
2050	0.00022	0.00001	0.00001

Eagle Ford Shale Play

Model development using Hubbert's Method for the Eagle Ford Shale play region resulted in the models for cumulative production and annual production as shown in Table A-13.

Table A-13. Hubbert's Method Production Models for Eagle Ford Shale Play Region

Product	Cumulative Production	Annual Production
Oil	$Q_{Oil,EF}(barrels) = \frac{4{,}517{,}942{,}672}{1+(188.27)e^{-0.2969(t-2014)}}$	$P(t)_{Oil,EF}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,EF} = \frac{(0.2969)(4{,}517{,}942{,}672)(188.27)e^{-0.2969(t-2014)}}{(1+(188.27)e^{-0.2969(t-2014)})^2}$
Gas	$Q_{G,EF}(MCF) = \frac{37{,}300{,}431{,}977}{1+(51.76)e^{-0.2411(t-2014)}}$	$P(t)_{G,EF}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,EF} = \frac{(0.2411)(37{,}300{,}431{,}977)(51.76)e^{-0.2411(t-2014)}}{(1+(51.76)e^{-0.2411(t-2014)})^2}$
Condensate	$Q_{C,EF}(barrels) = \frac{1{,}310{,}172{,}866}{1+(262.55)e^{-0.3156(t-2014)}}$	$P(t)_{C,EF}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,EF} = \frac{(0.3156)(1{,}310{,}172{,}866)(262.55)e^{-0.3156(t-2014)}}{(1+(262.55)e^{-0.3156(t-2014)})^2}$

The estimated model parameters for the Eagle Ford Shale play region are summarized in Table A-14.

Table A-14. Summary of Hubbert's Method Production Model Parameters for Eagle Ford Shale Play Region

Product	Q_∞	A	N_o
Oil	4,517,942,672	0.2969	188.27
Gas	37,300,431,977	0.2411	51.76
Condensate	1,310,172,866	0.3156	262.55

Figures A-25 and A-26 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-27 and A-28 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-29 and A-30 present actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-25. Hubbert's Model Fit to Historic Oil Production from the Eagle Ford Shale Play Region (2000-2014)

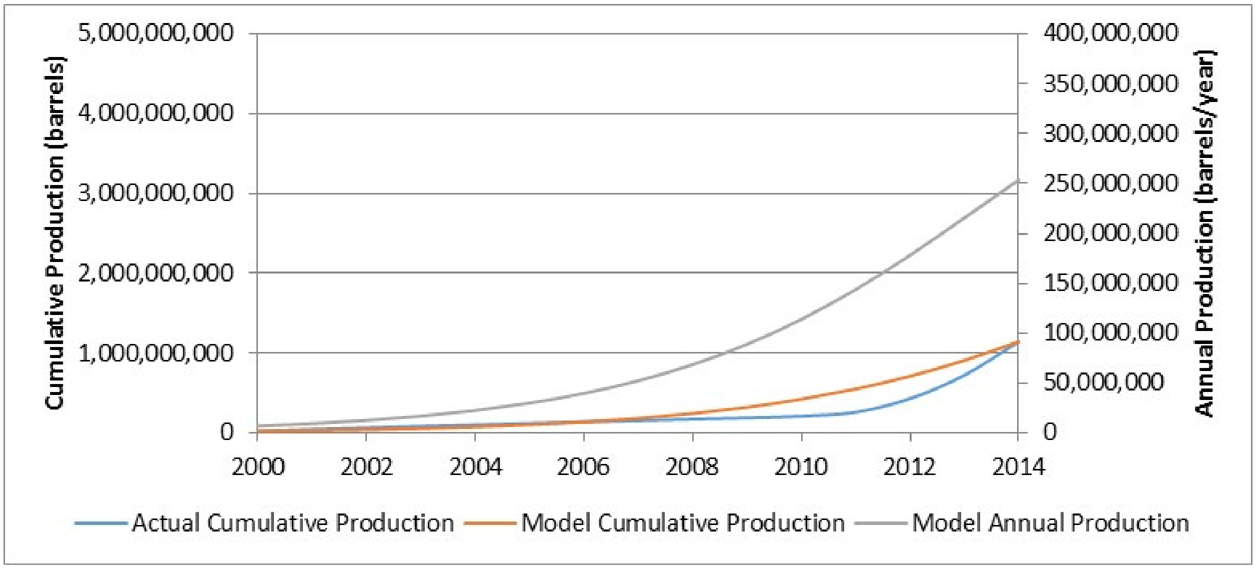


Figure A-26. Hubbert's Model Projected Cumulative and Annual Oil Production from the Eagle Ford Shale Play Region (2015-2050)

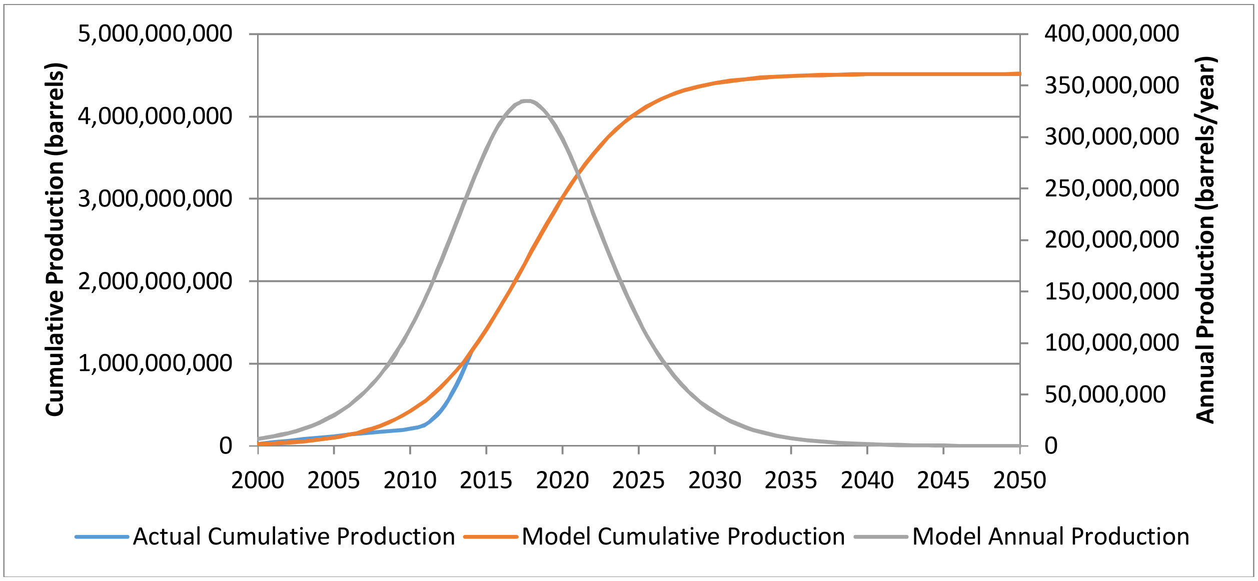


Figure A-27. Hubbert's Model Fit to Historic Natural Gas Production from the Eagle Ford Shale Play Region (2000-2014)

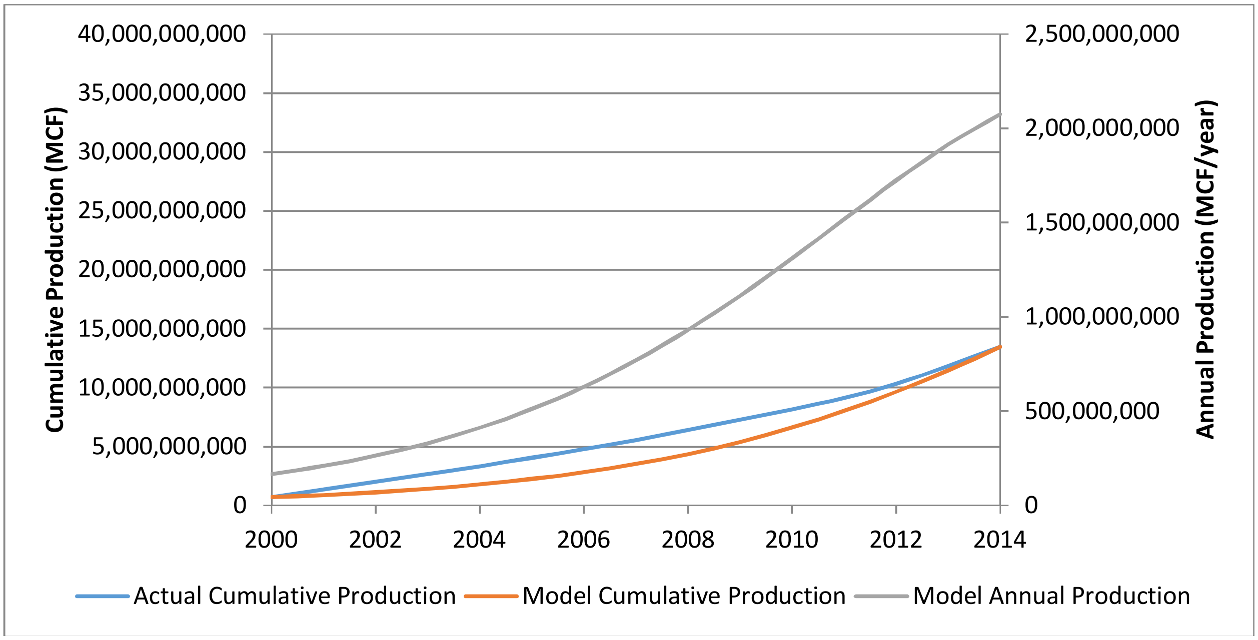


Figure A-28. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Eagle Ford Shale Play Region (2015-2050)

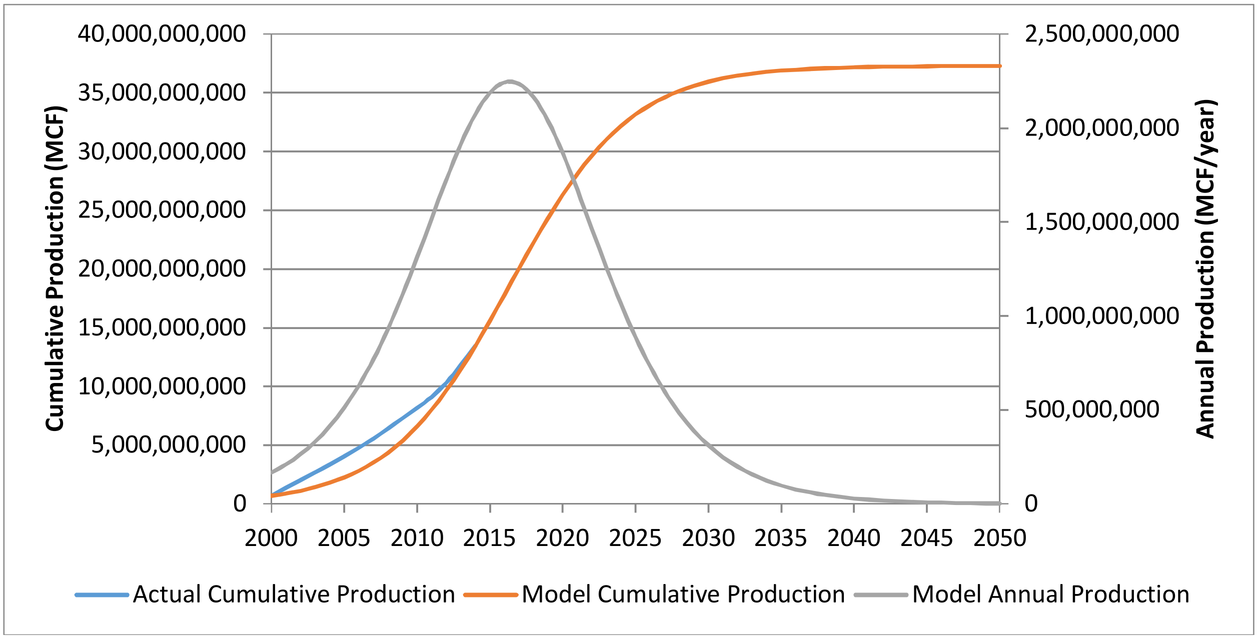


Figure A-29. Hubbert's Model Fit to Historic Condensate Production from the Eagle Ford Shale Play Region (2000-2014)

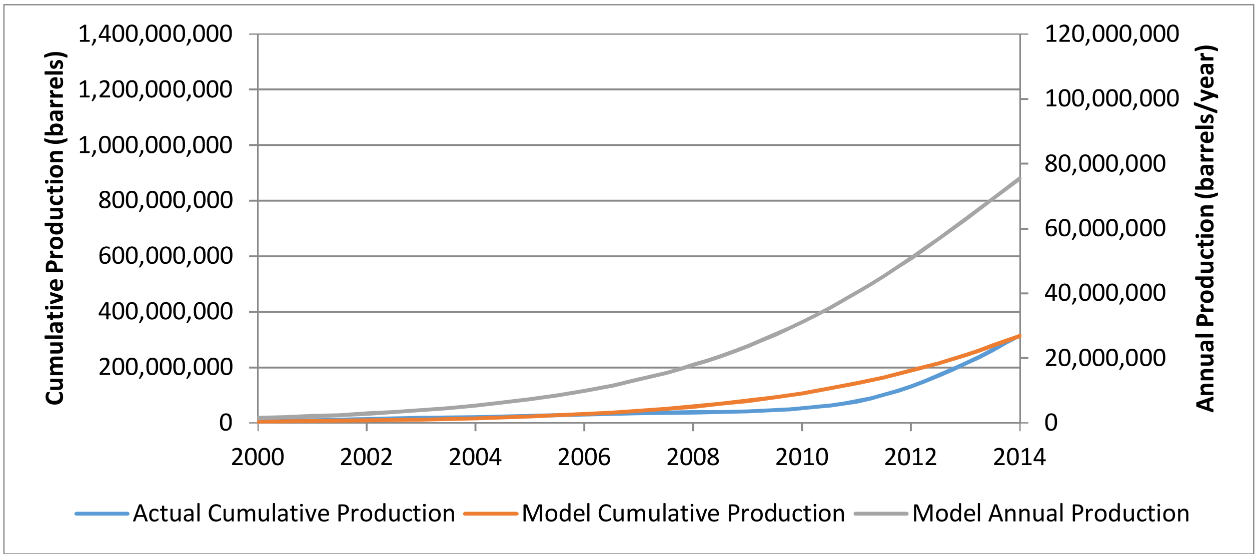
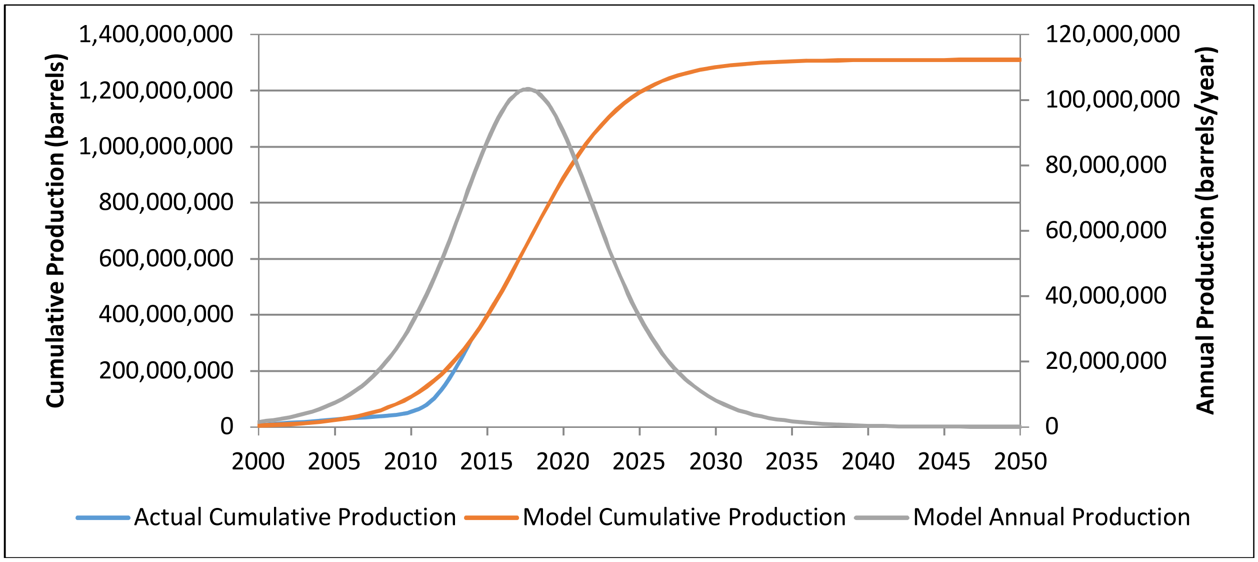


Figure A-30. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Eagle Ford Shale Play Region (2015-2050)



A summary of the annual growth factors calculated for the Eagle Ford Shale play region is presented in Table A-15.

Table A-15. Eagle Ford Shale Growth Factors

Year	Oil	Gas	Condensate
2015	1.138	1.055	1.156
2016	1.246	1.082	1.281
2017	1.310	1.078	1.356
2018	1.318	1.043	1.366
2019	1.269	0.982	1.310
2020	1.172	0.901	1.198
2021	1.041	0.806	1.049
2022	0.893	0.706	0.885
2023	0.743	0.607	0.722
2024	0.604	0.513	0.574
2025	0.481	0.428	0.447
2026	0.376	0.353	0.342
2027	0.291	0.288	0.259
2028	0.223	0.234	0.194
2029	0.170	0.188	0.144
2030	0.128	0.151	0.107
2031	0.096	0.120	0.079
2032	0.072	0.096	0.058
2033	0.054	0.076	0.043
2034	0.040	0.060	0.031
2035	0.030	0.048	0.023
2036	0.022	0.038	0.017
2037	0.017	0.030	0.012
2038	0.012	0.023	0.009
2039	0.009	0.018	0.006
2040	0.007	0.014	0.005
2041	0.005	0.011	0.003
2042	0.004	0.009	0.003
2043	0.003	0.007	0.002
2044	0.002	0.006	0.001
2045	0.002	0.004	0.001
2046	0.001	0.003	0.001
2047	0.001	0.003	0.001
2048	0.0006	0.0021	0.0004
2049	0.0005	0.0017	0.0003
2050	0.0004	0.0013	0.0002

Haynesville Shale Play

Model development under Hubbert's model for the Haynesville Shale play region resulted in the models for cumulative production and annual production as shown in Table A-16.

Table A-16. Hubbert's Method Production Models for Haynesville Shale Play Region

Product	Cumulative Production	Annual Production
Oil	$Q_{Oil,H}(barrels) = \frac{130{,}442{,}214}{1+(11.206)e^{-0.2438(t-2014)}}$	$P(t)_{Oil,H}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,H} = \frac{(0.2438)(130{,}442{,}214)(11.206)e^{-0.2438(t-2014)}}{(1+(11.206)e^{-0.2438(t-2014)})^2}$
Gas	$Q_{G,H}(MCF) = \frac{16{,}625{,}976{,}871}{1+(32.99)e^{-0.2980(t-2014)}}$	$P(t)_{G,H}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,H} = \frac{(0.2980)(16{,}625{,}976{,}871)(32.99)e^{-0.2980(t-2014)}}{(1+(32.99)e^{-0.2980(t-2014)})^2}$
Condensate	$Q_{C,H}(barrels) = \frac{69{,}988{,}261}{1+(25.19)e^{-0.3291(t-2014)}}$	$P(t)_{C,H}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,H} = \frac{(0.3291)(69{,}988{,}261)(25.19)e^{-0.3291(t-2014)}}{(1+(25.19)e^{-0.3291(t-2014)})^2}$

The estimated model parameters for the Haynesville Shale play region are summarized in Table A-17.

Table A-17. Summary of Hubbert's Method Production Model Parameters for Haynesville Shale Play Region

Product	Q_∞	A	N₀
Oil	130,442,214	0.2438	11.206
Gas	16,625,976,871	0.2980	32.99
Condensate	69,988,261	0.3291	25.19

Figures A-31 and A-32 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-33 and A-34 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-35 and A-36 present actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-31. Hubbert's Model Fit to Historic Oil Production from the Haynesville Shale Play Region (2000-2014)

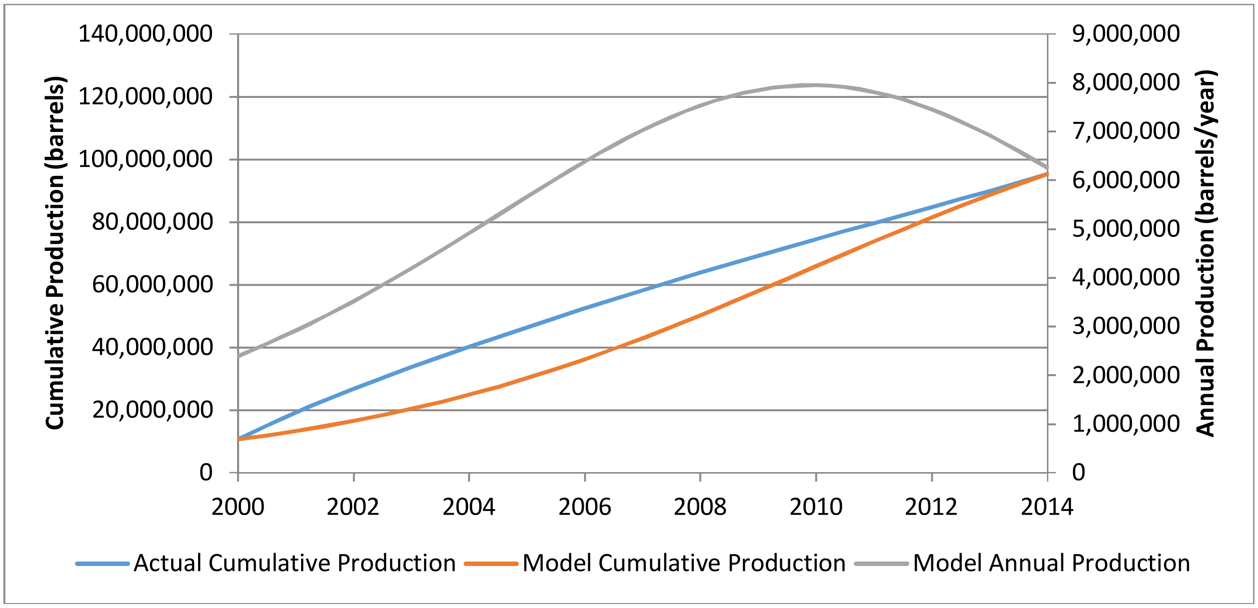


Figure A-32. Hubbert's Model Projected Cumulative and Annual Oil Production from the Haynesville Shale Play Region (2015-2050)

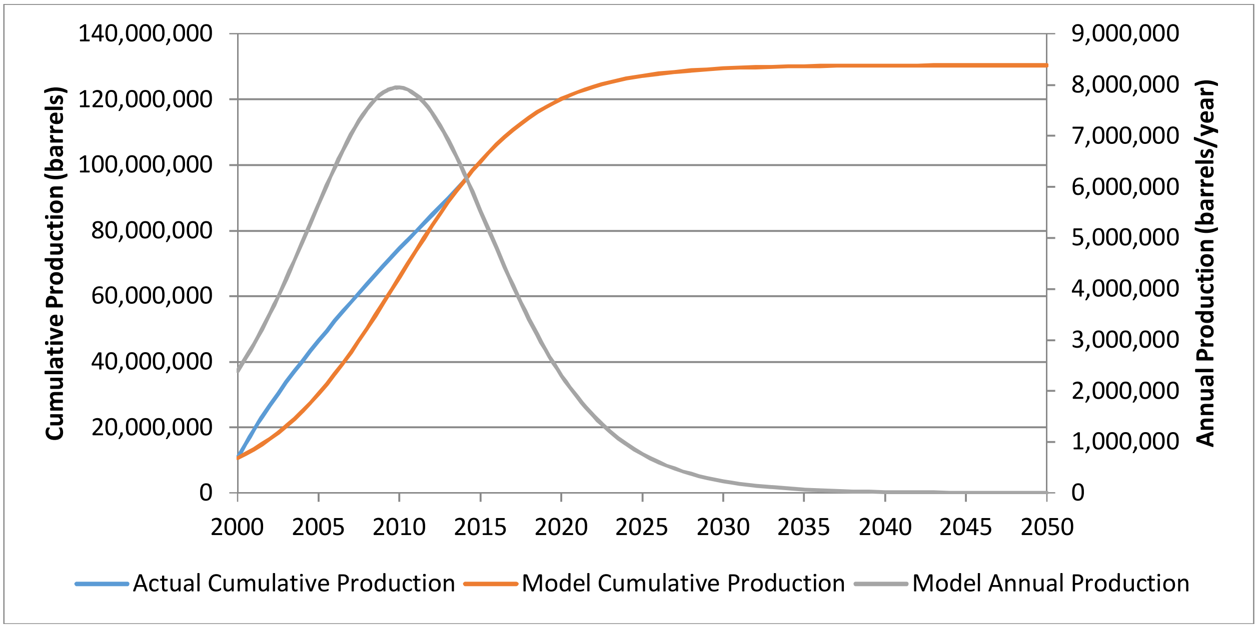


Figure A-33. Hubbert's Model Fit to Historic Natural Gas Production from the Haynesville Shale Play Region (2000-2014)

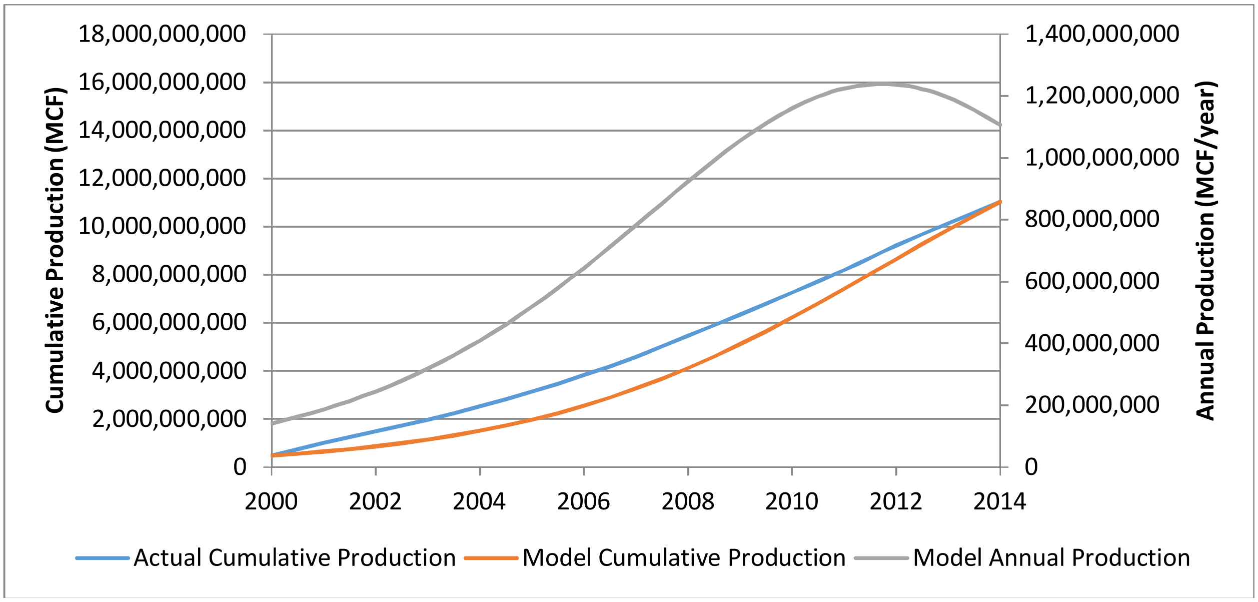


Figure A-34. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Haynesville Shale Play Region (2015-2050)

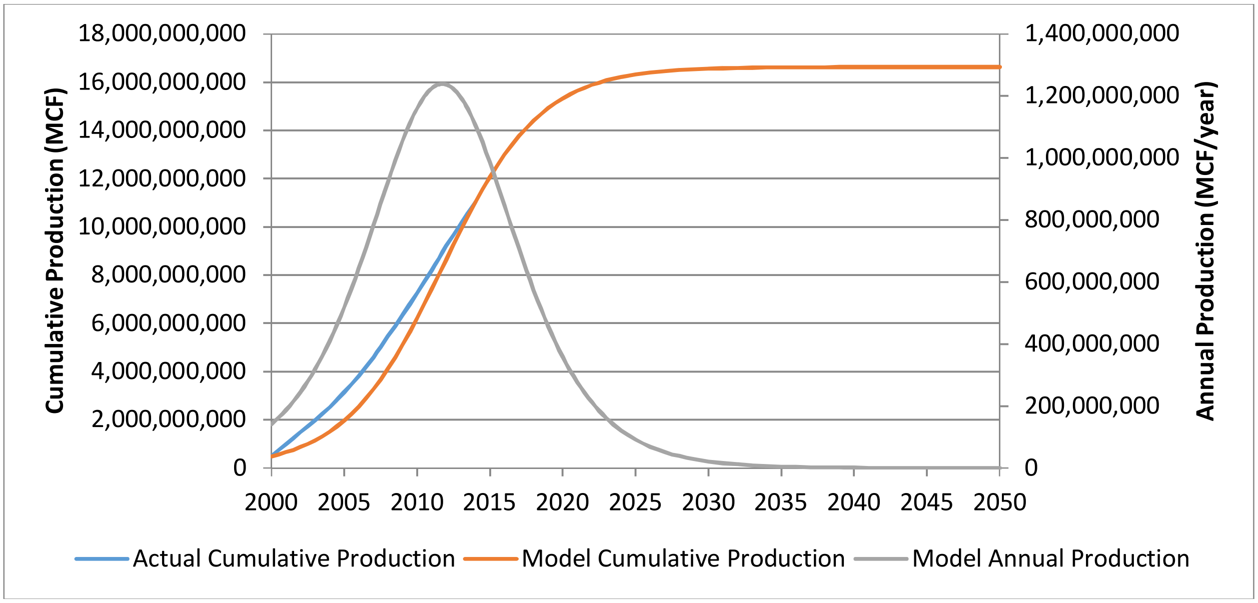


Figure A-35. Hubbert's Model Fit to Historic Condensate Production from the Haynesville Shale Play Region (2000-2014)

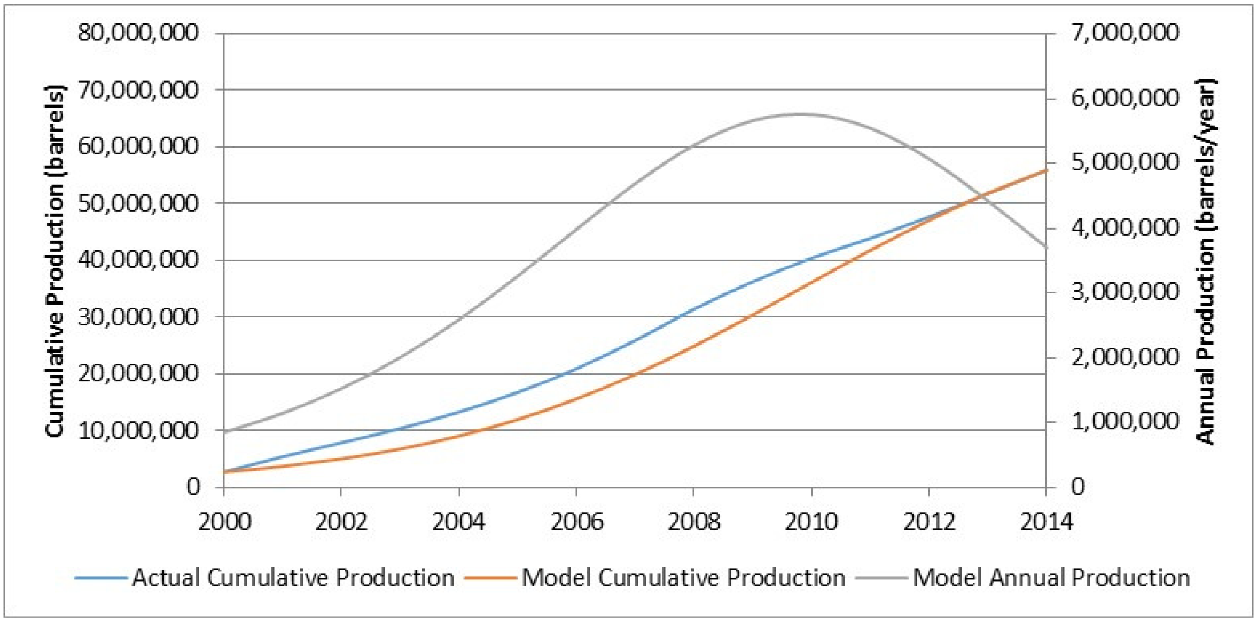
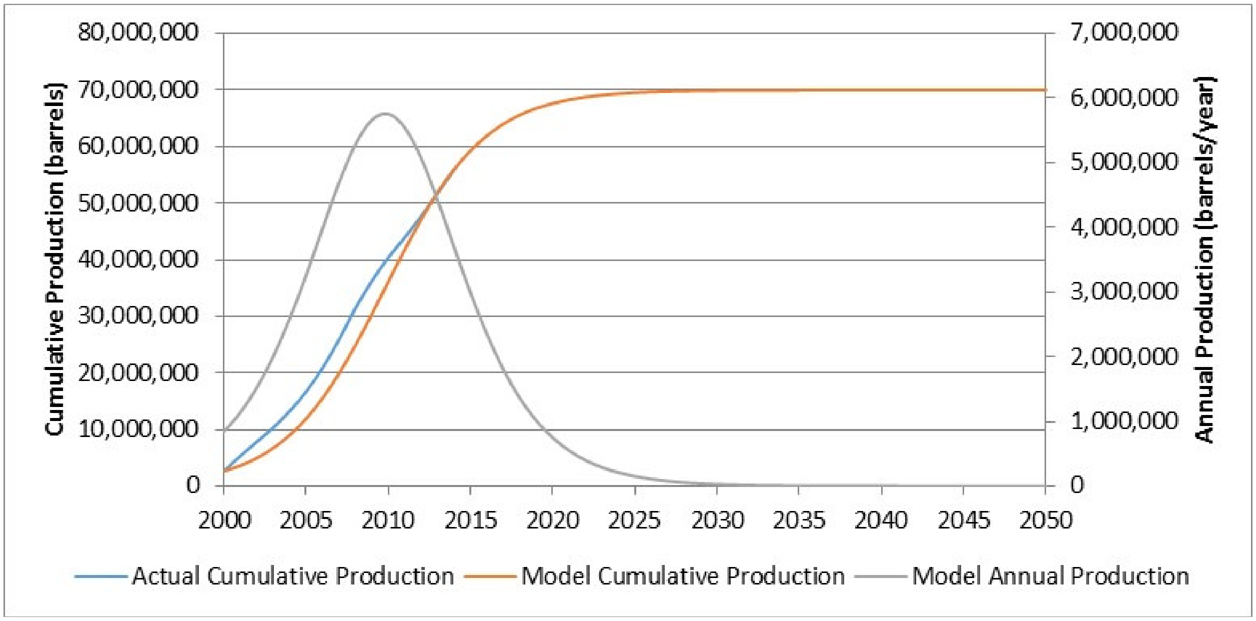


Figure A-36. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Haynesville Shale Play Region (2015-2050)



A summary of the annual growth factors calculated for the Haynesville Shale play region is presented in Table A-18.

Table A-18. Haynesville Shale Growth Factors

Year	Oil	Gas	Condensate
2015	0.884	0.890	0.808
2016	0.765	0.765	0.635
2017	0.651	0.638	0.488
2018	0.545	0.518	0.368
2019	0.450	0.413	0.275
2020	0.368	0.323	0.203
2021	0.299	0.250	0.149
2022	0.241	0.191	0.109
2023	0.193	0.145	0.079
2024	0.154	0.110	0.057
2025	0.122	0.083	0.041
2026	0.097	0.062	0.030
2027	0.076	0.046	0.022
2028	0.060	0.035	0.016
2029	0.047	0.026	0.011
2030	0.037	0.019	0.008
2031	0.029	0.014	0.006
2032	0.023	0.011	0.004
2033	0.018	0.008	0.003
2034	0.014	0.006	0.002
2035	0.011	0.004	0.002
2036	0.009	0.003	0.001
2037	0.007	0.002	0.001
2038	0.005	0.002	0.001
2039	0.0042	0.0013	0.0004
2040	0.0033	0.0010	0.0003
2041	0.0026	0.0007	0.0002
2042	0.0020	0.0005	0.0002
2043	0.0016	0.0004	0.0001
2044	0.0012	0.0003	0.0001
2045	0.0010	0.0002	0.0001
2046	0.00077	0.00016	0.00004
2047	0.00060	0.00012	0.00003
2048	0.00047	0.00009	0.00002
2049	0.00037	0.00007	0.00002
2050	0.00029	0.00005	0.00001

Permian Basin Play

Model development under Hubbert's Method for the Permian Basin oil play region resulted in the models for cumulative production and annual production as shown in Table A-19.

Table A-19. Hubbert's Method Production Models for Permian Basin Oil Play Region

Product	Cumulative Production	Annual Production
Oil	$Q_{Oil,P}(barrels) = \frac{12{,}798{,}311{,}130}{1+(44.778)e^{-0.2247(t-2014)}}$	$P(t)_{Oil,P}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{Oil,P} = \frac{(0.2247)(12{,}798{,}311{,}130)(44.778)e^{-0.2247(t-2014)}}{(1+(44.778)e^{-0.2247(t-2014)})^2}$
Gas	$Q_{G,P}(MCF) = \frac{11{,}564{,}077{,}230}{1+(13.94)e^{-0.3254(t-2014)}}$	$P(t)_{G,P}\left(\frac{MCF}{yr}\right) = \frac{dQ}{dt}_{G,P} = \frac{(0.3254)(11{,}564{,}077{,}230)(13.94)e^{-0.3254(t-2014)}}{(1+(13.94)e^{-0.3254(t-2014)})^2}$
Condensate	$Q_{C,P}(barrels) = \frac{123{,}940}{1+(25.11)e^{-0.4746(t-2014)}}$	$P(t)_{C,P}\left(\frac{barrels}{yr}\right) = \frac{dQ}{dt}_{C,P} = \frac{(0.4746)(123{,}940)(25.11)e^{-0.4746(t-2014)}}{(1+(25.11)e^{-0.4746(t-2014)})^2}$

The estimated model parameters for the Permian Basin oil play region are summarized in Table A-20.

Table A-20. Summary of Hubbert's Method Production Model Parameters for Permian Basin Oil Play Region

Product	Q_∞	a	N_o
Oil	12,798,311,130	0.2247	44.778
Gas	11,564,077,230	0.3254	13.94
Condensate	123,940	0.4746	25.11

Figures A-37 and A-38 present actual and modeled historic oil production, and projected oil production, respectively. Figures A-39 and A-40 present actual and modeled historic natural gas production, and projected natural gas production, respectively. Figures A-41 and A-42 present actual and modeled historic condensate production, and projected condensate production, respectively.

Figure A-37. Hubbert's Model Fit to Historic Oil Production from the Permian Basin Oil Play Region (2000-2014)

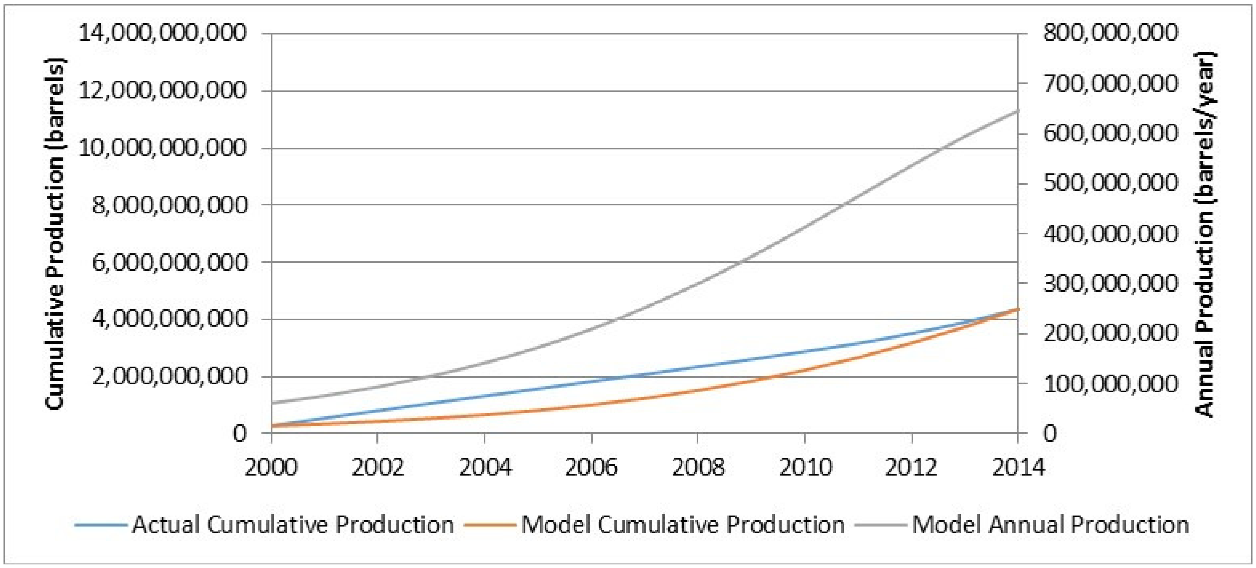


Figure A-38. Hubbert's Model Projected Cumulative and Annual Oil Production from the Permian Basin Oil Play Region (2015-2050)

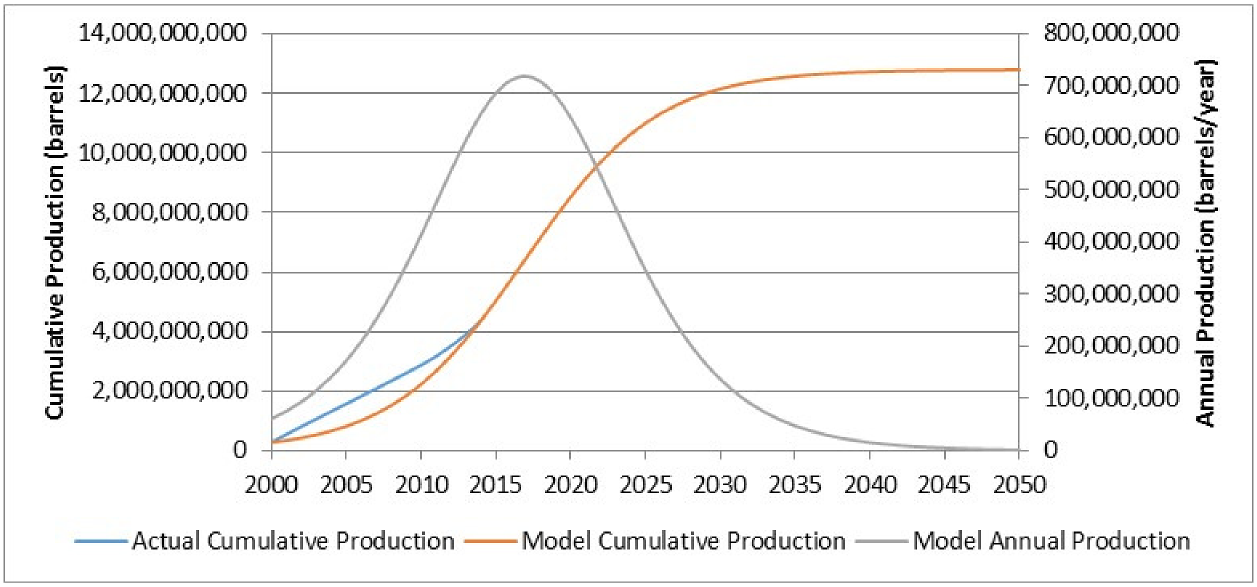


Figure A-39. Hubbert's Model Fit to Historic Natural Gas Production from the Permian Basin Oil Play Region (2000-2014)

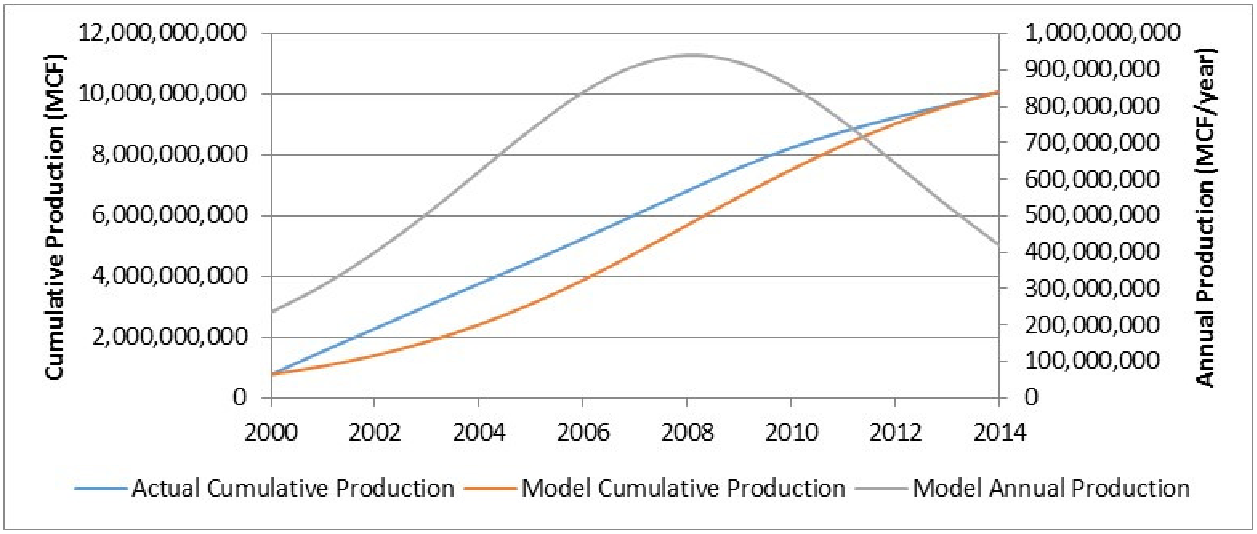


Figure A-40. Hubbert's Model Projected Cumulative and Annual Natural Gas Production from the Permian Basin Oil Play Region (2015-2050)

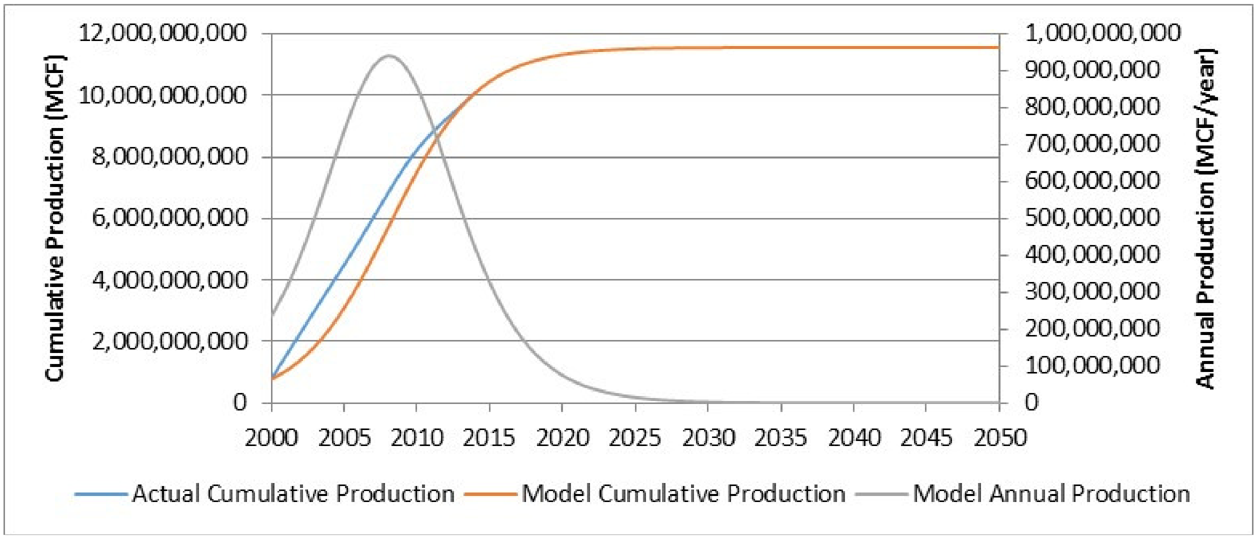


Figure A-41. Hubbert's Model Fit to Historic Condensate Production from the Permian Basin Oil Play Region (2000-2014)

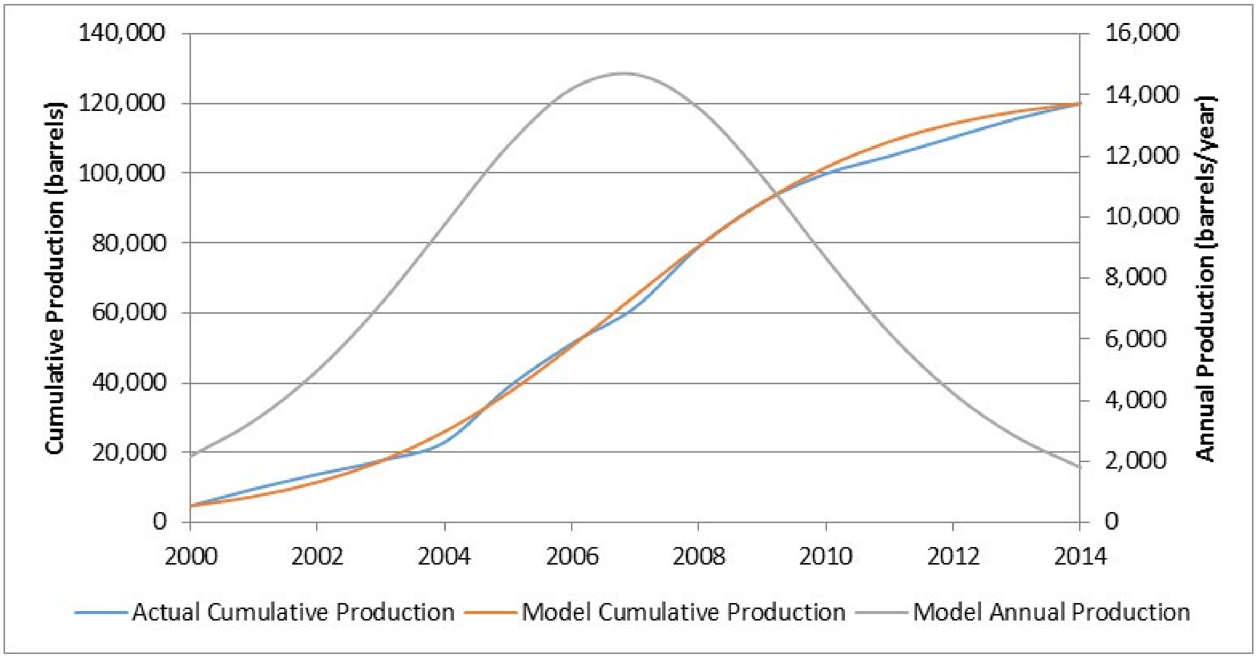
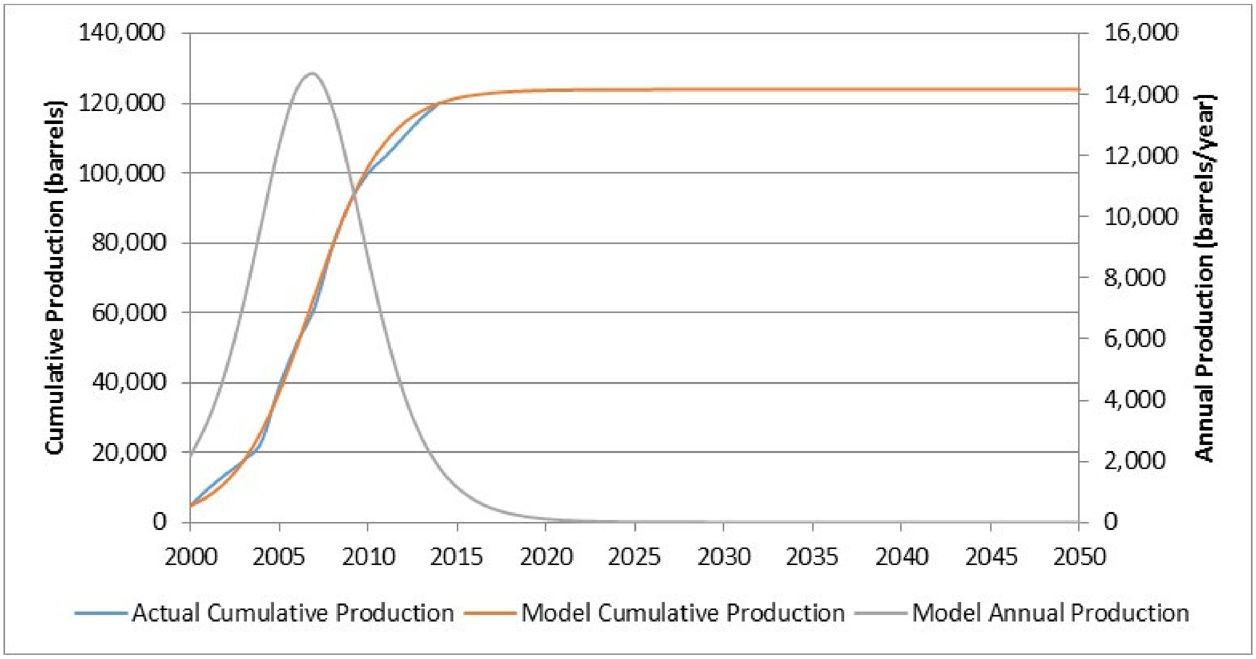


Figure A-42. Hubbert's Model Projected Cumulative and Annual Condensate Production from the Permian Basin Oil Play Region (2015-2050)



A summary of the annual growth factors calculated for the Permian Basin is presented in Table A-21.

Table A-21. Permian Basin Growth Factors

Year	Oil	Gas	Condensate
2015	1.061	0.776	0.637
2016	1.100	0.592	0.403
2017	1.112	0.445	0.253
2018	1.096	0.331	0.158
2019	1.053	0.244	0.099
2020	0.989	0.179	0.062
2021	0.908	0.131	0.038
2022	0.816	0.095	0.024
2023	0.720	0.069	0.015
2024	0.626	0.050	0.009
2025	0.536	0.036	0.006
2026	0.453	0.026	0.004
2027	0.379	0.019	0.002
2028	0.315	0.014	0.001
2029	0.259	0.010	0.001
2030	0.212	0.007	0.001
2031	1.73E-01	5.20E-03	3.34E-04
2032	1.41E-01	3.76E-03	2.08E-04
2033	1.14E-01	2.71E-03	1.29E-04
2034	9.19E-02	1.96E-03	8.05E-05
2035	7.40E-02	1.42E-03	5.01E-05
2036	5.95E-02	1.02E-03	3.12E-05
2037	4.78E-02	7.39E-04	1.94E-05
2038	3.84E-02	5.33E-04	1.21E-05
2039	3.08E-02	3.85E-04	7.50E-06
2040	2.46E-02	2.78E-04	4.67E-06
2041	1.97E-02	2.01E-04	2.90E-06
2042	1.58E-02	1.45E-04	1.81E-06
2043	1.26E-02	1.05E-04	1.12E-06
2044	1.01E-02	7.57E-05	6.99E-07
2045	8.07E-03	5.47E-05	4.35E-07
2046	6.45E-03	3.95E-05	2.71E-07
2047	5.16E-03	2.85E-05	1.68E-07
2048	4.12E-03	2.06E-05	1.05E-07
2049	3.29E-03	1.49E-05	6.52E-08
2050	2.63E-03	1.07E-05	4.05E-08

A.6 Conservative Baseline Assumptions

To provide a conservative estimate of emissions from oil and gas production activities in future years, an analysis was conducted to determine the lowest annual production of oil, gas, and condensate for the period 1993-2014 for each study area. This production level was then used as the minimum baseline of production activity in the future years.

To provide a conservative estimate of total well counts in future years, peak well counts were assumed to occur at the peak year of production, and then held constant for a four-year period before starting to decline in parallel to production decline. This assumption is based on historical gas well counts and gas production for the Barnett Shale and the Haynesville Shale, which have each already peaked in both gas production and gas well count. As shown in Figures A-43 and A-44 below, there was an approximate 4-year lag between peak gas production and peak gas well counts in the Barnett Shale; and gas well counts remained relatively constant for a period of 4 years in the Haynesville Shale after gas production peaked.

Figure A-43. Year of Peak Production and Peak Well Count: Barnett Shale

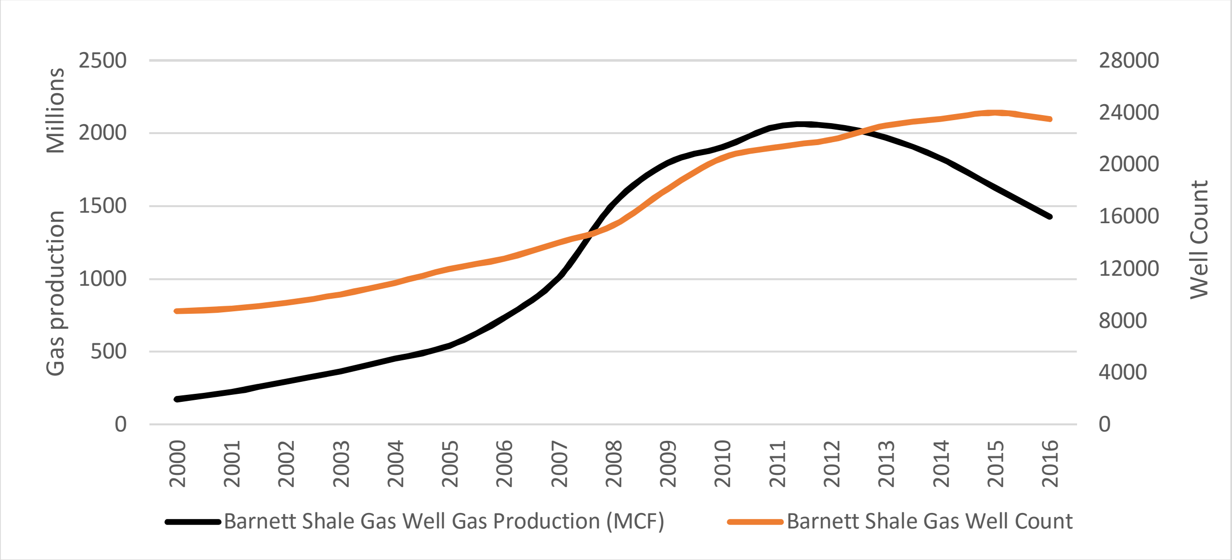
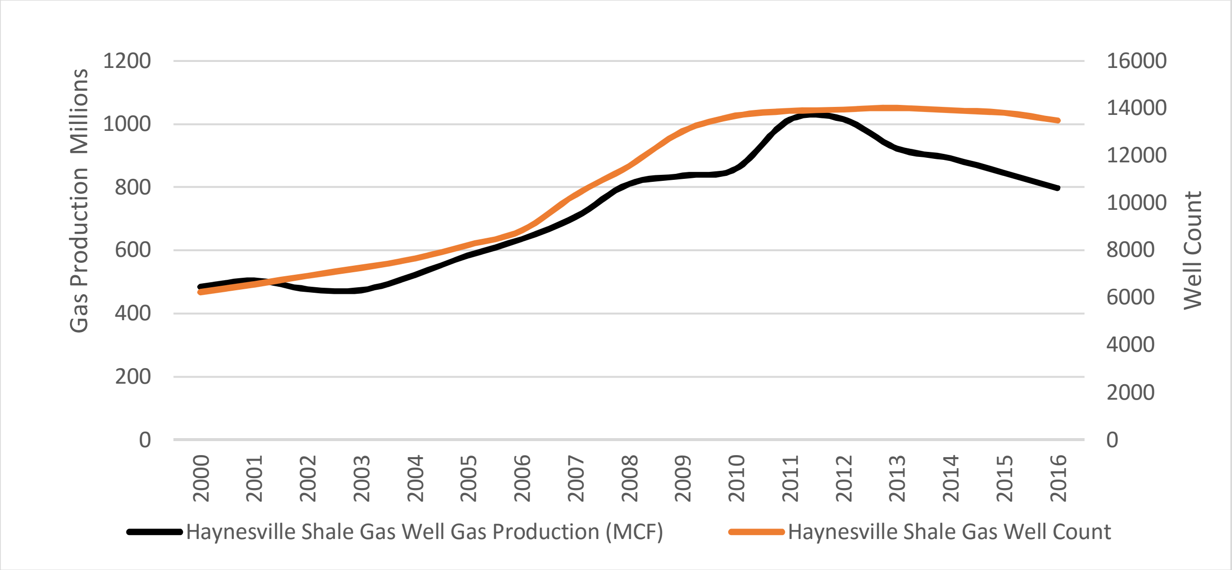


Figure A-44. Year of Peak Production and Peak Well Count: Haynesville Shale



Tables A-22 and A-23 show the final growth factors developed using the results of Hubbert's method found in Tables A-12, A-15, A-18, and A-21 above combined with these conservative baseline assumptions. As mentioned previously, growth factors for counties in Texas outside of the four study areas were estimated by averaging oil, gas, and condensate growth factors across each of the four study areas.

Table A-22. Final Production Growth Factors

	Barnett			Eagle Ford			Haynesville			Permian			Average		
Year	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**
2015	0.910	1.028	0.982	1.138	1.055	1.156	0.924*	0.890	0.808	1.061	0.776	0.637	1.008	0.937	0.896
2016	0.824*	0.988	0.906	1.246	1.082	1.281	0.924	0.765	0.635	1.100	0.731*	0.403	1.024	0.892	0.806
2017	0.824	0.891	0.789	1.310	1.078	1.356	0.924	0.638	0.578*	1.112	0.731	0.253	1.042	0.834	0.744
2018	0.824	0.758	0.653	1.318	1.043	1.366	0.924	0.539*	0.578	1.096	0.731	0.245*	1.040	0.768	0.711
2019	0.824	0.613	0.519	1.269	0.982	1.310	0.924	0.539	0.578	1.053	0.731	0.245	1.018	0.716	0.663
2020	0.824	0.476	0.398	1.172	0.901	1.198	0.924	0.539	0.578	0.989	0.731	0.245	0.977	0.662	0.605
2021	0.824	0.359	0.298	1.041	0.806	1.049	0.924	0.539	0.578	0.908	0.731	0.245	0.924	0.609	0.543
2022	0.824	0.264	0.219	0.893	0.706	0.885	0.924	0.539	0.578	0.816	0.731	0.245	0.864	0.560	0.482
2023	0.824	0.191	0.158	0.743	0.607	0.722	0.924	0.539	0.578	0.720	0.731	0.245	0.803	0.517	0.426
2024	0.824	0.136	0.113	0.604	0.513	0.574	0.924	0.539	0.578	0.626	0.731	0.245	0.744	0.480	0.378
2025	0.824	0.096	0.081	0.481	0.428	0.447	0.924	0.539	0.578	0.543*	0.731	0.245	0.693	0.449	0.338
2026	0.824	0.086*	0.071*	0.376	0.353	0.342	0.924	0.539	0.578	0.543	0.731	0.245	0.667	0.427	0.309
2027	0.824	0.086	0.071	0.291	0.291*	0.259	0.924	0.539	0.578	0.543	0.731	0.245	0.645	0.412*	0.288
2028	0.824	0.086	0.071	0.223	0.291	0.194	0.924	0.539	0.578	0.543	0.731	0.245	0.628	0.412	0.272
2029	0.824	0.086	0.071	0.170	0.291	0.144	0.924	0.539	0.578	0.543	0.731	0.245	0.615	0.412	0.260
2030	0.824	0.086	0.071	0.128	0.291	0.107	0.924	0.539	0.578	0.543	0.731	0.245	0.605	0.412	0.250
2031	0.824	0.086	0.071	0.096	0.291	0.079	0.924	0.539	0.578	0.543	0.731	0.245	0.597	0.412	0.243
2032	0.824	0.086	0.071	0.072	0.291	0.058	0.924	0.539	0.578	0.543	0.731	0.245	0.591	0.412	0.238
2033	0.824	0.086	0.071	0.054	0.291	0.043	0.924	0.539	0.578	0.543	0.731	0.245	0.586	0.412	0.234
2034	0.824	0.086	0.071	0.040	0.291	0.038*	0.924	0.539	0.578	0.543	0.731	0.245	0.583	0.412	0.233*
2035	0.824	0.086	0.071	0.038*	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582*	0.412	0.233
2036	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2037	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2038	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2039	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2040	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2041	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2042	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2043	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2044	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2045	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2046	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2047	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2048	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2049	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2050	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233

* 1st year of minimum baseline production.

Table A-23. Final Well Count Growth Factors

	Barnett			Eagle Ford			Haynesville			Permian			Average		
Year	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**	**Oil**	**Gas**	**Cond.**
2015	0.910	1.028	0.982	1.138	1.055	1.156	0.924*	0.890	0.808	1.061	0.776	0.637	1.008	0.937	0.896
2016	0.910	1.028	0.982	1.246	1.082	1.281	0.924	0.890	0.808	1.100	0.776	0.637	1.045	0.944	0.927
2017	0.910	1.028	0.982	1.310	1.082	1.356	0.924	0.890	0.808	1.112	0.776	0.637	1.064	0.944	0.946
2018	0.910	1.028	0.982	1.318	1.082	1.366	0.924	0.890	0.808	1.112	0.776	0.637	1.066	0.944	0.949
2019	0.824*	0.988	0.906	1.318	1.082	1.366	0.924	0.765	0.635	1.112	0.731*	0.403	1.044	0.892	0.828
2020	0.824	0.891	0.789	1.318	1.078	1.366	0.924	0.638	0.578*	1.112	0.731	0.253	1.044	0.834	0.746
2021	0.824	0.758	0.653	1.318	1.043	1.366	0.924	0.539*	0.578	1.096	0.731	0.245	1.040	0.768	0.711
2022	0.824	0.613	0.519	1.269	0.982	1.310	0.924	0.539	0.578	1.053	0.731	0.245	1.018	0.716	0.663
2023	0.824	0.476	0.398	1.172	0.901	1.198	0.924	0.539	0.578	0.989	0.731	0.245	0.977	0.662	0.605
2024	0.824	0.359	0.298	1.041	0.806	1.049	0.924	0.539	0.578	0.908	0.731	0.245	0.924	0.609	0.543
2025	0.824	0.264	0.219	0.893	0.706	0.885	0.924	0.539	0.578	0.816	0.731	0.245	0.864	0.560	0.482
2026	0.824	0.191	0.158	0.743	0.607	0.722	0.924	0.539	0.578	0.720	0.731	0.245	0.803	0.517	0.426
2027	0.824	0.136	0.113	0.604	0.513	0.574	0.924	0.539	0.578	0.626	0.731	0.245	0.744	0.480	0.378
2028	0.824	0.096	0.081	0.481	0.428	0.447	0.924	0.539	0.578	0.543*	0.731	0.245	0.693	0.449	0.338
2029	0.824	0.086*	0.071*	0.376	0.353	0.342	0.924	0.539	0.578	0.543	0.731	0.245	0.667	0.427	0.309
2030	0.824	0.086	0.071	0.291	0.291*	0.259	0.924	0.539	0.578	0.543	0.731	0.245	0.645	0.412*	0.288
2031	0.824	0.086	0.071	0.223	0.291	0.194	0.924	0.539	0.578	0.543	0.731	0.245	0.628	0.412	0.272
2032	0.824	0.086	0.071	0.170	0.291	0.144	0.924	0.539	0.578	0.543	0.731	0.245	0.615	0.412	0.260
2033	0.824	0.086	0.071	0.128	0.291	0.107	0.924	0.539	0.578	0.543	0.731	0.245	0.605	0.412	0.250
2034	0.824	0.086	0.071	0.096	0.291	0.079	0.924	0.539	0.578	0.543	0.731	0.245	0.597	0.412	0.243
2035	0.824	0.086	0.071	0.072	0.291	0.058	0.924	0.539	0.578	0.543	0.731	0.245	0.591	0.412	0.238
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2037	0.824	0.086	0.071	0.040	0.291	0.038*	0.924	0.539	0.578	0.543	0.731	0.245	0.583	0.412	0.233*
2038	0.824	0.086	0.071	0.038*	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582*	0.412	0.233
2039	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2040	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2041	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2042	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2043	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2044	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2045	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2046	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2047	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2048	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2049	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233
2050	0.824	0.086	0.071	0.038	0.291	0.038	0.924	0.539	0.578	0.543	0.731	0.245	0.582	0.412	0.233

* 1st year of minimum baseline well counts.

A.7 Area Source Growth Factors and Associated Data

As described in previous sections, Hubbert's method was employed to develop growth factors for oil production, natural gas production, and condensate production for each of the four oil and gas play regions in Texas (i.e., Barnett, Eagle Ford, Haynesville, and Permian). The growth factor development and calculation spreadsheet (Oil and Gas Production Modeling and Growth Factor Calculation_05102016.xlsx) for this method was submitted to TCEQ along with this report.

The final growth factors shown in Tables A-22 and A-23, determined after applying the conservative baseline assumptions described above to the Hubbert's method results, were then applied to oil and gas-related SCCs based on the projected growth in oil, gas, or condensate production or well counts as a scaling variable. For example, projected growth in oil production was used as the scaling variable for SCC 2310011020 "On-Shore Oil Production /Storage Tanks: Crude Oil". Table A-24 below identifies the scaling variable (i.e., oil, gas, or condensate production or well counts) used to assign the growth factors to each SCC.

Seven of the area source oil and gas SCCs are generic in the sense that they are not specific to a product (i.e., oil, gas, or condensate). For example, SCC 2310000000 is for "Oil & Gas Expl & Prod /All Processes /Total: All Processes". The scaling variable for those generic SCCs is identified as "Oil and Gas Production Forecasts" in Table A-24. For those seven SCCs, the growth factor is based on a weighted average of the oil and gas well counts in each county as compared to the total well counts. Table A-25 presents the 2016 oil and gas well counts as of February 2016 for each county and shows the percentage of each type of well in each county (RRC, 2016a). These percentages were then multiplied by the oil and gas production growth factors to derive a weighted growth factor for each of the seven SCCs as follows:

$$GF_{o+g} = [GF_o \times (\%\ \text{Oil Wells}/100)] + [GF_g \times (\%\ \text{Gas Wells}/100)]$$

Where:

GF_{o+g} = oil and gas growth factor;

GF_o = oil growth factor; and

GF_g = gas growth factor

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310000000	Oil & Gas Expl & Prod /All Processes /Total: All Processes	Oil and Gas
2310000220	Oil & Gas Expl & Prod /All Processes /Drill Rigs	Oil and Gas
2310000230	Oil & Gas Expl & Prod /All Processes /Workover Rigs	Oil and Gas
2310000330	Oil & Gas Expl & Prod /All Processes /Artificial Lift	Oil Well Count

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310000440	Oil & Gas Expl & Prod /All Processes /Saltwater Disposal Engines	Oil and Gas
2310000550	Oil & Gas Expl & Prod /All Processes /Produced Water	Oil and Gas
2310000660	Oil & Gas Expl & Prod /Hydraulic Fracturing Engines (Fracking)	Oil and Gas
2310001000	Oil & Gas Expl & Prod /All Processes: On-shore /Total: All Processes	Oil and Gas
2310010000	Oil & Gas Expl & Prod /Crude Petroleum /Total: All Processes	Oil
2310010100	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Heaters	Oil Well Count
2310010200	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Tanks - Flashing & Standing/Working/Breathing	Oil
2310010300	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Pneumatic Devices	Oil Well Count
2310010700	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Fugitives	Oil Well Count
2310010800	Oil & Gas Expl & Prod /Crude Petroleum /Oil Well Truck Loading	Oil
2310011000	On-Shore Oil Production /Total: All Processes	Oil
2310011020	On-Shore Oil Production /Storage Tanks: Crude Oil	Oil
2310011100	On-Shore Oil Production /Heater Treater	Oil Well Count
2310011201	On-Shore Oil Production /Tank Truck/Railcar Loading: Crude Oil	Oil
2310011450	On-Shore Oil Production /Wellhead	Oil Well Count
2310011500	On-Shore Oil Production /Fugitives: All Processes	Oil Well Count
2310011501	On-Shore Oil Production /Fugitives: Connectors	Oil Well Count
2310011502	On-Shore Oil Production /Fugitives: Flanges	Oil Well Count
2310011503	On-Shore Oil Production /Fugitives: Open Ended Lines	Oil Well Count
2310011504	On-Shore Oil Production /Fugitives: Pumps	Oil Well Count
2310011505	On-Shore Oil Production /Fugitives: Valves	Oil Well Count
2310011506	On-Shore Oil Production /Fugitives: Other	Oil Well Count
2310011600	On-Shore Oil Production /Artificial Lift Engines	Oil Well Count
2310020000	Oil & Gas Expl & Prod /Natural Gas /Total: All Processes	Gas
2310020600	Oil & Gas Expl & Prod /Natural Gas /Compressor Engines	Gas
2310020700	Oil & Gas Expl & Prod /Natural Gas /Gas Well Fugitives	Gas Well Count
2310020800	Oil & Gas Expl & Prod /Natural Gas /Gas Well Truck Loading	Condensate
2310021000	On-Shore Gas Production /Total: All Processes	Gas
2310021010	On-Shore Gas Production /Storage Tanks: Condensate	Condensate
2310021011	On-Shore Gas Production / Condensate Tank Flaring	Condensate
2310021030	On-Shore Gas Production /Tank Truck/Railcar Loading: Condensate	Condensate
2310021100	On-Shore Gas Production /Gas Well Heaters	Gas Well Count
2310021101	On-Shore Gas Production /Natural Gas Fired 2Cycle Lean Burn Compressor Engines < 50 HP	Gas

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310021102	On-Shore Gas Production /Natural Gas Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP	Gas
2310021103	On-Shore Gas Production /Natural Gas Fired 2Cycle Lean Burn Compressor Engines 500+ HP	Gas
2310021109	On-Shore Gas Production /Total: All Natural Gas Fired 2Cycle Lean Burn Compressor Engines	Gas
2310021201	On-Shore Gas Production /Natural Gas Fired 4Cycle Lean Burn Compressor Engines <50 HP	Gas
2310021202	On-Shore Gas Production /Natural Gas Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP	Gas
2310021203	On-Shore Gas Production /Natural Gas Fired 4Cycle Lean Burn Compressor Engines 500+ HP	Gas
2310021209	On-Shore Gas Production /Total: All Natural Gas Fired 4Cycle Lean Burn Compressor Engines	Gas
2310021251	Lateral/Gathering Line Compressors (4Cycle Lean)	Gas
2310021300	On-Shore Gas Production /Gas Well Pneumatic Devices	Gas Well Count
2310021301	On-Shore Gas Production /Natural Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP	Gas
2310021302	On-Shore Gas Production /Natural Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP	Gas
2310021303	On-Shore Gas Production /Natural Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP	Gas
2310021309	On-Shore Gas Production /Total: All Natural Gas Fired 4Cycle Rich Burn Compressor Engines	Gas
2310021310	On-Shore Gas Production / Gas Well Pneumatic Pumps	Gas Well Count
2310021351	Lateral/Gathering Line Compressors (4Cycle Rich)	Gas
2310021400	On-Shore Gas Production /Gas Well Dehydrators	Gas
2310021401	On-Shore Gas Production /Nat Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP w/NSCR	Gas
2310021402	On-Shore Gas Production /Nat Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP w/NSCR	Gas
2310021403	On-Shore Gas Production /Nat Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP w/NSCR	Gas
2310021409	On-Shore Gas Production /Total: All Nat Gas Fired 4Cycle Rich Burn Compressor Engines w/NSCR	Gas
2310021410	On-Shore Gas Production /Amine Unit	Gas
2310021411	On-Shore Gas Production / Gas Well Dehydrators - Flaring	Gas
2310021450	On-Shore Gas Production /Wellhead	Gas
2310021500	On-Shore Gas Production /Gas Well Completion - Flaring	Gas
2310021501	On-Shore Gas Production /Fugitives: Connectors	Gas Well Count
2310021502	On-Shore Gas Production /Fugitives: Flanges	Gas Well Count
2310021503	On-Shore Gas Production /Fugitives: Open Ended Lines	Gas Well Count
2310021504	On-Shore Gas Production /Fugitives: Pumps	Gas Well Count
2310021505	On-Shore Gas Production /Fugitives: Valves	Gas Well Count
2310021506	On-Shore Gas Production /Fugitives: Other	Gas Well Count
2310021509	On-Shore Gas Production /Fugitives: All Processes	Gas Well Count

Table A-24. Growth Factor Scaling Variables by SCC

SCC	SCC Description	Scaling Variable
2310021600	On-Shore Gas Production /Gas Well Venting	Gas Well Count
2310021601	On-Shore Gas Production / Gas Well Venting - Initial Completions	Gas
2310021602	On-Shore Gas Production / Gas Well Venting– Recompletions	Gas
2310021603	On-Shore Gas Production / Gas Well Venting - Blowdowns	Gas Well Count
2310021604	On-Shore Gas Production / Gas Well Venting - Compressor Startups	Gas
2310021605	On-Shore Gas Production / Gas Well Venting - Compressor Shutdowns	Gas
2310021700	On-Shore Gas Production / Miscellaneous Engines	Gas
2310023000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Cbm Gas Well - Dewatering Pump Engines	Gas
2310030000	Oil & Gas Expl & Prod /Natural Gas Liquids /Total: All Processes	Condensate
2310030210	Oil & Gas Expl & Prod /Natural Gas Liquids /Gas Well Tanks - Flashing & Standing/Working/Breathing, Uncontrolled	Condensate
2310030220	Oil & Gas Expl & Prod /Natural Gas Liquids /Gas Well Tanks - Flashing & Standing/Working/Breathing, Controlled	Condensate
2310030230	Natural Gas Liquids / Gas Well Tanks – Flaring	Condensate
2310030300	Natural Gas Liquids / Gas Well Water Tank Losses	Condensate
2310030400	Natural Gas Liquids / Truck Loading	Condensate
2310030401	Natural Gas Liquids / Gas Plant Truck Loading	Condensate
2310031000	Oil & Gas Expl & Prod /Natural Gas Liquids: On-shore /Total: All Processes	Condensate
2310111000	On-Shore Oil Exploration /All Processes	Oil
2310111100	On-Shore Oil Exploration /Mud Degassing	Oil
2310111401	On-Shore Oil Exploration /Oil Well Pneumatic Pumps	Oil Well Count
2310111700	On-Shore Oil Exploration /Oil Well Completion: All Processes	Oil
2310111701	On-Shore Oil Exploration /Oil Well Completion: Flaring	Oil
2310111702	On-Shore Oil Exploration /Oil Well Completion: Venting	Oil
2310121000	On-Shore Gas Exploration /All Processes	Gas
2310121100	On-Shore Gas Exploration /Mud Degassing	Gas
2310121401	On-Shore Gas Exploration /Gas Well Pneumatic Pumps	Gas Well Count
2310121700	On-Shore Gas Exploration /Gas Well Completion: All Processes	Gas
2310121701	On-Shore Gas Exploration /Gas Well Completion: Flaring	Gas
2310121702	On-Shore Gas Exploration /Gas Well Completion: Venting	Gas

Table A-25. Growth Factor Weighting Percentages

County	Oil and Gas Play	Oil Well Count	Gas Well Count	Total Well Count	% Oil	% Gas
Archer	Barnett Shale	3,207	4	3,211	99.9%	0.1%
Bosque	Barnett Shale	1	2	3	33.3%	66.7%
Clay	Barnett Shale	1,134	23	1,157	98.0%	2.0%
Comanche	Barnett Shale	89	170	259	34.4%	65.6%
Cooke	Barnett Shale	2,080	318	2,398	86.7%	13.3%
Coryell	Barnett Shale	4	1	5	80.0%	20.0%
Dallas	Barnett Shale	0	30	30	0.0%	100.0%
Denton	Barnett Shale	50	2,960	3,010	1.7%	98.3%
Eastland	Barnett Shale	560	701	1,261	44.4%	55.6%
Ellis	Barnett Shale	14	51	65	21.5%	78.5%
Erath	Barnett Shale	3	296	299	1.0%	99.0%
Hamilton	Barnett Shale	2	13	15	13.3%	86.7%
Hill	Barnett Shale	7	227	234	3.0%	97.0%
Hood	Barnett Shale	1	659	660	0.2%	99.8%
Jack	Barnett Shale	1,822	1,160	2,982	61.1%	38.9%
Johnson	Barnett Shale	2	3,080	3,082	0.1%	99.9%
Montague	Barnett Shale	2,229	826	3,055	73.0%	27.0%
Palo Pinto	Barnett Shale	467	1,312	1,779	26.3%	73.7%
Parker	Barnett Shale	9	1,749	1,758	0.5%	99.5%
Shackelford	Barnett Shale	1,808	194	2,002	90.3%	9.7%
Somervell	Barnett Shale	1	57	58	1.7%	98.3%
Stephens	Barnett Shale	1,427	1,021	2,448	58.3%	41.7%
Tarrant	Barnett Shale	20	3,928	3,948	0.5%	99.5%
Wise	Barnett Shale	495	4,481	4,976	9.9%	90.1%
Young	Barnett Shale	2,467	234	2,701	91.3%	8.7%
Atascosa	Eagle Ford Shale	1,842	67	1,909	96.5%	3.5%
Bastrop	Eagle Ford Shale	247	69	316	78.2%	21.8%
Bee	Eagle Ford Shale	214	344	558	38.4%	61.6%
Brazos	Eagle Ford Shale	646	80	726	89.0%	11.0%
Burleson	Eagle Ford Shale	1,049	97	1146	91.5%	8.5%
De Witt	Eagle Ford Shale	1,421	0	1421	100.0%	0.0%
Dimmit	Eagle Ford Shale	1,606	1,346	2,952	54.4%	45.6%
Fayette	Eagle Ford Shale	620	209	829	74.8%	25.2%
Frio	Eagle Ford Shale	692	94	786	88.0%	12.0%
Gonzales	Eagle Ford Shale	1,293	12	1,305	99.1%	0.9%
Grimes	Eagle Ford Shale	78	197	275	28.4%	71.6%
Karnes	Eagle Ford Shale	1,727	572	2,299	75.1%	24.9%
La Salle	Eagle Ford Shale	196	0	196	100.0%	0.0%
Lavaca	Eagle Ford Shale	226	445	671	33.7%	66.3%
Lee	Eagle Ford Shale	788	66	854	92.3%	7.7%
Leon	Eagle Ford Shale	229	587	816	28.1%	71.9%
Live Oak	Eagle Ford Shale	530	533	1,063	49.9%	50.1%
Madison	Eagle Ford Shale	107	0	107	100.0%	0.0%
Maverick	Eagle Ford Shale	682	114	796	85.7%	14.3%

Table A-25. Growth Factor Weighting Percentages

County	Oil and Gas Play	Oil Well Count	Gas Well Count	Total Well Count	% Oil	% Gas
McMullen	Eagle Ford Shale	682	114	796	85.7%	14.3%
Milam	Eagle Ford Shale	1,797	10	1,807	99.4%	0.6%
Robertson	Eagle Ford Shale	239	920	1,159	20.6%	79.4%
Walker	Eagle Ford Shale	16	17	33	48.5%	51.5%
Webb	Eagle Ford Shale	102	5,893	5,995	1.7%	98.3%
Wilson	Eagle Ford Shale	624	2	626	99.7%	0.3%
Zavala	Eagle Ford Shale	449	58	507	88.6%	11.4%
Angelina	Haynesville Shale	2	93	95	2.1%	97.9%
Gregg	Haynesville Shale	2,954	887	3,841	76.9%	23.1%
Harrison	Haynesville Shale	269	2,519	2,788	9.6%	90.4%
Marion	Haynesville Shale	107	0	107	100.0%	0.0%
Nacogdoches	Haynesville Shale	45	1,384	1,429	3.1%	96.9%
Panola	Haynesville Shale	233	5,190	5,423	4.3%	95.7%
Rusk	Haynesville Shale	1,716	2,395	4,111	41.7%	58.3%
Sabine	Haynesville Shale	8	14	22	36.4%	63.6%
San Augustine	Haynesville Shale	11	251	262	4.2%	95.8%
Shelby	Haynesville Shale	33	666	699	4.7%	95.3%
Andrews	Permian Basin	11,136	128	11,264	98.9%	1.1%
Borden	Permian Basin	671	0	671	100.0%	0.0%
Brewster	Permian Basin	0	0	0	0	0
Cochran	Permian Basin	1,858	28	1,886	98.5%	1.5%
Coke	Permian Basin	333	25	358	93.0%	7.0%
Crane	Permian Basin	4,688	459	5,147	91.1%	8.9%
Crockett	Permian Basin	2,645	5726	8,371	31.6%	68.4%
Crosby	Permian Basin	784	0	784	100.0%	0.0%
Culberson	Permian Basin	136	221	357	38.1%	61.9%
Dawson	Permian Basin	1,421	0	1,421	100.0%	0.0%
Dickens	Permian Basin	227	0	227	100.0%	0.0%
Ector	Permian Basin	7,751	75	7,826	99.0%	1.0%
Edwards	Permian Basin	99	515	614	16.1%	83.9%
Fisher	Permian Basin	569	18	587	96.9%	3.1%
Gaines	Permian Basin	3,932	139	4,071	96.6%	3.4%
Garza	Permian Basin	2,223	0	2,223	100.0%	0.0%
Glasscock	Permian Basin	4,574	84	4,658	98.2%	1.8%
Hale	Permian Basin	212	0	212	100.0%	0.0%
Hockley	Permian Basin	4,108	13	4,121	99.7%	0.3%
Howard	Permian Basin	4,808	26	4,834	99.5%	0.5%
Hudspeth	Permian Basin	0	0	0	0	0
Irion	Permian Basin	2,446	257	2,703	90.5%	9.5%
Jeff Davis	Permian Basin	1	1	2	50.0%	50.0%
Kent	Permian Basin	622	0	622	100.0%	0.0%
Kimble	Permian Basin	1	14	15	6.7%	93.3%
King	Permian Basin	471	30	501	94.0%	6.0%
Lamb	Permian Basin	68	0	68	100.0%	0.0%

Table A-25. Growth Factor Weighting Percentages

County	Oil and Gas Play	Oil Well Count	Gas Well Count	Total Well Count	% Oil	% Gas
Loving	Permian Basin	1,028	304	1,332	77.2%	22.8%
Lubbock	Permian Basin	448	0	448	100.0%	0.0%
Lynn	Permian Basin	107	0	107	100.0%	0.0%
Martin	Permian Basin	5,719	2	5,721	100.0%	0.0%
Midland	Permian Basin	6,526	133	6,659	98.0%	2.0%
Mitchell	Permian Basin	2,730	4	2,734	99.9%	0.1%
Nolan	Permian Basin	639	38	677	94.4%	5.6%
Pecos	Permian Basin	3,226	1,340	4,566	70.7%	29.3%
Presidio	Permian Basin	0	0	0	0	0
Reagan	Permian Basin	5,453	45	5,498	99.2%	0.8%
Reeves	Permian Basin	1,918	338	2,256	85.0%	15.0%
Schleicher	Permian Basin	396	806	1,202	32.9%	67.1%
Scurry	Permian Basin	2,665	1	2,666	100.0%	0.0%
Sterling	Permian Basin	1391	578	1,969	70.6%	29.4%
Stonewall	Permian Basin	632	1	633	99.8%	0.2%
Sutton	Permian Basin	59	5,816	5,875	1.0%	99.0%
Terrell	Permian Basin	21	669	690	3.0%	97.0%
Terry	Permian Basin	899	7	906	99.2%	0.8%
Tom Green	Permian Basin	653	73	726	89.9%	10.1%
Upton	Permian Basin	5,813	345	6,158	94.4%	5.6%
Val Verde	Permian Basin	6	242	248	2.4%	97.6%
Ward	Permian Basin	3,676	248	3,924	93.7%	6.3%
Winkler	Permian Basin	1,810	312	2,122	85.3%	14.7%
Yoakum	Permian Basin	3,797	22	3,819	99.4%	0.6%

A.8 References

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APPENDIX B

POINT SOURCE SIC-TO-NAICS CROSSWALK AND GROWTH FACTOR SURROGATE ASSIGNMENTS

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
119	Cash Grains, NEC	3112XX[a]	Grain and Oilseed Milling	3112	Grain and oilseed milling
723	Crop Prep Services For Market	3112XX[b]	Grain and Oilseed Milling	3112	Grain and oilseed milling
1221	Bituminous Coal/Lignite Surface Mining	212111	Bituminous Coal and Lignite Surface Mining	2121	Coal mining
1241	Coal Mining Services	213113	Support Activities for Coal Mining	2131	Support activities for mining
1311	Crude Petroleum & Natural Gas	211111[c]	Crude Petroleum and Natural Gas Extraction	SCC 2310000000	Oil and gas exploration and production, Total, All processes
1321	Natural Gas Liquids	211112[d]	Natural Gas Liquid Extraction	SCC 2310000000	Oil and gas exploration and production, Total, All processes
1382	Oil and Gas Field Exploration Services	541360	Geophysical Surveying and Mapping Services	5413	Architectural, engineering, and related services
1389	Oil and Gas Field Services, NEC	237120	Oil and Gas Pipeline and Related Structures Construction	2371	Utility system construction
1422	Crushed and Broken Limestone	212312	Crushed and Broken Limestone Mining and Quarrying	2123	Nonmetallic mineral mining and quarrying
1541	Industrial Building/Warehouses	236220	Commercial and Institutional Building Construction	2362	Nonresidential building construction
1629	Heavy Construction, NEC	237990	Other Heavy and Civil Engineering Construction	2379	Other heavy and civil engineering construction
1721	Painting Paper Hanging Decorating	238320	Painting and Wall Covering Contractors	2383	Building finishing contractors
2011	Meat Packing Plants	311611	Animal (except Poultry) Slaughtering	3116	Animal slaughtering and processing
2013	Sausages & Other Prepared Meat	311612	Meat Processed from Carcasses	3116	Animal slaughtering and processing
2023	Dry Condensed/Evaporated Dairy Products	311514[e]	Dry, Condensed, and Evaporated Dairy Product Manufacturing	3115	Dairy product manufacturing
2026	Fluid Milk	311511[f]	Fluid Milk Manufacturing	3115	Dairy product manufacturing
2032	Canned Specialties	311999	All Other Miscellaneous Food Manufacturing	3119	Other food manufacturing

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[a] Original NAICS 111130 (Dry Pea and Bean Farming) was matched to SIC 119; changed to NAICS 3112XX (Grain and Oilseed Milling) based on discussion with TCEQ.

[b] Original NAICS 115114 (Postharvest Crop Activities [except Cotton Ginning]) was matched to SIC 723; changed to NAICS 3112XX (Grain and Oilseed Milling) based on discussion with TCEQ.

[c] For SIC 1311, the original growth factor data assignment was Economy.com output data for NAICS 2111 (Oil and Gas Extraction). This was changed to the area source SCC 2310000000 based on discussion with TCEQ.

[d] For SIC 1321, the original growth factor data assignment was Economy.com output data for NAICS 2111 (Oil and Gas Extraction). This was changed to the area source SCC 2310000000 based on discussion with TCEQ.

[e] Original NAICS 311511 (Fluid Milk) incorrectly matched to SIC 2023; changed to NAICS 311514 (Dry/Condensed/Evaporated Dairy Products).

[f] Original NAICS 311514 (Dry/Condensed/Evaporated Dairy Products) incorrectly matched to SIC 2026; changed to NAICS 311511 (Fluid Milk).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
2035	Pickles Sauces and Salad Dress	311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing	3119	Other food manufacturing
2041	Flour & Other Grain Mill Products	311211	Flour Milling	3112	Grain and oilseed milling
2046	Wet Corn Milling	311221	Wet Corn Milling	3112	Grain and oilseed milling
2048	Prepared Feeds, NEC	311119	Other Animal Food Manufacturing	3111	Animal food manufacturing
2051	Bread, Cake and Related Products	311812	Commercial Bakeries	3118	Bakeries and tortilla manufacturing
2061	Raw Cane Sugar Except Refining	311314	Cane Sugar Manufacturing	3113	Sugar and confectionery product manufacturing
2074	Cottonseed Oil Mills	311224	Soybean and Other Oilseed Processing	3112	Grain and oilseed milling
2077	Animal and Marine Fats and Oil	311613	Rendering and Meat Byproduct Processing	3116	Animal slaughtering and processing
2082	Malt Beverages	312120	Breweries	3121	Beverage manufacturing
2095	Roasted Coffee	311920	Coffee and Tea Manufacturing	3119	Other food manufacturing
2096	Potato, Corn Chips, Similar Snack	311919	Other Snack Food Manufacturing	3119	Other food manufacturing
2099	Food Preparations, NEC	311991	Perishable Prepared Food Manufacturing	3119	Other food manufacturing
2221	Broad woven Fabric Mills/Man-Made Fiber and Silk	313210	Broad woven Fabric Mills	3132	Fabric mills
2295	Coated Fabrics, Not Rubberized	313320	Fabric Coating Mills	3133	Textile and fabric finishing and fabric coating mills
2353	Hats, Caps and Millinery	315990	Apparel Accessories and Other Apparel Manufacturing	3159	Apparel accessories and other apparel manufacturing
2421	Sawmills & Planning Mills General	321113	Sawmills	3211	Sawmills and wood preservation
2431	Millwork	321911	Wood Window and Door Manufacturing	3219	Other wood product manufacturing
2434	Wood Kitchen Cabinets	337110	Wood Kitchen Cabinet and Countertop Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing
2436	Softwood Veneer and Plywood	321212	Softwood Veneer and Plywood Manufacturing	3212	Veneer, plywood, and engineered wood product manufacturing
2449	Wood Containers, NEC	321999	All Other Miscellaneous Wood Product Manufacturing	3219	Other wood product manufacturing
2493	Reconstituted Wood Products	321219	Reconstituted Wood Product Manufacturing	3212	Veneer, plywood, and engineered wood product manufacturing
2499	Wood Products, NEC	321999	All Other Miscellaneous Wood Product Manufacturing	3219	Other wood product manufacturing
2519	Household Furniture, NEC	337125	Household Furniture (except Wood and Metal) Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
2521	Wood Office Furniture	337211	Wood Office Furniture Manufacturing	3372	Office furniture (including fixtures) manufacturing
2541	Wood Partitions and Fixtures	337110	Wood Kitchen Cabinet and Countertop Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing
2542	Partition and Fixtures Except Wood	337127	Institutional Furniture Manufacturing	3371	Household and institutional furniture and kitchen cabinet manufacturing
2621	Paper Mills	322121	Paper (except Newsprint) Mills	3221	Pulp, paper, and paperboard mills
2631	Paperboard Mills	322130	Paperboard Mills	3221	Pulp, paper, and paperboard mills
2653	Corrugated and Solid Fiber Box	322211	Corrugated and Solid Fiber Box Manufacturing	3222	Converted paper product manufacturing
2656	Sanitary Food Containers	322219	Other Paperboard Container Manufacturing	3222	Converted paper product manufacturing
2671	Paper Coated & Laminated Pkg.	322220[g]	Paper Bag and Coated and Treated Paper Manufacturing	3222	Converted paper product manufacturing
2672	Paper Coated & Laminated, NEC	322220[h]	Paper Bag and Coated and Treated Paper Manufacturing	3222	Converted paper product manufacturing
2673	Bags, Plastics, Laminated Coat	326111	Plastics Bag and Pouch Manufacturing	3261	Plastics product manufacturing
2679	Converted Paper Products, NEC	322299	All Other Converted Paper Product Manufacturing	3222	Converted paper product manufacturing
2711	Newspapers	511110	Newspaper Publishers	5111	Newspaper, periodical, book, and directory publishers
2752	Commercial Printing Lithograph	323111	Commercial Printing (except Screen and Books)	3231	Printing and related support activities
2754	Commercial Printing, Gravure	323111	Commercial Printing (except Screen and Books)	3231	Printing and related support activities
2759	Commercial Printing, NEC	323111	Commercial Printing (except Screen and Books)	3231	Printing and related support activities
2812	Alkalies and Chlorine	325180	Other Basic Inorganic Chemical Manufacturing	3251	Basic chemical manufacturing
2813	Industrial Gases	325120	Industrial Gas Manufacturing	3251	Basic chemical manufacturing
2819	Industrial Inorganic Chemicals	325180	Other Basic Inorganic Chemical Manufacturing	3251	Basic chemical manufacturing

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[g] Original NAICS 326112 (Plastics Packaging, Film and Sheet Manufacturing) incorrectly matched to SIC 2671; changed to NAICS 322220 (Paper Bag and Coated and Treated Paper Manufacturing).

[h] Original NAICS 326111 (Plastics Bag and Pouch Manufacturing) incorrectly matched to SIC 2672; changed to NAICS 322220 (Paper Bag and Coated and Treated Paper Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
2821	Plastics Materials and Synthetic Resins	325211	Plastics Material and Resin Manufacturing	3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
2822	Synthetic Rubber	325212	Synthetic Rubber Manufacturing	3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
2833	Medicinals and Botanicals	325411	Medicinal and Botanical Manufacturing	3254	Pharmaceutical and medicine manufacturing
2834	Pharmaceutical Preparations	325412	Pharmaceutical Preparation Manufacturing	3254	Pharmaceutical and medicine manufacturing
2842	Specialty Cleaning, Polishes and Sanitation Goods	325612	Polish and Other Sanitation Good Manufacturing	3256	Soap, cleaning compound, and toilet preparation manufacturing
2843	Surface Active Agents	325613	Surface Active Agent Manufacturing	3256	Soap, cleaning compound, and toilet preparation manufacturing
2844	Toilet Preparations	325620	Toilet Preparation Manufacturing	3256	Soap, cleaning compound, and toilet preparation manufacturing
2851	Paints and Allied Products	325510	Paint and Coating Manufacturing	3255	Paint, coating, and adhesive manufacturing
2865	Cyclic Crudes and Intermediates, and Organic Dyes	325110	Petrochemical Manufacturing	3251	Basic chemical manufacturing
2869	Industrial Organic Chemicals, NEC	325110	Petrochemical Manufacturing	3251	Basic chemical manufacturing
2873	Nitrogenous Fertilizers	325311	Nitrogenous Fertilizer Manufacturing	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
2874	Phosphatic Fertilizers	325312	Phosphatic Fertilizer Manufacturing	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
2879	Agricultural Chemicals, NEC	325320	Pesticide and Other Agricultural Chemical Manufacturing	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
2891	Adhesives and Sealants	325520	Adhesive Manufacturing	3255	Paint, coating, and adhesive manufacturing
2895	Carbon Black	325180	Other Basic Inorganic Chemical Manufacturing	3251	Basic chemical manufacturing
2899	Chemical Preparations, NEC	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing	3259	Other chemical product and preparation manufacturing
2911	Petroleum Refining	324110	Petroleum Refineries	3241	Petroleum and coal products manufacturing
2951	Paving Mixtures and Blocks	324121	Asphalt Paving Mixture and Block Manufacturing	3241	Petroleum and coal products manufacturing
2952	Asphalt Felts and Coatings	324122	Asphalt Shingle and Coating Materials Manufacturing	3241	Petroleum and coal products manufacturing
2992	Lubricating Oils and Greases	324191	Petroleum Lubricating Oil and Grease Manufacturing	3241	Petroleum and coal products manufacturing
2999	Petroleum and Coal Products, NEC	324199	All Other Petroleum and Coal Products Manufacturing	3241	Petroleum and coal products manufacturing

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3011	Tires and Inner Tubes	326211	Tire Manufacturing (except Retreading)	3262	Rubber product manufacturing
3052	Rubber & Plastics Hose and Belting	326220	Rubber and Plastics Hoses and Belting Manufacturing	3262	Rubber product manufacturing
3053	Gaskets, Packing and Sealing Devices	339991	Gasket, Packing, and Sealing Device Manufacturing	3399	Other miscellaneous manufacturing
3061	Mechanical Rubber Goods	326291	Rubber Product Manufacturing for Mechanical Use	3262	Rubber product manufacturing
3081	Unsupported Plastics, Film & Sheet	326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing	3261	Plastics product manufacturing
3082	Unsupported Plastics Profile Shape	326121	Unlaminated Plastics Profile Shape Manufacturing	3261	Plastics product manufacturing
3084	Plastics, Pipe	326122	Plastics Pipe and Pipe Fitting Manufacturing	3261	Plastics product manufacturing
3086	Plastics, Foam Products	326140	Polystyrene Foam Product Manufacturing	3261	Plastics product manufacturing
3087	Custom Compound Purchased Resin	325991	Custom Compounding of Purchased Resins	3259	Other chemical product and preparation manufacturing
3088	Plastics, Plumbing Fixtures	326191	Plastics Plumbing Fixture Manufacturing	3261	Plastics product manufacturing
3089	Plastics Products, NEC	326121	Unlaminated Plastics Profile Shape Manufacturing	3261	Plastics product manufacturing
3143	Men’s Footwear, Except Athletic	316210	Footwear Manufacturing	3162	Footwear manufacturing
3149	Footwear, Except Rubber, NEC	316210	Footwear Manufacturing	3162	Footwear manufacturing
3211	Flat Glass	327211	Flat Glass Manufacturing	3272	Glass and glass product manufacturing
3221	Glass Containers	327213	Glass Container Manufacturing	3272	Glass and glass product manufacturing
3229	Pressed and Blown Glass, NEC	327212	Other Pressed and Blown Glass and Glassware Manufacturing	3272	Glass and glass product manufacturing
3231	Products Of Purchased Glass	327215	Glass Product Manufacturing Made of Purchased Glass	3272	Glass and glass product manufacturing
3241	Cement, Hydraulic	327310	Cement Manufacturing	3273	Cement and concrete product manufacturing
3251	Brick and Structural Clay Tile	327120	Clay Building Material and Refractories Manufacturing	3271	Clay product and refractory manufacturing
3253	Ceramic Wall and Floor Tile	327120	Clay Building Material and Refractories Manufacturing	3271	Clay product and refractory manufacturing
3261	Vitreous Plumbing Fixtures	327110	Pottery, Ceramics, and Plumbing Fixture Manufacturing	3271	Clay product and refractory manufacturing

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3269	Pottery Products, NEC	327110	Pottery, Ceramics, and Plumbing Fixture Manufacturing	3271	Clay product and refractory manufacturing
3272	Concrete Products, NEC	327390	Other Concrete Product Manufacturing	3273	Cement and concrete product manufacturing
3274	Lime	327410	Lime Manufacturing	3274	Lime and gypsum product manufacturing
3275	Gypsum Products	327420	Gypsum Product Manufacturing	3274	Lime and gypsum product manufacturing
3291	Abrasive Products	327910	Abrasive Product Manufacturing	3279	Other nonmetallic mineral product manufacturing
3295	Minerals, Ground Or Treated	327992	Ground or Treated Mineral and Earth Manufacturing	3279	Other nonmetallic mineral product manufacturing
3296	Mineral Wool	327993	Mineral Wool Manufacturing	3279	Other nonmetallic mineral product manufacturing
3299	Nonmetallic Mineral Products	327999[i]	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	3279	Other nonmetallic mineral product manufacturing
3312	Blast Furnaces and Steel Mills	331110[j]	Iron and Steel Mills and Ferroalloy Manufacturing	3311	Iron and steel mills and ferroalloy manufacturing
3317	Steel Pipe and Tubes	331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	3312	Steel product manufacturing from purchased steel
3321	Gray & Ductile Iron Foundries	331511	Iron Foundries	3315	Foundries
3322	Malleable Iron Foundries	331511	Iron Foundries	3315	Foundries
3325	Steel Foundries, NEC	331513	Steel Foundries (except Investment)	3315	Foundries
3331	Primary Copper	331410	Nonferrous Metal (except Aluminum) Smelting and Refining	3314	Nonferrous metal (except aluminum) production and processing
3334	Primary Aluminum	331313	Alumina Refining and Primary Aluminum Production	3313	Alumina and aluminum production and processing
3341	Secondary Nonferrous Metals	331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)	3314	Nonferrous metal (except aluminum) production and processing
3351	Copper Rolling and Drawing	331420	Copper Rolling, Drawing, Extruding, and Alloying	3314	Nonferrous metal (except aluminum) production and processing
3353	Aluminum Sheet Plate & Foil	331315	Aluminum Sheet, Plate, and Foil Manufacturing	3313	Alumina and aluminum production and processing

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[i] Original NAICS 327110 (Pottery, Ceramics, and Plumbing Fixture Manufacturing) incorrectly matched to SIC 3299; changed to NAICS 327999 (All Other Miscellaneous Nonmetallic Mineral Product Manufacturing).

[j] Original NAICS 331221 (Rolled Steel Shape Manufacturing) incorrectly matched to SIC 3312; changed to NAICS 331110 (Iron and Steel Mills and Ferroalloy Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3354	Aluminum Extruded Products	331318	Other Aluminum Rolling, Drawing, and Extruding	3313	Alumina and aluminum production and processing
3357	Nonferrous Wire Drawing & Insulating	331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding	3314	Nonferrous metal (except aluminum) production and processing
3364	Nonferrous Die-Casting, Except Aluminum	331523	Nonferrous Metal Die-Casting Foundries	3315	Foundries
3366	Copper Foundries	331529	Other Nonferrous Metal Foundries (except Die-Casting)	3315	Foundries
3411	Metal Cans	332431	Metal Can Manufacturing	3324	Boiler, tank, and shipping container manufacturing
3412	Metal Barrels, Drums & Pails	332439	Other Metal Container Manufacturing	3324	Boiler, tank, and shipping container manufacturing
3441	Fabricated Structural Metal	332312	Fabricated Structural Metal Manufacturing	3323	Architectural and structural metals manufacturing
3442	Metal Doors, Sash, and Trim	332321	Metal Window and Door Manufacturing	3323	Architectural and structural metals manufacturing
3443	Fabricated Plate Work (Boiler Shops)	332313	Plate Work Manufacturing	3323	Architectural and structural metals manufacturing
3444	Sheet Metal Work	332322	Sheet Metal Work Manufacturing	3323	Architectural and structural metals manufacturing
3448	Prefabricated Metal Buildings	332311	Prefabricated Metal Building and Component Manufacturing	3323	Architectural and structural metals manufacturing
3452	Bolts Nuts Rivets & Washers	332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing	3327	Machine shops, turned product, and screw, nut, and bolt manufacturing
3462	Iron and Steel Forgings	332111	Iron and Steel Forging	3321	Forging and stamping
3463	Nonferrous Forgings	332112	Nonferrous Forging	3321	Forging and stamping
3471	Plating and Polishing	332813	Electroplating, Plating, Polishing, Anodizing, and Coloring	3328	Coating, engraving, heat treating, and allied activities
3479	Metal Coating and Allied Services	332812[k]	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	3328	Coating, engraving, heat treating, and allied activities
3483	Ammunition, Except For Small Arm	332993	Ammunition (except Small Arms) Manufacturing	3329	Other fabricated metal product manufacturing
3492	Fluid Power Valves & Hose Fittings	332912	Fluid Power Valve and Hose Fitting Manufacturing	3329	Other fabricated metal product manufacturing

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[k] Original NAICS 332999 (All Other Miscellaneous Fabricated Metal Product Manufacturing) incorrectly matched to SIC 3479; changed to NAICS 332812 (Metal Coating, Engraving [except Jewelry and Silverware], and Allied Services to Manufacturers).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3498	Fabricated Pipe and Pipe Fittings	332996	Fabricated Pipe and Pipe Fitting Manufacturing	3329	Other fabricated metal product manufacturing
3499	Fabricated Metal Products, NEC	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing	3329	Other fabricated metal product manufacturing
3511	Turbines and Turbine Generator	333611	Turbine and Turbine Generator Set Units Manufacturing	3336	Engine, turbine, and power transmission equipment manufacturing
3519	Internal Combustion Engines	333618[l]	Other Engine Equipment Manufacturing	3336	Engine, turbine, and power transmission equipment manufacturing
3523	Farm Machinery and Equipment	333111[m]	Farm Machinery and Equipment Manufacturing	3331	Agriculture, construction, and mining machinery manufacturing
3531	Construction Machinery	333120[n]	Construction Machinery Manufacturing	3331	Agriculture, construction, and mining machinery manufacturing
3533	Oil and Gas Field Machinery	333132	Oil and Gas Field Machinery and Equipment Manufacturing	3331	Agriculture, construction, and mining machinery manufacturing
3535	Conveyors and Conveying Equipment	333922	Conveyor and Conveying Equipment Manufacturing	3339	Other general purpose machinery manufacturing
3537	Industrial Trucks and Tractors	333924[o]	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing	3339	Other general purpose machinery manufacturing
3553	Woodworking Machinery	333243	Sawmill, Woodworking, and Paper Machinery Manufacturing	3332	Industrial machinery manufacturing
3555	Printing Trades Machinery	333244	Printing Machinery and Equipment Manufacturing	3332	Industrial machinery manufacturing
3563	Air and Gas Compressors	333912	Air and Gas Compressor Manufacturing	3339	Other general purpose machinery manufacturing
3569	General Industrial Machinery, NEC	333999[p]	All Other Miscellaneous General Purpose Machinery Manufacturing	3339	Other general purpose machinery manufacturing

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[l] Original NAICS 336390 (Other Motor Vehicle Parts Manufacturing) incorrectly matched to SIC 3519; changed to NAICS 333618 (Other Engine Equipment Manufacturing).

[m] Original NAICS 333922 (Conveyor and Conveying Equipment Manufacturing) incorrectly matched to SIC 3523; changed to NAICS 333111 (Farm Machinery and Equipment Manufacturing).

[n] Original NAICS 336510 (Railyard Rolling Stock Manufacturing) incorrectly matched to SIC 3531; changed to NAICS 333120 (Construction Machinery Manufacturing).

[o] Original NAICS 332999 (All Other Miscellaneous Fabricated Metal Product Manufacturing) incorrectly matched to SIC 3537; changed to NAICS 333924 (Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing).

[p] Original NAICS 314999 (All Other Miscellaneous Textile Product Mills) incorrectly matched to SIC 3569; changed to NAICS 333999 (All Other Miscellaneous General Purpose Machinery Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3585	Refrigeration & Heating Equipment	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	3334	Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing
3599	Machinery Except Electrical, NEC	333999	All Other Miscellaneous General Purpose Machinery Manufacturing	3339	Other general purpose machinery manufacturing
3613	Switchgear & Switchboard Apparatus	335313	Switchgear and Switchboard Apparatus Manufacturing	3353	Electrical equipment manufacturing
3621	Motors and Generators	335312	Motor and Generator Manufacturing	3353	Electrical equipment manufacturing
3669	Communications Equipment, NEC	334290	Other Communications Equipment Manufacturing	3342	Communications equipment manufacturing
3672	Printed Circuit Boards	334412	Bare Printed Circuit Board Manufacturing	3344	Semiconductor and other electronic component manufacturing
3674	Semiconductors and Related Devices	334413	Semiconductor and Related Device Manufacturing	3344	Semiconductor and other electronic component manufacturing
3679	Electronic Components, NEC	334419	Other Electronic Component Manufacturing	3344	Semiconductor and other electronic component manufacturing
3699	Electrical Equipment & Supply	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	3359	Other electrical equipment and component manufacturing
3711	Motor Vehicles and Car Bodies	336112, 336111, 336211[q]	Light Truck and Utility Vehicle Manufacturing; Automobile Manufacturing; Motor Vehicle Body Manufacturing	3361 & 3362	(Motor vehicle manufacturing & Motor vehicle body and trailer manufacturing)
3713	Truck and Bus Bodies	336120[r]	Heavy Duty Truck Manufacturing	3361	Motor vehicle manufacturing
3714	Motor Vehicle Parts & Accessories	336390	Other Motor Vehicle Parts Manufacturing	3363	Motor vehicle parts manufacturing
3715	Truck Trailers	336212	Truck Trailer Manufacturing	3362	Motor vehicle body and trailer manufacturing
3716	Motor Homes	336213	Motor Home Manufacturing	3362	Motor vehicle body and trailer manufacturing
3721	Aircraft	336411	Aircraft Manufacturing	3364	Aerospace product and parts manufacturing
3724	Aircraft Engines & Engine Parts	336412	Aircraft Engine and Engine Parts Manufacturing	3364	Aerospace product and parts manufacturing

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[q] Original NAICS 336112 (Light Truck and Utility Vehicle Manufacturing); added NAICS 336111 (Automobile Manufacturing) and NAICS 336211 (Motor Vehicle Body Manufacturing) to NAICS 336112 for SIC 3711.

[r] Original NAICS 336211 (Motor Vehicle Body Manufacturing) incorrectly matched to SIC 3713; changed to NAICS 336120 (Heavy Duty Truck Manufacturing).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
3728	Aircraft Parts & Equipment, NEC	336413[s]	Other Aircraft Parts and Auxiliary Equipment Manufacturing	3364	Aerospace product and parts manufacturing
3731	Ship Building and Repairing	336611	Ship Building and Repairing	3366	Ship and boat building
3732	Boat Building and Repairing	336612	Boat Building	3366	Ship and boat building
3743	Railroad Equipment	336510	Railroad Rolling Stock Manufacturing	3365	Railroad rolling stock manufacturing
3792	Travel Trailers and Campers	336214	Travel Trailer and Camper Manufacturing	3362	Motor vehicle body and trailer manufacturing
3812	Search and Navigation Equipment	334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	3345	Navigational, measuring, electromedical, and control instruments manufacturing
3821	Laboratory Apparatus and Furniture	33911	Medical Equipment and Supplies Manufacturing	3391	Medical equipment and supplies manufacturing
3827	Optical Instruments and Lenses	333314	Optical Instrument and Lens Manufacturing	3333	Commercial and service industry machinery manufacturing
3949	Sporting & Athletic Goods, NEC	339920	Sporting and Athletic Goods Manufacturing	3399	Other miscellaneous manufacturing
3996	Hard Surface Floor Coverings	326199	All Other Plastics Product Manufacturing	3261	Plastics product manufacturing
3999	Manufacturing Industries, NEC	339999[t]	All Other Miscellaneous Manufacturing	3399	Other miscellaneous manufacturing
4212	Local trucking Without Storage	484110	General Freight Trucking, Local	4841	General freight trucking
4213	Trucking, Except Local	484230, 48412[u]	Specialized Freight (except Used Goods) Trucking, Long-Distance; General freight trucking, long-distance	4841 & 4842	(General freight trucking & Specialized freight trucking)
4214	Local Trucking With Storage	484110	General Freight Trucking, Local	4841	General freight trucking
4226	Special Warehousing and Storage	424710[v]	Petroleum Bulk Stations and Terminals	4247	Petroleum and petroleum products merchant wholesalers
4491	Marine Cargo Handling	488310	Port and Harbor Operations	4883	Support activities for water transportation

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[s] Original NAICS 332912 (Fluid Power Valve and Hose Fitting Manufacturing) incorrectly matched to SIC 3728; changed to NAICS 336413 (Other Aircraft Parts and Auxiliary Equipment Manufacturing).

[t] Original NAICS 325998 (All Other Miscellaneous Chemical Product and Preparation Manufacturing) incorrectly matched to SIC 3999; changed to NAICS 339999 (All Other Miscellaneous Manufacturing).

[u] Added NAICS 48412 (General Freight Trucking, Long-Distance) to NAICS 484230 for SIC 4213.

[v] Original NAICS 493110 (General Warehousing and Storage) was matched to SIC 4226; changed to NAICS 424710 (Petroleum Bulk Stations and Terminals) based on discussion with TCEQ.

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
4512	Air Transportation, Scheduled	481111	Scheduled Passenger Air Transportation	4811	Scheduled air transportation
4581	Airports, Flying Fields, Service	488111	Air Traffic Control	4881	Support activities for air transportation
4612	Crude Petroleum Pipe Lines	486110	Pipeline Transportation of Crude Oil	4860	Pipeline transportation
4613	Refined Petroleum Pipelines	486910	Pipeline Transportation of Refined Petroleum Products	4860	Pipeline transportation
4619	Pipelines, NEC	486990	All Other Pipeline Transportation	4860	Pipeline transportation
4741	Rental Of Railroad Cars	532411	Commercial Air, Rail, and Water Transportation Equipment Rental and Leasing	5324	Commercial and industrial machinery and equipment rental and leasing
4789	Transportation Services, NEC	488999	All Other Support Activities for Transportation	4889	Other support activities for transportation
4911	Electric Services	*AEO*[w]	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)	*AEO*, by fuel type, with and without CPP	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)
4922	Natural Gas Transmission	486210	Pipeline Transportation of Natural Gas	4860	Pipeline transportation
4923	Gas Transmission and Distribution	486210, 221210[x]	Pipeline Transportation of Natural Gas; Natural Gas Distribution	2212 & 4860	(Natural gas distribution & Pipeline transportation)
4925	Gas Production and Distribution	221210	Natural Gas Distribution	2212	Natural gas distribution
4931	Electric and Other Services Combined	*AEO*[y]	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)	*AEO*, by fuel type, with and without CPP	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)
4939	Combination Utility, NEC	*AEO*[z]	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)	*AEO*, by fuel type, with and without CPP	Electricity demand forecasts (2016 Early Release *AEO* data), by fuel type (CPP base case and no CPP scenario)
4941	Water Supply	221310	Water Supply and Irrigation Systems	2213	Water, sewage and other systems
4952	Sewerage Systems	221320	Sewage Treatment Facilities	2213	Water, sewage and other systems

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[w] The growth factor surrogate assignment for SIC 4911 was changed from Economy.com gross product data to 2016 Early Releases *AEO* electricity forecasts, by fuel type, based on TCEQ recommendation.

[x] Added NAICS 221210 (Natural Gas Distribution) to NAICS 486210 for SIC 4923.

[y] The growth factor surrogate assignment for SIC 4931 was changed from Economy.com gross product data to *AEO* electricity forecasts, by fuel type, based on TCEQ recommendation.

[z] The growth factor surrogate assignment for SIC 4939 was changed from Economy.com gross product data to *AEO* electricity forecasts, by fuel type, based on TCEQ recommendation.

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
4953	Refuse Systems	562212	Solid Waste Landfill	5622	Waste treatment and disposal
4961	Steam and Air Conditioning Supply	221330	Steam and Air-Conditioning Supply	2213	Water, sewage and other systems
5032	Brick, Stone, Related Materials	423320[aa]	Brick, Stone, and Related Construction Material Merchant Wholesalers	4233	Lumber and other construction materials merchant wholesalers
5047	Medicinal and Hospital Equipment	423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers	4234	Professional and commercial equipment and supplies merchant wholesalers
5052	Coal & Other Minerals & Ores	423520	Coal and Other Mineral and Ore Merchant Wholesalers	4235	Metal and mineral (except petroleum) merchant wholesalers
5075	Warm Air Heat & Air Conditioning	423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	4237	Hardware, and plumbing and heating equipment and supplies merchant wholesalers
5153	Grain and Field Beans	424510	Grain and Field Bean Merchant Wholesalers	4245	Farm product raw material merchant wholesalers
5169	Chemicals and Allied Products, NEC	424690	Other Chemical and Allied Products Merchant Wholesalers	4246	Chemical and allied products merchant wholesalers
5171	Petroleum Bulk Stations & Terminals	424710	Petroleum Bulk Stations and Terminals	4247	Petroleum and petroleum products merchant wholesalers
5541	Gasoline Service Stations	447110	Gasoline Stations with Convenience Stores	4471	Gasoline stations
5983	Fuel Oil Dealers	454310	Fuel Dealers	4543	Direct selling establishments
6399	Insurance Carriers, NEC	524128	Other Direct Insurance (except Life, Health, and Medical) Carriers	5241	Insurance carriers
7374	Data Processing and Data Preparation Services	518210	Data Processing, Hosting, and Related Services	5182	Data processing, hosting, and related services
7389	Business Services, NEC	561499	All Other Business Support Services	5614	Business support services
7532	Top, Body and Upholstery Repair & Paint Shops	811121	Automotive Body, Paint, and Interior Repair and Maintenance	8111	Automotive repair and maintenance
7542	Car Washes	811192	Car Washes	8111	Automotive repair and maintenance
7699	Repair Services, NEC	811[bb]	Repair and Maintenance	811X	Repair and maintenance
8062	General Medical & Surgical Hospitals	622110	General Medical and Surgical Hospitals	6221	General medical and surgical hospitals

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[aa] Original NAICS 444190 (Other Building Material Dealers) incorrectly matched to SIC 5032; changed to NAICS 423320 (Brick, Stone, and Related Construction Material Merchant Wholesalers).

[bb] Original NAICS 444120 (Paint and Wallpaper Stores) incorrectly matched to SIC 7699; changed to NAICS 811 (Repair and maintenance services).

Table B-1. Point Source SIC-to-NAICS Crosswalk and Growth Factor Surrogate Assignments

SIC	SIC Description	NAICS	NAICS Description	Growth Factor Surrogate (NAICS)	Surrogate Description (Gross product, Million Constant 2009 $)
8221	Colleges and Universities, NEC	611310	Colleges, Universities, and Professional Schools	6113	Colleges, universities, and professional schools
8731	Commercial Physical and Biological Research	54171	Research and Development in the Physical, Engineering, and Life Sciences	5417	Scientific research and development services
8733	Noncommercial Research Organizations	541720	Research and Development in the Social Sciences and Humanities	5417	Scientific research and development services
8734	Testing Laboratories	541380	Testing Laboratories	5413	Architectural, engineering, and related services
9661	Space Research and Technology	927110	Space Research and Technology	5417	Scientific research and development services
9711	National Security	928110	National Security	NA	NA (Constant/No Growth Scenario)
9999	Nonclassifiable Establishments	Constant[cc]	Constant/No Growth Scenario	NA	NA (Constant/No Growth Scenario)

[cc] Original NAICS 339 (Miscellaneous Manufacturing) incorrectly matched to SIC 9999; changed to a constant/straight line with no growth.

APPENDIX C
AREA SOURCE GROWTH FACTOR SURROGATE ASSIGNMENTS

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2102004000	Industrial Fuel Combustion: Distillate Oil: Boilers/IC Eng.	*AEO* regional consumption data[a]	Industrial - Distillate Fuel Oil
2102005000	Industrial Fuel Combustion: Residual Oil	*AEO* regional consumption data	Industrial - Residual Fuel Oil
2102006000	Industrial Fuel Combustion: Natural Gas: Boilers/IC Eng.	*AEO* regional consumption data	Industrial - Natural Gas
2102006001	Industrial Fuel Combustion - Natural Gas (Boilers)	*AEO* regional consumption data	Industrial - Natural Gas
2102006002	Industrial Fuel Combustion - Natural Gas (IC Engines)	*AEO* regional consumption data	Industrial - Natural Gas
2102007000	Industrial Fuel Combustion: Liquefied Petroleum Gas (LPG)	*AEO* regional consumption data	Industrial - Liquefied Petroleum Gases
2102008000	Industrial Fuel Combustion: Wood	*AEO* regional consumption data	Industrial - Renewable Energy
2102011000	Industrial Fuel Combustion: Kerosene	*AEO* regional consumption data	Industrial - Distillate Fuel Oil
2103004000	Commercial/Institutional Fuel Combustion: Distillate Oil	*AEO* regional consumption data	Commercial - Distillate Fuel Oil
2103005000	Commercial/Institutional Fuel Combustion: Residual Oil	*AEO* regional consumption data	Commercial - Residual Fuel Oil
2103006000	Commercial/Institutional Fuel Combustion - Natural Gas	*AEO* regional consumption data	Commercial - Natural Gas
2103007000	Commercial/Institutional Fuel Combustion: Liquefied Petroleum Gas (LPG) Combustors	*AEO* regional consumption data	Commercial - Propane
2103008000	Commercial/Institutional Fuel Combustion: Wood	*AEO* regional consumption data	Commercial - Renewable Energy
2103011000	Commercial/Institutional Fuel Combustion: Kerosene Combustors	*AEO* regional consumption data	Commercial - Kerosene
2104004000	Residential Fuel Combustion - Distillate Oil	*AEO* regional consumption data	Residential - Distillate Fuel Oil
2104005000	Residential Fuel Combustion - Residual Oil	*AEO* regional consumption data	Residential - Distillate Fuel Oil
2104006000	Residential Fuel Combustion: Natural Gas All Combustors	*AEO* regional consumption data	Residential - Natural Gas
2104007000	Residential Fuel Combustion: Liquefied Petroleum Gas (LPG)	*AEO* regional consumption data	Residential - Propane
2104008100	Residential Wood Combustion: Fireplaces	*AEO* regional consumption data	Residential - Renewable Energy
2104008210	Residential Wood Combustion: Woodstove Fireplace Inserts Non-EPA Certified	*AEO* regional consumption data	Residential - Renewable Energy
2104008220	Residential Wood Combustion: Woodstove Fireplace Inserts EPA Certified Non-Catalytic	*AEO* regional consumption data	Residential - Renewable Energy
2104008230	Residential Wood Combustion: Woodstove Fireplace Inserts EPA Certified Catalytic	*AEO* regional consumption data	Residential - Renewable Energy

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[a] *Annual Energy Outlook* consumption data for West South Central Region (Arkansas, Louisiana, Oklahoma, and Texas) (quadrillion BTU) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2104008300	Residential Fuel Combustion - Wood - Woodstoves (Freestanding)	*AEO* regional consumption data	Residential - Renewable Energy
2104008310	Residential Wood Combustion: Woodstoves Freestanding Non-EPA Certified	*AEO* regional consumption data	Residential - Renewable Energy
2104008320	Residential Wood Combustion: Woodstoves: Freestanding EPA Certified Non-Catalytic	*AEO* regional consumption data	Residential - Renewable Energy
2104008330	Residential Wood Combustion: Woodstoves Freestanding EPA Certified Catalytic	*AEO* regional consumption data	Residential - Renewable Energy
2104008400	Residential Wood Combustion: Woodstove Pellet Fired, General	*AEO* regional consumption data	Residential - Renewable Energy
2104008610	Residential Wood Combustion: Hydronic Heater: Outdoor	*AEO* regional consumption data	Residential - Renewable Energy
2104008700	Residential Wood Combustion: Outdoor Wood Burning Devices	*AEO* regional consumption data	Residential - Renewable Energy
2104009000	Residential Fuel Combustion: Firelog	*AEO* regional consumption data	Residential - Renewable Energy
2104011000	Residential Fuel Combustion: Kerosene	*AEO* regional consumption data	Residential - Kerosene
2294000000	Paved Roads: All Paved Roads: Total: Fugitives	Population[b]	NA
2296000000	Unpaved Roads: All Unpaved Roads Total: Fugitives	Population	NA
2302002100	Commercial Cooking: Conveyorized Charbroiling	Economy.com data[c]	Special food services & Restaurants and other eating places
2302002200	Commercial Cooking: Under-Fired Charbroiling	Economy.com data	Special food services & Restaurants and other eating places
2302003000	Commercial Cooking - Deep Fat Frying	Economy.com data	Special food services & Restaurants and other eating places
2302003100	Commercial Cooking - Flat Griddle Frying	Economy.com data	Special food services & Restaurants and other eating places
2302003200	Commercial Cooking - Clamshell Griddle Frying	Economy.com data	Special food services & Restaurants and other eating places
2302010000	Food: Meat Products	Economy.com data	Animal slaughtering and processing
2302040000	Food: Grain Mill Products	Economy.com data	Grain and oilseed milling
2302050000	Food: Bakery Products	Economy.com data	Bakeries and tortilla manufacturing
2302070001	Food: Fermentation/Beverages: Breweries	Economy.com data	Beverage manufacturing
2302070005	Food: Fermentation/Beverages: Wineries	Economy.com data	Beverage manufacturing
2304050000	Secondary Metals: Nonferrous Foundries (Castings)	Economy.com data	Foundries
2305070000	Mineral Processes: Concrete Gypsum Plaster Products	Economy.com data	Cement and concrete product manufacturing & Lime and gypsum product manufacturing
2306010000	Petroleum Refining: Asphalt Paving/Roofing Materials	Economy.com data	Petroleum and coal products manufacturing
2307020000	Wood Products: Sawmills/Planing Mills	Economy.com data	Sawmills and wood preservation
2307060000	Wood Products: Miscellaneous Wood Products	Economy.com data	Other wood product manufacturing
2309000000	Fabricated Metals: Total	Economy.com data	Fabricated metal product manufacturing
2309100010	Fabricated Metals: Electroplating	Economy.com data	Coating; engraving; heat treating; and allied activities
2309100080	Fabricated Metals: Hot Dip Galvanizing (Zinc)	Economy.com data	Coating; engraving; heat treating; and allied activities
2310000000	Industrial Processes- Oil and Gas Exploration and Production- All Processes: Total: All Processes	Projected production levels[d]	Weighted oil and gas production forecast

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[b] Texas State Data Center county-level population projections (TSDC, 2014).

[c] Economy.com county-level gross product data (million constant 2009 $) (Economy.com, 2016).

[d] Projected production levels based on analysis of curves developed using Hubbert's method (Hubbert, 1956; Hubbert, 1980).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310000220	Industrial Processes- Oil and Gas Exploration and Production- All Processes: Drill Rigs	Projected production levels	Weighted oil and gas production forecast
2310000230	Oil & Gas Exploration & Production /All Processes /Workover Rigs	Projected production levels	Weighted oil and gas production forecast
2310000330	Oil and Gas Exploration and Production Artificial Lift (Pumpjack)	Projected production levels	Oil production forecast
2310000440	Industrial Processes- Oil and Gas Exploration and Production- All Processes: Saltwater Disposal Engines	Projected production levels	Weighted oil and gas production forecast
2310000550	Produced Waters/ Saltwater Injection	Projected production levels	Weighted oil and gas production forecast
2310000660	Oil and Gas Exploration and Production: Hydraulic Fracturing Engines (Fracking)	Projected production levels	Weighted oil and gas production forecast
2310001000	Industrial Processes- Oil and Gas Exploration and Production- All Processes: On-Shore: Total: All Processes	Projected production levels	Weighted oil and gas production forecast
2310002000	Off Shore Oil & Gas Production All Processes	*AEO* offshore oil & gas production data[e]	Total offshore oil & gas production
2310002301	Off Shore Oil and Gas Production Flare Pilot Light	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002305	Off Shore Oil and Gas Production Flaring	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002401	Off Shore Oil and Gas Production Pneumatic Well Pumps	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002411	Off Shore Oil and Gas Production Pressure/Level Controllers	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310002421	Off Shore Oil and Gas Production Cold Vents	*AEO* offshore oil & gas production data	Total offshore oil & gas production
2310010000	Industrial Processes- Oil and Gas Exploration and Production- Crude Petroleum: Total: All Processes	Projected production levels	Oil production forecast
2310010100	Oil Production Well Heaters	Projected production levels	Oil production forecast
2310010200	Oil Production Tanks Including Flashing	Projected production levels	Oil production forecast
2310010300	Oil Production Pneumatic Devices	Projected production levels	Oil production forecast
2310010700	Industrial Processes- Oil and Gas Exploration and Production- Crude Petroleum: Oil Well Fugitives	Projected production levels	Oil production forecast
2310010800	Industrial Processes- Oil and Gas Exploration and Production- Crude Petroleum: Oil Well Truck Loading	Projected production levels	Oil production forecast
2310011000	On Shore Crude Oil Production All Processes (Casinghead Gas)	Projected production levels	Oil production forecast
2310011020	On Shore Oil Production Crude Tanks (Including Flash)	Projected production levels	Oil production forecast
2310011100	On Shore Oil Production Heater Treater	Projected production levels	Oil production forecast

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[e] *Annual Energy Outlook* combined offshore oil and natural gas production data for Gulf (quadrillion BTU) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310011201	On Shore Oil Production Truck/Rail Loading of Crude	Projected production levels	Oil production forecast
2310011450	On Shore Oil Production Wellhead	Projected production levels	Oil production forecast
2310011500	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Production: Fugitives: All Processes	Projected production levels	Oil production forecast
2310011501	On Shore Oil Production Fugitives Connectors	Projected production levels	Oil production forecast
2310011502	On Shore Oil Production Fugitives Flanges	Projected production levels	Oil production forecast
2310011503	On Shore Oil Production Fugitives Open Ended Lines	Projected production levels	Oil production forecast
2310011504	On Shore Oil Production Fugitives Pumps	Projected production levels	Oil production forecast
2310011505	On Shore Oil Production Fugitives Valves	Projected production levels	Oil production forecast
2310011506	On Shore Oil Production Fugitives Other	Projected production levels	Oil production forecast
2310011600	On-Shore Oil Production /Artificial Lift Engines	Projected production levels	Oil production forecast
2310012000	Off Shore Crude Oil Production Total All Processes	*AEO* offshore oil production data[f]	Total offshore oil production
2310012020	Off Shore Oil Production Crude Oil Storage	*AEO* offshore oil production data	Total offshore oil production
2310012201	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Production: Barge Loading: Crude Oil	*AEO* offshore oil production data	Total offshore oil production
2310012511	Off Shore Oil Production Fugitives Connectors Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012512	Off Shore Oil Production Fugitives Flanges Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012515	Off Shore Oil Production Fugitives Valves Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012516	Off Shore Oil Production Fugitives Other Oil Streams	*AEO* offshore oil production data	Total offshore oil production
2310012521	Off Shore Oil Production Fugitives Connectors Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310012522	Off Shore Oil Production Fugitives Flanges Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310012525	Off Shore Oil Production Fugitives Valves Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310012526	Off Shore Oil Production Fugitives Other Oil/Water	*AEO* offshore oil production data	Total offshore oil production
2310020000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Total: All Processes	Projected production levels	Gas production forecast

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[f] *Annual Energy Outlook* offshore oil production data for Gulf (million barrels/day) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310020600	Gas Production Compressor Engines	Projected production levels	Gas production forecast
2310020700	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Gas Well Fugitives	Projected production levels	Gas production forecast
2310020800	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Gas Well Truck Loading	Projected production levels	Condensate production forecast
2310021000	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Processes	Projected production levels	Gas production forecast
2310021010	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Storage Tanks: Condensate	Projected production levels	Gas production forecast
2310021011	On-Shore Gas Production / Condensate Tank Flaring	Projected production levels	Condensate production forecast
2310021030	On Shore Gas Production Truck and Rail Loading of Condensate	Projected production levels	Gas production forecast
2310021100	On-Shore Gas Production Heaters	Projected production levels	Gas production forecast
2310021101	On-Shore Gas Production: Natural Gas Fired 2-Cycle Lean Burn Compressor Engines <50 hp	Projected production levels	Gas production forecast
2310021102	On-Shore Gas Production: Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 50 To 499 hp	Projected production levels	Gas production forecast
2310021103	On-Shore Gas Production Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 500+ hp	Projected production levels	Gas production forecast
2310021109	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Natural Gas Fired 2Cycle Lean Burn Compressor Engines	Projected production levels	Gas production forecast
2310021201	On-Shore Gas Production Natural Gas Fired 4-Cycle Lean Burn Compressor Engines <50 hp	Projected production levels	Gas production forecast
2310021202	On-Shore Gas Production Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 50 hp - 499 hp	Projected production levels	Gas production forecast
2310021203	On-Shore Gas Production Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 500+ hp	Projected production levels	Gas production forecast
2310021209	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Natural Gas Fired 4Cycle Lean Burn Compressor Engines	Projected production levels	Gas production forecast
2310021251	Lateral/Gathering Line Compressors (4Cycle Lean)	Projected production levels	Gas production forecast
2310021300	On-Shore Gas Production Pneumatic Devices	Projected production levels	Gas production forecast
2310021301	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 hp	Projected production levels	Gas production forecast
2310021302	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50 To 499 hp	Projected production levels	Gas production forecast
2310021303	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ hp	Projected production levels	Gas production forecast

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310021309	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Natural Gas Fired 4Cycle Rich Burn Compressor Engines	Projected production levels	Gas production forecast
2310021310	On-Shore Gas Production / Gas Well Pneumatic Pumps	Projected production levels	Gas production forecast
2310021351	Lateral/Gathering Line Compressors (4Cycle Rich)	Projected production levels	Gas production forecast
2310021400	On-Shore Gas Production Dehydrators	Projected production levels	Gas production forecast
2310021401	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Eng. <50 hp W/ Non Specific Catalytic Reduction	Projected production levels	Gas production forecast
2310021402	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Eng. 50-499 hp W/ Non Specific Catalytic Reduction	Projected production levels	Gas production forecast
2310021403	On-Shore Gas Production Natural Gas Fired 4-Cycle Rich Burn Compressor Eng. 500+ hp W/ Non Specific Catalytic Reduction	Projected production levels	Gas production forecast
2310021409	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Total: All Nat Gas Fired 4Cycle Rich Burn Compressor Engines W/ Nscr	Projected production levels	Gas production forecast
2310021410	On-Shore Gas Production /Amine Unit	Projected production levels	Gas production forecast
2310021411	On-Shore Gas Production / Gas Well Dehydrators – Flaring	Projected production levels	Gas production forecast
2310021450	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Wellhead	Projected production levels	Gas production forecast
2310021500	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Gas Well Completion - Flaring and Venting	Projected production levels	Gas production forecast
2310021501	On-Shore Gas Production: Fugitives: Connectors	Projected production levels	Gas production forecast
2310021502	On-Shore Gas Production: Fugitives: Flanges	Projected production levels	Gas production forecast
2310021503	On-Shore Gas Production: Fugitives: Open Ended Lines	Projected production levels	Gas production forecast
2310021504	On-Shore Gas Production: Fugitives: Pumps	Projected production levels	Gas production forecast
2310021505	On-Shore Gas Production: Fugitives: Valves	Projected production levels	Gas production forecast
2310021506	On-Shore Gas Production: Fugitives: Other	Projected production levels	Gas production forecast
2310021509	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Production: Fugitives: All Processes	Projected production levels	Gas production forecast
2310021600	On-Shore Gas Production Gas Well Venting	Projected production levels	Gas production forecast
2310021601	On-Shore Gas Production / Gas Well Venting - Initial Completions	Projected production levels	Gas production forecast
2310021602	On-Shore Gas Production / Gas Well Venting - Recompletions	Projected production levels	Gas production forecast

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310021603	Gas Well Venting – Blowdowns	Projected production levels	Gas production forecast
2310021604	On-Shore Gas Production / Gas Well Venting - Compressor Startups	Projected production levels	Gas production forecast
2310021605	On-Shore Gas Production / Gas Well Venting - Compressor Shutdowns	Projected production levels	Gas production forecast
2310021700	On-Shore Gas Production / Miscellaneous Engines	Projected production levels	Gas production forecast
2310022000	Off Shore Gas Production Total All Processes	*AEO* offshore natural gas production data[g]	Total offshore natural gas production
2310022010	Off-Shore Gas Production: Storage Tanks: Condensate	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022051	Off-Shore Gas Production: Turbines: Natural Gas	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022090	Off-Shore Gas Production: Boilers/Heaters: Natural Gas	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022105	Off-Shore Gas Production: Diesel Engines	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022300	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Production: Compressor Engines: 4Cycle Rich	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022410	Off-Shore Natural Gas Production Amine Unit	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022420	Off-Shore Gas Production: Dehydrator	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022501	Off-Shore Gas Production: Fugitives: Connectors: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022502	Off-Shore Gas Production: Fugitives: Flanges: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022505	Off-Shore Gas Production: Fugitives: Valves: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production
2310022506	Off-Shore Gas Production: Fugitives: Other: Gas Streams	*AEO* offshore natural gas production data	Total offshore natural gas production

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[g] *Annual Energy Outlook* offshore natural gas production data for Gulf (trillion dry cubic feet) (EIA, 2016a).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310023000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas: Cbm Gas Well - Dewatering Pump Engines	Projected production levels	Gas production forecast
2310030000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Total: All Processes	Projected production levels	Condensate production forecast
2310030210	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Gas Well Tanks - Flashing & Standing/Working/Breathing, Uncontrolled	Projected production levels	Condensate production forecast
2310030220	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Gas Well Tanks - Flashing & Standing/Working/Breathing, Controlled	Projected production levels	Condensate production forecast
2310030230	Natural Gas Liquids / Gas Well Tanks - Flaring	Projected production levels	Gas production forecast
2310030300	Natural Gas Liquids / Gas Well Water Tank Losses	Projected production levels	Gas production forecast
2310030400	Natural Gas Liquids / Truck Loading	Projected production levels	Gas production forecast
2310030401	Natural Gas Liquids / Gas Plant Truck Loading	Projected production levels	Gas production forecast
2310031000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: On-Shore: Total: All Processes	Projected production levels	Condensate production forecast
2310032000	Industrial Processes- Oil and Gas Exploration and Production- Natural Gas Liquids: Off-Shore: Total: All Processes	*AEO* offshore natural gas production data	Total offshore natural gas production
2310111000	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Exploration: All Processes	Projected production levels	Oil production forecast
2310111100	On-Shore Oil Exploration: Mud Degassing	Projected production levels	Oil production forecast
2310111401	On-Shore Oil Exploration: Oil Well Pneumatic Pumps	Projected production levels	Oil production forecast
2310111700	On-Shore Oil Exploration: Oil Well Completion: All Processes	Projected production levels	Oil production forecast
2310111701	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Exploration: Oil Well Completion: Flaring	Projected production levels	Oil production forecast
2310111702	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Oil Exploration: Oil Well Completion: Venting	Projected production levels	Oil production forecast
2310112000	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: All Processes	*AEO* offshore oil production data	Total offshore oil production
2310112100	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Mud Degassing Activities	*AEO* offshore oil production data	Total offshore oil production
2310112401	Off-Shore Oil Exploration: Oil Well Pneumatic Pumps	*AEO* offshore oil production data	Total offshore oil production
2310112700	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Oil Well Completion: All Processes	*AEO* offshore oil production data	Total offshore oil production
2310112701	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Oil Well Completion: Flaring	*AEO* offshore oil production data	Total offshore oil production

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2310112702	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Oil Exploration: Oil Well Completion: Venting	*AEO* offshore oil production data	Total offshore oil production
2310121000	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: All Processes	Projected production levels	Gas production forecast
2310121100	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Mud Degassing	Projected production levels	Gas production forecast
2310121401	On-Shore Gas Exploration: Gas Well Pneumatic Pumps	Projected production levels	Gas production forecast
2310121700	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Gas Well Completion: All Processes	Projected production levels	Gas production forecast
2310121701	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Gas Well Completion: Flaring	Projected production levels	Gas production forecast
2310121702	Industrial Processes- Oil and Gas Exploration and Production- On-Shore Gas Exploration: Gas Well Completion: Venting	Projected production levels	Gas production forecast
2310122000	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: All Processes	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122100	Off-Shore Gas Exploration: Mud Degassing	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122401	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Pneumatic Pumps	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122700	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Completion: All Processes	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122701	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Completion: Flaring	*AEO* offshore natural gas production data	Total offshore natural gas production
2310122702	Industrial Processes- Oil and Gas Exploration and Production- Off-Shore Gas Exploration: Gas Well Completion: Venting	*AEO* offshore natural gas production data	Total offshore natural gas production
2311010000	Residential Construction: Total	Economy.com data	Residential building construction
2311020000	Industrial/Commercial/Institutional Construction: Total	Economy.com data	Nonresidential building construction
2311030000	Road Construction: Total	Economy.com data	Highway; street; and bridge construction
2325000000	Mining & Quarrying: All Processes	Economy.com data	Mining (except oil and gas)
2325020000	Mining & Quarrying: Crushed and Broken Stone	Economy.com data	Nonmetallic mineral mining and quarrying
2325050000	Mining & Quarrying - Chemical and Fertilizer Materials	Economy.com data	Nonmetallic mineral mining and quarrying
2399000000	Industrial Processes - Not Elsewhere Classified	Economy.com data	Miscellaneous manufacturing
2401001000	Surface Coating: Architectural Coatings: Total: All Solvent Types	Population	NA
2401005000	Surface Coating: Auto Refinishing: Total: All Solvent Types	Economy.com data	Automotive repair and maintenance
2401008000	Surface Coating: Traffic Markings: Total: All Solvent Types	Economy.com data	Highway; street; and bridge construction
2401010000	Surface Coating: Textile Products: Total: All Solvent Types	Economy.com data	Textile mills & Textile product mills
2401015000	Surface Coating: Factory Finished Wood: Total: All Solvent Types	Economy.com data	Wood product manufacturing
2401020000	Surface Coating: Wood Furniture: Total: All Solvent Types	Economy.com data	Furniture and related product manufacturing
2401025000	Surface Coating: Metal Furniture: Total: All Solvent Types	Economy.com data	Furniture and related product manufacturing

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2401030000	Surface Coating: Paper: Total: All Solvent Types	Economy.com data	Paper manufacturing
2401035000	Surface Coating: Plastics: Total: All Solvent Types	Economy.com data	Plastics product manufacturing
2401040000	Surface Coating: Metal Cans: Total: All Solvent Types	Economy.com data	Boiler; tank; and shipping container manufacturing
2401045000	Surface Coating: Metal Coils: Total: All Solvent Types	Economy.com data	Spring and wire product manufacturing
2401050000	Surface Coating: Misc. Finished Metals: Total: All Solvent Types	Economy.com data	Fabricated metal product manufacturing
2401055000	Surface Coating: Machinery & Equipment: Total: All Solvent Types	Economy.com data	Machinery manufacturing
2401060000	Surface Coating: Large Appliances: Total: All Solvent Types	Economy.com data	Household appliance manufacturing
2401065000	Surface Coating: Electronic & Other Electrical: Total: All Solvent Types	Economy.com data	Computer and electronic product manufacturing & Electrical equipment; appliance; and component manufacturing
2401070000	Surface Coating: Motor Vehicles: Total: All Solvent Types	Economy.com data	Motor vehicle manufacturing, Motor vehicle body and trailer manufacturing, and Motor vehicle parts manufacturing
2401075000	Surface Coating: Aircraft: Total: All Solvent Types	Economy.com data	Aerospace product and parts manufacturing
2401080000	Surface Coating: Marine: Total: All Solvent Types	Economy.com data	Ship and boat building
2401085000	Surface Coating: Railroad: Total: All Solvent Types	Economy.com data	Railroad rolling stock manufacturing
2401090000	Surface Coating: Misc. Manufacturing: Total: All Solvent Types	Economy.com data	Miscellaneous manufacturing
2401100000	Surface Coating: Industrial Maintenance: Total: All Solvent Types	Economy.com data	Manufacturing, 3XX
2401200000	Surface Coating: Special Purpose: Total: All Solvent Types	Economy.com data	Manufacturing, 3XX
2401990000	All Surface Coating Categories	Economy.com data	Manufacturing, 3XX
2415000000	Degreasing: All Processes: All Industries: Total: All Solvent Types	Economy.com data	Manufacturing, 3XX
2415100000	Degreasing (Open Top) - All Industries	Economy.com data	Manufacturing, 3XX
2415105000	Degreasing (Open Top) - Furniture & Fixtures	Economy.com data	Furniture and related product manufacturing
2415110000	Degreasing (Open Top) - Primary Metal Ind.	Economy.com data	Primary metal manufacturing
2415120000	Degreasing (Open Top) - Fabricated Metal	Economy.com data	Fabricated metal product manufacturing
2415125000	Degreasing (Open Top) - Industrial Machinery & Equip	Economy.com data	Machinery manufacturing
2415130000	Degreasing (Open Top) - Electronic & Other Electric	Economy.com data	Computer and electronic product manufacturing & Electrical equipment; appliance; and component manufacturing
2415135000	Degreasing (Open Top) - Transportation Equipment	Economy.com data	Transportation equipment manufacturing
2415140000	Degreasing (Open Top) - Instruments & Related Products	Economy.com data	Navigational; measuring; electromedical; and control instruments manufacturing, Medical equipment and supplies manufacturing, and Commercial and service industry machinery manufacturing
2415145000	Degreasing (Open Top) - Misc. Manufacturing	Economy.com data	Miscellaneous manufacturing
2415300000	Degreasing (Cold Cleaning) - All Industries	Economy.com data	Manufacturing, 3XX
2415305000	Degreasing (Cold Cleaning) - Furniture & Fixtures	Economy.com data	Furniture and related product manufacturing
2415310000	Degreasing (Cold Cleaning) - Primary Metal Ind.	Economy.com data	Primary metal manufacturing
2415320000	Degreasing (Cold Cleaning) - Fabricated Metal	Economy.com data	Fabricated metal product manufacturing
2415325000	Degreasing (Cold Cleaning) - Industrial Machinery & Equipment	Economy.com data	Machinery manufacturing
2415330000	Degreasing (Cold Cleaning) - Electronic & Other Electric	Economy.com data	Computer and electronic product manufacturing & Electrical equipment; appliance; and component manufacturing
2415335000	Degreasing (Cold Cleaning) - Transportation Equipment	Economy.com data	Transportation equipment manufacturing
2415340000	Degreasing (Cold Cleaning) - Instruments & Related Products	Economy.com data	Navigational; measuring; electromedical; and control instruments manufacturing, Medical equipment and supplies manufacturing, and Commercial and service industry machinery manufacturing
2415345000	Degreasing (Cold Cleaning) - Misc. Manufacturing	Economy.com data	Miscellaneous manufacturing
2415355000	Degreasing (Cold Cleaning) - Automotive Dealers	Economy.com data	Motor vehicle and parts dealers
2415360000	Degreasing (Cold Cleaning) - Auto Repair Services	Economy.com data	Automotive repair and maintenance

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2415365000	Degreasing (Cold Cleaning) - Misc. Repair Services	Economy.com data	Electronic and precision equipment repair and maintenance, Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance, and Personal and household goods repair and maintenance
2420000000	Dry Cleaning: All Processes: All Solvent Types	Economy.com data	Drycleaning and laundry services
2420010055	Dry Cleaning - Commercial/Industrial (Perchloroethylene)	Economy.com data	Drycleaning and laundry services
2420010370	Dry Cleaning - Commercial/Industrial (Special Naphthas)	Economy.com data	Drycleaning and laundry services
2420020055	Dry Cleaning - Coin Operated (Perchloroethylene)	Economy.com data	Drycleaning and laundry services
2425000000	Graphic Arts: All Processes: All Solvent Types	Economy.com data	Printing and related support activities
2430000000	Rubber/Plastics: All Processes: Total - All Solvent Types	Economy.com data	Plastics and rubber products manufacturing
2440020000	Misc. Industrial: Total: All Solvent Types	Economy.com data	Miscellaneous manufacturing
2460100000	Consumer/Commercial: All Personal Care Products	Population	NA
2460200000	Consumer/Commercial: All Household Products	Population	NA
2460400000	Consumer/Commercial: All Automotive Aftermarket Products	Population	NA
2460500000	Consumer/Commercial: All Coatings and Related Products	Population	NA
2460520000	Consumer/Commercial Solvent Use (Coatings Related Products)	Population	NA
2460600000	Consumer/Commercial: All Adhesives and Sealants	Population	NA
2460800000	Consumer/Commercial: All Fifra Related Products	Population	NA
2460900000	Consumer/Commercial: Miscellaneous Products: Nec	Population	NA
2461021000	Commercial Products: Cutback Asphalt: All Solvent Types	Economy.com data	Highway; street; and bridge construction
2461022000	Commercial Products: Emulsified Asphalt: All Solvent Types	Economy.com data	Highway; street; and bridge construction
2461023000	Asphalt Application - Asphalt Roofing	Economy.com data	Nonresidential building construction
2461800000	Commercial Solvent Use - Pesticides (All)	Population	NA
2461850000	Commercial Products: Pesticides: Herbicides: All Processes	Population	NA
2465000000	Consumer Solvent Use (Total)	Population	NA
2465100000	Consumer Solvent Use (Personal Care Products)	Population	NA
2501000090	Petroleum Product Storage and Transport (Breathing) - Distillate Oil	*AEO* regional consumption data	Total - Distillate Fuel Oil (Consumption, quadrillion BTU)
2501000120	Petroleum Product Storage and Transport (Breathing) - Gasoline	*AEO* regional consumption data	Total - Motor Gasoline (Consumption, quadrillion BTU)
2501000150	Petroleum Product Storage and Transport (Breathing) - Jet Naphtha	*AEO* regional consumption data	Total - Jet Fuel (Consumption, quadrillion BTU)
2501000180	Petroleum Product Storage and Transport (Breathing) - Kerosene	*AEO* regional consumption data	Total - Kerosene (Consumption, quadrillion BTU)
2501010030	Petroleum Product Storage and Transport (Breathing) - Crude Oil	*AEO* regional consumption data	Total Crude production - Offshore and Onshore, (million barrels)
2501010060	Petroleum Product Storage and Transport (Breathing) - Residual Oil	*AEO* regional consumption data	Total - Residual Fuel Oil (Consumption, quadrillion BTU)
2501011011	Residential Portable Gas Cans: Permeation	Population	NA
2501011012	Residential Portable Gas Cans: Evaporation	Population	NA
2501011013	Residential Portable Gas Cans: Spillage During Transport	Population	NA
2501011014	Residential Portable Gas Cans: Refilling at the Pump- Vapor Displacement	Population	NA
2501011015	Residential Portable Gas Cans: Refilling at the Pump- Spillage	Population	NA
2501012011	Commercial Portable Gas Cans: Permeation	Population	NA

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2501012012	Commercial Portable Gas Cans: Evaporation (Includes Diurnal Losses)	Population	NA
2501012013	Commercial Portable Gas Cans: Spillage During Transport	Population	NA
2501012014	Commercial Portable Gas Cans: Refilling at the Pump- Vapor Displacement	Population	NA
2501012015	Commercial Portable Gas Cans: Refilling at the Pump- Spillage	Population	NA
2501050120	Petroleum Product Storage Gasoline Bulk Terminals All Evaporative Losses.	*AEO* regional consumption data	Total - Motor Gasoline
2501055120	Petroleum Product Storage Gasoline Bulk Plants All Evaporative Losses	*AEO* regional consumption data	Total - Motor Gasoline
2501060051	Petroleum Products: Gasoline Service Stations: Stage 1: Submerged Filling	*AEO* regional consumption data	Total - Motor Gasoline
2501060052	Petroleum Products: Gasoline Service Stations: Stage 1: Splash Filling	*AEO* regional consumption data	Total - Motor Gasoline
2501060053	Petroleum Products: Gasoline Service Stations: Stage 1: Balanced Submerged Filling	*AEO* regional consumption data	Total - Motor Gasoline
2501060100	Gasoline Service Stations - Stage 2 (Total)	*AEO* regional consumption data	Total - Motor Gasoline
2501060101	Petroleum Products: Gasoline Service Stations: Stage 2: Displacement Loss/Uncontrolled	*AEO* regional consumption data	Total - Motor Gasoline
2501060102	Petroleum Products: Gasoline Service Stations: Stage 2: Displacement Loss/Controlled	*AEO* regional consumption data	Total - Motor Gasoline
2501060103	Petroleum Products: Gasoline Service Stations: Stage 2: Spillage	*AEO* regional consumption data	Total - Motor Gasoline
2501060200	Petroleum Products: Gasoline Service Stations: Underground Tank: Total	*AEO* regional consumption data	Total - Motor Gasoline
2501060201	Gasoline Service Stations - Underground Tank Breathing and Emptying	*AEO* regional consumption data	Total - Motor Gasoline
2501070100	Petroleum Products: Diesel Service Stations: Stage 2: Total	*AEO* regional consumption data	Total - Distillate Fuel Oil
2501080050	Airports Aviation Gasoline Stage 1 Total	*AEO* regional consumption data	Total - Jet Fuel
2501080100	Airports Aviation Gasoline Stage 2 Total	*AEO* regional consumption data	Total - Jet Fuel
2501995120	Petroleum Product Storage and Transport (Working Loss) - Gasoline	*AEO* regional consumption data	Total - Motor Gasoline
2505020000	Petroleum Products: Marine Vessel Transport: Total: All Products	*AEO* regional production data[h]	Total Crude production - Offshore and Onshore
2505030120	Petroleum Products: Truck Transport: Gasoline	*AEO* regional consumption data	Total - Motor Gasoline
2505040120	Petroleum Products: Pipeline Transport: Gasoline	*AEO* regional consumption data	Total - Motor Gasoline
2515040000	Organic Chemical Transport: Pipelines: Total: All Products	Economy.com data	Pipeline transportation
2515040045	Organic Chemical Transport: Pipelines: 1,3-Butadiene	Economy.com data	Pipeline transportation

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[h] *Annual Energy Outlook* offshore and onshore oil production data (million barrels/day).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2515040190	Organic Chemical Transport: Pipelines: Ethylene	Economy.com data	Pipeline transportation
2515040348	Organic Chemical Transport: Pipelines: Propylene	Economy.com data	Pipeline transportation
2601010000	Waste Disposal Treatment: On-Site Incineration: Industrial	Economy.com data	Waste treatment and disposal
2601020000	Waste Disposal Treatment: On-Site Incineration: Commercial/Institutional	Population	NA
2610000100	Open Burning: Yard Waste: Leaves: Unspecified	Population	NA
2610000400	Open Burning: Yard Waste: Brush: Unspecified	Population	NA
2610000500	Open Burning: Land Clearing Debris Except Logging Debris	Economy.com data	Other specialty trade contractors
2610030000	Open Burning: Residential: Household Wastes	Population	NA
2620000000	Landfills – All	Population	NA
2620030000	Landfills: Municipal: Total	Population	NA
2630000000	Wastewater Treatment – All	Population	NA
2630020000	Wastewater Treatment: Public Owned: Total Processed	Population	NA
2660000000	Leaking Underground Storage Tanks: All Types	Economy.com data	Remediation and other waste management services
2801000000	Agriculture Production (Total)	Constant[i]	Constant/No Growth Scenario
2801000003	Agriculture: Crops: Tilling	Constant	Constant/No Growth Scenario
2801500000	Agriculture: Field Burning: Total All Crop Types	Constant	Constant/No Growth Scenario
2801700001	Agriculture: Fertilizer Application: Anhydrous Ammonia	Constant	Constant/No Growth Scenario
2801700002	Agriculture: Fertilizer Application: Aqua Ammonia	Constant	Constant/No Growth Scenario
2801700003	Agriculture: Fertilizer Application: Nitrogen Solutions	Constant	Constant/No Growth Scenario
2801700004	Agriculture: Fertilizer Application: Urea	Constant	Constant/No Growth Scenario
2801700005	Agriculture: Fertilizer Application: Ammonium Nitrate	Constant	Constant/No Growth Scenario
2801700006	Agriculture: Fertilizer Application: Ammonium Sulfate	Constant	Constant/No Growth Scenario
2801700007	Agriculture: Fertilizer Application: Ammonium Thiosulfate	Constant	Constant/No Growth Scenario
2801700008	Fertilizer Application - Other Straight Nitrogen	Constant	Constant/No Growth Scenario
2801700009	Fertilizer Application - Ammonium Phosphates	Constant	Constant/No Growth Scenario
2801700010	Agriculture: Fertilizer Application: N-P-K	Constant	Constant/No Growth Scenario
2801700011	Agriculture: Fertilizer Application: Calcium Ammonium Nitrate	Constant	Constant/No Growth Scenario
2801700012	Agriculture: Fertilizer Application: Potassium Nitrate	Constant	Constant/No Growth Scenario
2801700013	Agriculture: Fertilizer Application: Diammonium Phosphate	Constant	Constant/No Growth Scenario
2801700014	Agriculture: Fertilizer Application: Monoammonium Phosphate	Constant	Constant/No Growth Scenario
2801700015	Agriculture: Fertilizer Application: Liquid Ammonium Polyphosphate	Constant	Constant/No Growth Scenario
2801700099	Agriculture: Fertilizer Application: Miscellaneous Fertilizers	Constant	Constant/No Growth Scenario
2805001000	Beef Cattle Feedlots – Total	Constant	Constant/No Growth Scenario
2805001100	Agriculture: Beef Cattle Feedlots: Confinement	Constant	Constant/No Growth Scenario
2805001200	Agriculture: Beef Cattle Feedlots: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805001300	Agriculture: Beef Cattle Feedlots: Land Application of Manure	Constant	Constant/No Growth Scenario
2805002000	Agriculture: Beef Cattle Production Composite Nec	Constant	Constant/No Growth Scenario
2805003100	Agriculture: Beef Cattle Pasture/Range: Confinement	Constant	Constant/No Growth Scenario
2805007100	Agriculture: Poultry Prod. Layers W/ Dry Manure Mgmt Confinment	Constant	Constant/No Growth Scenario
2805007300	Agriculture: Poultry Prod - Land Application of Manure	Constant	Constant/No Growth Scenario

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[i] Emissions are assumed to be constant over time (i.e., growth factor is 1.0000).

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2805008100	Agriculture: Poultry Production: Layers with Wet Manure Confinment	Constant	Constant/No Growth Scenario
2805008200	Agriculture: Poultry Production: Wet Manure Handling and Storage	Constant	Constant/No Growth Scenario
2805008300	Agriculture: Poultry Prod. Land Application of Wet Manure	Constant	Constant/No Growth Scenario
2805009100	Agriculture: Poultry: Confinement	Constant	Constant/No Growth Scenario
2805009200	Agriculture: Poultry: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805009300	Agriculture: Poultry: Land Application of Manure	Constant	Constant/No Growth Scenario
2805010100	Agriculture: Turkey Production: Confinement	Constant	Constant/No Growth Scenario
2805010200	Agriculture: Turkey Production: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805010300	Agriculture: Turkey Production: Land Application of Manure	Constant	Constant/No Growth Scenario
2805018000	Agriculture: Dairy Cattle: Composite: Nec	Constant	Constant/No Growth Scenario
2805019100	Agriculture: Dairy Cattle: Flush Dairy: Confinement	Constant	Constant/No Growth Scenario
2805019200	Agriculture: Dairy Cattle: Flush Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805019300	Agriculture: Dairy Cattle: Flush Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805021100	Agriculture: Dairy Cattle: Scrape Dairy: Confinement	Constant	Constant/No Growth Scenario
2805021200	Agriculture: Dairy Cattle: Scrape Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805021300	Agriculture: Dairy Cattle: Scrape Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805022100	Agriculture: Dairy Cattle: Deep Pit Dairy: Confinement	Constant	Constant/No Growth Scenario
2805022200	Agriculture: Dairy Cattle: Deep Pit Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805022300	Agriculture: Dairy Cattle: Deep Pit Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805023100	Agriculture: Dairy Cattle: Drylot/Pasture Dairy: Confinement	Constant	Constant/No Growth Scenario
2805023200	Agriculture: Dairy Cattle: Drylot/Pasture Dairy: Manure Handling/Storage	Constant	Constant/No Growth Scenario
2805023300	Agriculture: Dairy Cattle: Drylot/Pasture Dairy: Land Application of Manure	Constant	Constant/No Growth Scenario
2805025000	Hogs & Pigs - Composite	Constant	Constant/No Growth Scenario
2805030000	Agriculture: Poultry & Chickens: Composite	Constant	Constant/No Growth Scenario
2805030007	Agriculture: Poultry & Chickens: Ducks	Constant	Constant/No Growth Scenario
2805030008	Agriculture: Poultry & Chickens: Geese	Constant	Constant/No Growth Scenario
2805035000	Agriculture: Horses & Ponies: Composite	Constant	Constant/No Growth Scenario
2805039100	Agriculture: Swine Production: Lagoons: Confinement	Constant	Constant/No Growth Scenario
2805039200	Agriculture: Swine Production: Lagoons: Manure Handling & Storage	Constant	Constant/No Growth Scenario
2805039300	Agriculture: Swine Production: Lagoons: Land Application of Manure	Constant	Constant/No Growth Scenario
2805040000	Agriculture: Sheep & Lambs: Composite	Constant	Constant/No Growth Scenario
2805045000	Agriculture: Goats: Waste Emissions Nec	Constant	Constant/No Growth Scenario
2805047100	Agriculture: Swine Production: Deep-Pit House: Land Application of Manure: Confinement	Constant	Constant/No Growth Scenario
2805047300	Agriculture: Swine Production: Deep-Pit House: Land Application of Manure	Constant	Constant/No Growth Scenario

Table C-1. Area Source Growth Factor Surrogate Assignments

SCC	SCC Description	Growth Factor Surrogate	Surrogate Description
2805053100	Agriculture: Swine Production: Out Door Operations: Land Application of Manure	Constant	Constant/No Growth Scenario
2806010000	Domestic Animals: Waste Emissions: Cats: Total	Population	NA
2806015000	Domestic Animals: Waste Emissions: Dogs: Total	Population	NA
2807025000	Wild Animals: Waste Emissions: Elk: Total	Constant	Constant/No Growth Scenario
2807030000	Wild Animals: Waste Emissions: Deer: Total	Constant	Constant/No Growth Scenario
2810001000	Other Combustion - Forest Wildfires	Constant	Constant/No Growth Scenario
2810005000	Other Combustion: Managed Burning: Slash: Logging Debris	Constant	Constant/No Growth Scenario
2810015000	Other Combustion - Prescribed Burning for Forest Management	Constant	Constant/No Growth Scenario
2810020000	Other Combustion - Prescribed Burning of Rangeland	Constant	Constant/No Growth Scenario
2810025000	Other Combustion: Charcoal Grilling	Population	NA
2810030000	Other Combustion: Structure Fires	Population	NA
2810040000	Other Combustion - Aircraft/Rocket Engine Firing and Testing	Constant	Constant/No Growth Scenario
2810050000	Other Combustion: Motor Vehicle Fires	Population	NA
2810060100	Miscellaneous Area Sources: Other Combustion: Human Cremation	Population	NA
2830000000	All Catastrophic / Accidental Releases	Constant	Constant/No Growth Scenario

APPENDIX 5

CHARACTERIZATION OF OIL AND GAS PRODUCTION EQUIPMENT AND DEVELOP A METHODOLOGY TO ESTIMATE STATEWIDE EMISSIONS AND SPECIFIED OIL AND GAS WELL ACTIVITIES EMISSIONS INVENTORY UPDATE

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

ERG No. 0227.03.026
TCEQ Contract No. 582-7-84003
Work Order No. 582-7-84003-FY10-26

Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions

FINAL REPORT

TCEQ Contract No. 582-7-84003
Work Order No. 582-7-84003-FY10-26

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November 24, 2010

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List of Acronyms

Acronym	**Definition**
BBL	Barrels
CENRAP	Central Regional Air Planning Association
CO	Carbon Monoxide
DFW	Dallas-Fort Worth
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ERG	Eastern Research Group
HAP	Hazardous Air Pollutants
HARC	Houston Advanced Research Center
Hp-Hr	Horsepower Hour
Hp	Horsepower
hr/yr	Hours per year
lbs	Pounds
MMBtu/hr	Million British Thermal Units per hour
MMscf	Million standard cubic feet
Mscf	Thousand standard cubic feet
NEI	National Emissions Inventory
NIF	NEI Input Format
NO_x	Nitrogen Oxides
NSCR	Non selective catalytic reduction
NSPS	New Source Performance Standard
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 microns
RVP	Reid Vapor Pressure
SCC	Source Classification Code
scf	Standard cubic feet
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
STP	Standard temperature and pressure
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TERC	Texas Environmental Research Consortium
TexAER	Texas Air Emissions Repository
TOC	Total Organic Carbon
TRC	Texas Railroad Commission
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

This report is a deliverable for Texas Commission on Environmental Quality (TCEQ) Work Order No. 582-07-84003-FY10-26 to better identify and characterize area source emissions from upstream onshore oil and gas production sites that operated in Texas in 2008, and to develop a 2008 base year air emissions inventory from these sites. On an individual basis, emissions from any single oil and gas production site are likely minimal as there may only be a few pieces of equipment at any one site. This equipment could include storage tanks, dehydrators, oil and gas piping, or small natural gas fired engines. However, with over 90,000 gas wells and 150,000 oil wells in Texas, the cumulative magnitude of these emissions may be significant. In particular, due to recent advancements in exploration and production technology such as the hydraulic fracturing of natural gas wells, this activity is increasingly taking place in populated areas, including ozone nonattainment areas. Therefore, closer scrutiny and evaluation of this area source category is warranted.

Emissions estimates developed from this inventory project may be used for improved input data to photochemical air quality dispersion modeling, emissions sensitivity analyses, State Implementation Plan (SIP) development, and other agency activities.

The emissions inventory developed under this project addresses area source criteria pollutant emissions of volatile organic compounds (VOC), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and sulfur dioxide (SO_2); certain Hazardous Air Pollutant (HAPs) emissions such as benzene, toluene, ethylbenzene, and xylene from dehydrators, oil and condensate storage tanks, and oil and condensate loading racks; and a variety of HAPs from combustion sources.

This study builds on three previous studies ERG conducted for TCEQ to estimate emissions from oil and gas exploration and production activities. The first, implemented in 2007, focused on compiling a state-wide emissions inventory (including both onshore and offshore sources) for oil and gas exploration and production for a 2005 base year (TCEQ, 2007). The second study, conducted in 2009 for a 2008 base year, focused only on emissions from onshore oil and gas well drilling rig engines (TCEQ, 2009). The third study, which was just completed, developed an emissions inventory for offshore oil and gas platforms (TCEQ, 2010). In contrast, this current study addresses onshore area sources (those not included in the Texas point source inventory). Collectively, these studies provide a comprehensive emissions inventory from onshore area sources, offshore oil and gas platforms, and onshore drilling rig activities.

In addition to compiling the emissions inventory, other objectives of this project were to identify the emission source types operating at oil and gas production sites, to develop a methodology for estimating area source emissions from oil and gas production sites based on the oil and gas produced at the county level, to develop survey materials that may be used to obtain detailed information needed to estimate emissions, and to identify the producers of oil and gas for each county. In conjunction with these activities, an emissions calculator was developed in Microsoft Excel that will allow TCEQ to update the emissions inventory for future years by providing updated county-level activity data. Finally, the emissions inventory was compiled into National Emissions Inventory Input Format (NIF) 3.0 text files for import into the Texas Air Emissions Repository (TexAER).

ERG was able to compile the 2008 area source emissions inventory from upstream onshore oil and gas production sites by obtaining both county-level activity data, and specific emissions and emission factor data for each source type. This data was obtained from a variety of sources, including existing databases (such as the Texas Railroad Commission (TRC) oil and gas production data), point source emissions inventory reports submitted to TCEQ (for dehydrators), vendor data (for compression engines and pumpjack engines), and published emission factor and activity data from the Houston Advanced Research Center (HARC), the Central Regional Air Planning Association (CENRAP), and the U.S. Environmental Protection Agency (EPA).

Table E-1 presents a state-wide summary of criteria pollutant (and total HAP) emissions by source category, and Table E-2 presents a summary of criteria pollutant (and total HAP) emissions for each county. As can be seen in these tables, emissions from area source upstream oil and gas production sites on a state-wide basis are significant with over 200,000 tons of NO_x, 1,500,000 tons of VOC, and 30,000 tons of HAPs emitted in 2008. The main source of NO_x

emissions are compressor engines, while the main source of VOC and HAP emissions are oil and condensate storage tanks.

It should be noted that the emission estimates provided in this report were based on available data and do not take into account more specific emission information such as county-specific gas composition data, or the extent that control devices that may be used on certain source types (such as well completions) to reduce emissions. More accurate emissions estimates would require a comprehensive survey of upstream oil and gas site operators to obtain information such as county-level gas composition data, quantification of the use of control devices, updated equipment profiles (such as the number and size of heater treaters used on a typical well pad), and updated equipment characteristics and counts.

Table E-1. State-wide Emissions Inventory for 2008 by Source Category

SCC	Source Category Description	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
2310000330	Artificial Lift	23,169.14	46,369.72	154.04	154.04	9.56	440.12	140.49
2310011020	Storage Tanks: Crude Oil						282,420.05	5,060.01
2310011100	Heater Treater	9,267.25	11,032.44	838.47	838.47	21.32	606.78	208.67
2310011201	Tank Truck/Railcar Loading: Crude Oil						26,810.72	479.91
2310011450	Wellhead						116,245.65	
2310011501	Fugitives: Connectors						2,956.39	
2310011502	Fugitives: Flanges						135.46	
2310011503	Fugitives: Open Ended Lines						605.72	
2310011504	Fugitives: Pumps						4,326.59	
2310011505	Fugitives: Valves						7,821.14	
2310011506	Fugitives: Other						12,480.55	
2310020600	Compressor Engines	133.77	464.56	13.58	13.58	0.21	81.40	29.00
2310021010	Storage Tanks: Condensate						864,087.90	17,281.71
2310021030	Tank Truck/Railcar Loading Condensate						7,235.50	144.71
2310021100	Gas Well Heaters	7,564.83	9,005.75	684.44	684.44	0.04	495.32	170.34
2310021101	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines <50 Hp	140.52	209.25	9.72	9.72	0.16	43.38	15.46
2310021102	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 50 To 499 Hp	2,907.93	13,776.30	352.37	352.37	5.71	2,012.02	716.78
2310021203	Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 500+ Hp	14,746.41	27,288.73	76.95	76.95	15.94	3,817.42	2,337.58
2310021301	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 Hp	93.37	1,175.69	3.86	3.86	0.25	5.61	5.50

Table E-1. State-wide Emissions Inventory for 2008 by Source Category (Cont.)

SCC	Source Category Description	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
2310021302	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50 To 499hp	38,988.69	86,462.54	226.24	226.24	14.83	1,487.26	1,451.93
2310021400	Gas Well Dehydrators	904.59	293.36				6,344.85	5,255.17
2310021402	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50-499hp W/ Nscr	767.55	3,321.00	35.02	35.02	2.05	17.73	17.46
2310021403	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ Hp W/ Nscr	29,646.80	47,837.57	175.33	175.33	11.26	794.33	775.73
2310021501	Fugitives: Connectors						1,161.52	
2310021502	Fugitives: Flanges						1,199.68	
2310021503	Fugitives: Open Ended Lines						916.82	
2310021504	Fugitives: Pumps						476.31	
2310021505	Fugitives: Valves						7,387.52	
2310021506	Fugitives: Other						8,732.37	
2310021600	Gas Well Venting						8,601.78	
2310121700	Gas Well Completion: All Processes						10,139.56	
2310111700	Oil Well Completion: All Processes						19,425.44	
2310121401	Gas Well Pneumatic Pumps						169,209.86	
	Total:	**128,330.85**	**247,236.91**	**2,570.01**	**2,570.01**	**81.34**	**1,568,522.73**	**34,090.45**

Table E-2. State-wide Emissions Inventory for 2008 by County

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Anderson	241.28	444.72	5.31	5.31	0.16	2,858.24	52.77
Andrews	1,825.99	3,291.18	49.14	49.14	1.57	31,691.46	444.20
Angelina	161.97	311.11	2.15	2.15	0.08	629.30	25.94
Aransas	165.25	317.00	2.28	2.28	0.09	6,574.04	144.42
Archer	614.91	1,088.88	18.74	18.74	0.58	2,719.03	24.45
Armstrong	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atascosa	321.56	578.81	8.71	8.71	0.27	2,237.28	31.44
Austin	127.18	237.83	2.42	2.42	0.07	2,040.58	43.74
Bailey	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bandera	0.21	0.37	0.01	0.01	0.00	5.14	0.03
Bastrop	74.21	128.49	2.56	2.56	0.06	1,286.18	16.32
Baylor	26.78	47.39	0.82	0.82	0.03	189.33	1.96
Bee	581.15	1,101.85	9.42	9.42	0.31	4,717.44	125.89
Bell	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bexar	531.99	941.46	16.28	16.28	0.51	2,120.86	7.60
Blanco	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Borden	166.31	300.48	4.40	4.40	0.14	4,107.39	62.92
Bosque	3.45	6.30	0.08	0.08	0.00	17.43	0.34
Bowie	5.13	9.25	0.14	0.14	0.00	148.70	2.69
Brazoria	207.73	199.95	6.59	6.59	0.28	14,003.43	292.15
Brazos	240.26	444.10	5.18	5.18	0.16	3,781.19	74.41
Brewster	0.00	0.00	0.00	0.00	0.00	5.88	0.00
Briscoe	0.00	0.00	0.00	0.00	0.00	12.33	0.01
Brooks	690.71	1,318.85	10.17	10.17	0.35	16,242.00	374.16
Brown	204.73	339.96	8.55	8.55	0.14	1,626.85	6.71
Burleson	366.21	669.08	8.80	8.80	0.28	3,881.39	67.20
Burnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO$_x$ (tons/yr)	PM$_{10}$ (tons/yr)	PM$_{2.5}$ (tons/yr)	SO$_2$ (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Caldwell	676.24	1,197.43	20.61	20.61	0.64	3,452.64	22.69
Calhoun	189.99	360.25	3.07	3.07	0.10	7,473.42	160.35
Callahan	182.61	321.30	5.76	5.76	0.16	983.48	9.65
Cameron	1.68	3.12	0.03	0.03	0.00	10.26	0.20
Camp	30.41	55.01	0.79	0.79	0.03	259.21	4.96
Carson	569.73	1,021.51	15.74	15.74	0.41	1,954.76	34.12
Cass	54.95	98.13	1.55	1.55	0.04	662.46	11.89
Castro	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chambers	84.76	94.63	2.75	2.75	0.11	4,424.08	90.13
Cherokee	364.58	682.18	6.78	6.78	0.18	2,911.32	72.93
Childress	1.69	2.99	0.05	0.05	0.00	57.40	0.71
Clay	231.82	409.65	7.14	7.14	0.21	1,476.89	16.60
Cochran	445.16	791.68	13.17	13.17	0.41	6,168.35	67.45
Coke	109.55	200.99	2.54	2.54	0.08	1,010.20	15.88
Coleman	173.73	295.58	6.51	6.51	0.13	1,363.81	9.92
Collin	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Collingsworth	50.04	76.34	2.77	2.77	0.02	742.63	2.58
Colorado	319.38	601.84	5.54	5.54	0.16	4,980.62	115.78
Comal	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Comanche	34.22	53.57	1.76	1.76	0.02	438.42	1.97
Concho	72.58	128.12	2.23	2.23	0.06	821.04	9.65
Cooke	495.43	884.64	14.25	14.25	0.45	3,467.02	50.26
Coryell	0.00	0.00	0.00	0.00	0.00	3.13	0.00
Cottle	95.67	180.55	1.63	1.63	0.05	2,376.44	52.30
Crane	1,739.98	3,208.47	38.61	38.61	1.26	17,274.91	291.73
Crockett	2,274.88	4,015.15	68.61	68.61	1.15	28,501.91	414.45
Crosby	85.55	151.51	2.61	2.61	0.08	1,056.14	9.67

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Culberson	72.79	137.98	1.20	1.20	0.04	284.44	8.75
Dallam	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dallas	28.04	80.04	0.21	0.21	0.02	24.60	4.23
Dawson	275.48	492.78	7.84	7.84	0.25	5,344.51	72.02
Deaf Smith	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delta	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Denton	1,763.52	4,690.36	29.51	29.51	1.14	13,254.59	416.58
Dewitt	676.49	1,300.83	9.00	9.00	0.35	11,617.04	287.72
Dickens	49.70	88.22	1.49	1.49	0.05	1,446.43	20.78
Dimmit	197.89	353.20	5.65	5.65	0.15	2,515.16	31.86
Donley	0.53	0.77	0.03	0.03	0.00	15.82	0.17
Duval	1,111.17	2,101.02	18.70	18.70	0.63	12,897.27	314.00
Eastland	285.26	476.94	11.51	11.51	0.18	3,654.84	39.72
Ector	1,798.24	3,277.22	44.40	44.40	1.47	26,211.12	388.97
Edwards	270.78	492.35	6.60	6.60	0.13	1,377.01	25.49
El Paso	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ellis	51.17	144.09	0.47	0.47	0.04	52.43	7.56
Erath	161.14	295.43	3.68	3.68	0.07	1,556.95	32.84
Falls	4.01	7.09	0.12	0.12	0.00	21.49	0.09
Fannin	0.00	0.00	0.00	0.00	0.00	11.86	0.00
Fayette	356.62	659.40	7.64	7.64	0.23	5,607.61	115.67
Fisher	107.82	193.50	2.99	2.99	0.09	1,365.54	16.44
Floyd	0.42	0.75	0.01	0.01	0.00	2.97	0.03
Foard	27.94	43.90	1.42	1.42	0.01	414.38	2.57
Fort Bend	169.68	171.80	5.51	5.51	0.22	8,072.59	166.58
Franklin	69.40	127.99	1.52	1.52	0.05	1,389.52	28.31
Freestone	3,821.60	7,289.51	56.95	56.95	1.93	9,858.72	475.09

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Frio	139.12	246.28	4.21	4.21	0.12	1,393.74	14.40
Gaines	1,165.52	2,133.47	27.65	27.65	0.92	27,788.32	460.84
Galveston	86.46	76.28	2.61	2.61	0.12	17,475.45	358.12
Garza	445.72	790.41	13.45	13.45	0.42	6,133.80	63.01
Gillespie	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glasscock	416.67	761.54	10.00	10.00	0.32	5,431.20	84.49
Goliad	731.21	1,386.08	11.85	11.85	0.37	7,851.72	199.63
Gonzales	51.40	92.76	1.37	1.37	0.04	578.12	8.62
Gray	825.55	1,440.69	27.11	27.11	0.64	4,163.88	45.84
Grayson	201.98	365.62	5.22	5.22	0.16	1,707.03	31.65
Gregg	1,423.90	2,592.32	34.92	34.92	1.00	10,980.44	227.68
Grimes	334.10	638.29	4.87	4.87	0.17	1,264.12	50.60
Guadalupe	402.11	711.73	12.29	12.29	0.38	2,576.45	22.66
Hale	62.99	114.67	1.57	1.57	0.05	2,698.37	46.20
Hall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton	3.12	5.33	0.11	0.11	0.00	36.47	0.47
Hansford	377.68	676.20	10.32	10.32	0.17	2,601.06	43.25
Hardeman	52.13	92.68	1.54	1.54	0.05	1,230.36	19.89
Hardin	258.68	348.83	7.85	7.85	0.30	22,648.65	447.94
Harris	176.00	181.67	5.65	5.65	0.23	8,801.29	184.44
Harrison	1,879.59	3,514.48	35.19	35.19	0.93	25,383.90	583.58
Hartley	39.06	70.27	1.04	1.04	0.02	399.51	6.56
Haskell	53.83	95.30	1.64	1.64	0.05	443.81	5.44
Hays	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hemphill	2,092.63	3,936.72	37.08	37.08	1.03	32,774.76	754.74
Henderson	453.75	854.13	7.99	7.99	0.24	2,535.12	73.92
Hidalgo	3,264.69	6,276.64	43.49	43.49	1.68	56,554.95	1,407.72

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Hill	308.20	597.97	3.53	3.53	0.16	233.61	34.41
Hockley	1,004.10	1,795.93	28.58	28.58	0.91	22,011.88	308.12
Hood	926.80	1,777.59	12.89	12.89	0.47	9,914.41	269.97
Hopkins	20.84	37.79	0.53	0.53	0.02	298.78	5.06
Houston	164.62	308.00	3.11	3.11	0.10	1,587.91	35.84
Howard	803.87	1,436.74	23.00	23.00	0.73	9,904.95	107.63
Hudspeth	0.12	0.17	0.01	0.01	0.00	3.29	0.03
Hunt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hutchinson	903.43	1,601.32	27.09	27.09	0.72	4,039.66	49.29
Irion	531.51	961.89	13.77	13.77	0.40	5,877.27	82.51
Jack	646.65	1,121.02	21.80	21.80	0.42	6,701.91	92.20
Jackson	303.15	569.09	5.55	5.55	0.17	9,879.64	204.59
Jasper	205.58	394.00	2.87	2.87	0.11	6,405.78	143.58
Jeff Davis	0.00	0.00	0.00	0.00	0.00	1.29	0.03
Jefferson	287.19	182.64	8.05	8.05	0.46	55,659.21	1,163.27
Jim Hogg	266.50	500.41	4.83	4.83	0.14	4,021.10	92.33
Jim Wells	127.37	226.90	3.61	3.61	0.06	1,576.61	26.20
Johnson	4,495.48	12,647.53	43.01	43.01	3.19	5,209.18	684.81
Jones	167.32	296.69	5.05	5.05	0.16	1,277.91	14.79
Karnes	171.32	323.25	2.95	2.95	0.10	3,454.12	76.12
Kaufman	4.50	8.03	0.14	0.14	0.00	62.82	1.05
Kendall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kenedy	665.44	1,286.34	8.13	8.13	0.35	4,087.71	143.43
Kent	203.51	375.70	4.48	4.48	0.16	4,304.19	73.92
Kerr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kimble	2.94	4.50	0.16	0.16	0.00	41.29	0.17
King	112.59	198.82	3.47	3.47	0.10	2,010.47	35.20

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO$_x$ (tons/yr)	PM$_{10}$ (tons/yr)	PM$_{2.5}$ (tons/yr)	SO$_2$ (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Kinney	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kleberg	494.21	948.96	6.71	6.71	0.25	8,845.84	217.77
Knox	46.18	81.72	1.41	1.41	0.04	354.81	4.00
La Salle	259.22	470.95	6.38	6.38	0.13	4,078.69	76.37
Lamar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lamb	15.10	27.13	0.42	0.42	0.01	686.85	11.01
Lampasas	0.16	0.20	0.01	0.01	0.00	4.24	0.00
Lavaca	924.67	1,764.89	13.68	13.68	0.47	12,277.67	311.64
Lee	307.30	564.26	7.08	7.08	0.23	2,650.76	49.84
Leon	1,079.72	2,070.29	15.01	15.01	0.58	5,733.49	197.49
Liberty	331.40	341.24	9.92	9.92	0.45	27,316.75	570.30
Limestone	1,393.87	2,655.14	21.17	21.17	0.71	4,377.56	180.91
Lipscomb	1,125.34	2,104.13	21.36	21.36	0.58	17,104.94	381.52
Live Oak	378.16	709.70	6.91	6.91	0.20	6,807.99	149.58
Llano	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loving	1,567.71	3,023.10	20.15	20.15	0.89	6,348.57	251.69
Lubbock	89.19	158.04	2.71	2.71	0.08	1,825.32	23.15
Lynn	18.52	33.00	0.54	0.54	0.02	350.40	4.52
Madison	117.26	216.26	2.56	2.56	0.07	1,290.52	26.07
Marion	96.78	174.38	2.56	2.56	0.06	1,407.02	25.69
Martin	596.73	1,088.02	14.69	14.69	0.49	10,928.66	168.72
Mason	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Matagorda	609.79	1,168.96	8.47	8.47	0.32	19,098.24	428.64
Maverick	182.47	323.89	5.42	5.42	0.15	3,715.58	42.08
McCulloch	14.65	25.47	0.50	0.50	0.01	109.65	1.15
McLennan	8.65	15.30	0.26	0.26	0.01	27.43	0.12
McMullen	493.90	900.42	11.92	11.92	0.29	6,027.42	110.63

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Medina	275.72	487.25	8.50	8.50	0.26	1,235.77	4.54
Menard	27.00	47.52	0.85	0.85	0.02	266.84	2.69
Midland	1,610.04	2,951.97	37.75	37.75	1.27	20,938.23	333.93
Milam	218.91	387.83	6.65	6.65	0.21	1,216.87	9.32
Mills	0.36	0.51	0.02	0.02	0.00	6.38	0.02
Mitchell	502.49	890.13	15.28	15.28	0.48	6,645.63	65.00
Montague	551.48	987.06	15.59	15.59	0.49	3,448.92	48.39
Montgomery	73.56	81.80	2.86	2.86	0.08	2,890.56	54.67
Moore	744.02	1,343.19	19.29	19.29	0.40	3,502.87	63.64
Morris	0.21	0.37	0.01	0.01	0.00	2.01	0.03
Motley	3.80	6.72	0.12	0.12	0.00	52.75	0.49
Nacogdoches	1,527.76	2,897.04	24.29	24.29	0.77	12,723.39	353.60
Navarro	170.24	301.61	5.16	5.16	0.16	1,444.51	18.73
Newton	78.50	145.69	1.63	1.63	0.05	1,601.94	31.72
Nolan	133.50	240.21	3.63	3.63	0.11	1,931.63	25.88
Nueces	605.47	1,127.23	11.99	11.99	0.31	15,740.17	332.51
Ochiltree	561.88	1,020.35	13.94	13.94	0.31	5,760.68	108.67
Oldham	5.68	10.02	0.17	0.17	0.00	247.24	3.74
Orange	67.79	71.25	2.06	2.06	0.09	8,467.82	172.90
Palo Pinto	455.72	785.82	15.70	15.70	0.21	7,033.45	105.26
Panola	3,784.21	7,052.88	73.18	73.18	1.82	50,362.96	1,170.88
Parker	1,225.52	3,294.01	19.49	19.49	0.80	9,840.76	290.06
Parmer	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pecos	4,534.56	8,670.50	66.30	66.30	2.63	21,760.89	703.44
Polk	415.68	797.76	5.69	5.69	0.22	29,650.93	625.12
Potter	350.79	632.33	9.25	9.25	0.21	1,799.21	27.27
Presidio	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Rains	59.61	115.43	0.71	0.71	0.03	38.47	6.62
Randall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reagan	1,209.82	2,204.56	29.89	29.89	0.99	11,808.61	158.58
Real	1.91	3.34	0.06	0.06	0.00	16.74	0.15
Red River	9.57	16.96	0.29	0.29	0.01	159.73	2.26
Reeves	575.50	1,077.94	10.88	10.88	0.36	3,146.28	72.34
Refugio	652.55	1,218.19	12.72	12.72	0.40	9,671.07	197.77
Roberts	881.18	1,659.43	15.47	15.47	0.45	15,296.54	346.65
Robertson	3,591.03	6,960.37	41.87	41.87	1.90	4,202.14	427.68
Rockwall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Runnels	145.66	262.06	3.96	3.96	0.12	1,177.54	15.82
Rusk	2,394.04	4,447.78	48.27	48.27	1.34	26,428.99	597.16
Sabine	2.04	3.67	0.06	0.06	0.00	19.20	0.14
San Augustine	159.66	309.99	1.77	1.77	0.09	452.69	23.22
San Jacinto	182.43	350.28	2.47	2.47	0.09	6,462.64	144.35
San Patricio	303.08	570.53	5.36	5.36	0.16	12,721.07	267.75
San Saba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schleicher	297.16	521.39	9.30	9.30	0.15	3,975.13	56.43
Scurry	920.14	1,696.28	20.52	20.52	0.72	16,745.60	282.63
Shackelford	446.66	787.83	13.87	13.87	0.39	2,584.60	27.41
Shelby	788.21	1,506.84	11.24	11.24	0.40	4,681.48	153.59
Sherman	382.36	689.34	9.93	9.93	0.17	2,226.58	38.78
Smith	600.16	1,117.21	11.83	11.83	0.32	6,759.09	157.15
Somervell	69.05	132.73	0.93	0.93	0.04	261.32	10.71
Starr	1,801.98	3,435.69	27.08	27.08	0.92	39,905.70	922.75
Stephens	548.00	962.55	17.22	17.22	0.36	6,028.28	86.04
Sterling	507.62	898.57	15.24	15.24	0.35	5,045.87	54.84

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Stonewall	125.21	222.61	3.72	3.72	0.12	1,647.78	17.01
Sutton	1,536.07	2,640.40	53.45	53.45	0.57	14,703.05	158.36
Swisher	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tarrant	4,070.91	11,441.36	39.54	39.54	2.88	4,929.92	620.02
Taylor	92.16	163.25	2.80	2.80	0.09	693.08	8.42
Terrell	890.56	1,697.22	13.46	13.46	0.45	4,554.08	153.52
Terry	217.93	388.12	6.39	6.39	0.20	5,118.11	70.81
Throckmorton	221.50	393.95	6.55	6.55	0.20	1,242.06	15.21
Titus	42.19	74.68	1.29	1.29	0.04	506.68	8.03
Tom Green	170.07	304.64	4.76	4.76	0.14	1,945.37	23.40
Travis	3.37	5.97	0.10	0.10	0.00	14.43	0.07
Trinity	10.94	19.88	0.27	0.27	0.01	193.38	3.42
Tyler	463.76	896.18	5.69	5.69	0.25	57,953.39	1,201.05
Upshur	604.48	1,126.42	11.73	11.73	0.30	10,582.53	238.20
Upton	1,602.98	2,998.03	30.90	30.90	1.09	32,833.54	647.89
Uvalde	0.20	0.26	0.02	0.02	0.00	4.37	0.01
Val Verde	210.53	394.38	3.90	3.90	0.10	620.76	21.64
Van Zandt	193.81	352.82	4.81	4.81	0.15	1,204.59	23.27
Victoria	287.47	535.68	5.67	5.67	0.16	3,296.01	69.83
Walker	13.49	24.74	0.31	0.31	0.01	85.26	1.73
Waller	88.01	106.67	2.83	2.83	0.11	2,859.24	56.46
Ward	1,288.64	2,381.97	28.00	28.00	0.94	9,588.88	230.25
Washington	256.76	485.36	4.31	4.31	0.14	2,513.65	64.54
Webb	3,123.82	5,806.41	62.66	62.66	1.48	28,275.41	664.71
Wharton	692.11	1,309.84	11.43	11.43	0.37	15,986.48	354.54
Wheeler	2,223.92	4,231.74	34.40	34.40	1.15	40,674.02	955.94
Wichita	1,185.96	2,099.33	36.23	36.23	1.13	5,040.04	46.60

Table E-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Wilbarger	174.53	308.95	5.33	5.33	0.17	1,147.90	13.03
Willacy	353.53	681.05	4.59	4.59	0.19	8,274.58	193.92
Williamson	9.07	16.05	0.28	0.28	0.01	53.29	0.33
Wilson	129.98	230.01	3.98	3.98	0.12	757.55	6.10
Winkler	917.14	1,698.44	19.52	19.52	0.63	7,815.47	141.18
Wise	2,749.59	5,099.17	55.75	55.75	1.35	24,225.59	597.53
Wood	239.16	438.82	5.52	5.52	0.18	4,200.35	82.03
Yoakum	1,074.18	1,960.14	26.21	26.21	0.88	25,649.46	414.59
Young	556.32	978.60	17.57	17.57	0.50	3,394.26	35.11
Zapata	4,438.24	8,472.07	65.54	65.54	2.24	13,384.86	594.31
Zavala	64.75	114.70	1.94	1.94	0.05	1,016.76	14.24
Total:	**128,330.85**	**247,236.91**	**2,570.01**	**2,570.01**	**81.34**	**1,568,522.73**	**34,090.45**

1.0 INTRODUCTION

This study was implemented for the Texas Commission on Environmental Quality (TCEQ) to identify and characterize area source emissions from upstream oil and gas production sites that operated in Texas in 2008, and to provide county level emission estimates for each of these source types.

This study was divided into four primary technical work tasks:

- Identification and review of existing studies pertaining to estimating emissions from oil and gas production sites and recommendation of a preferred emission estimation approach for each identified emissions source type;
- Development of survey materials that may be used to obtain detailed information needed to estimate emissions, and identification of the producers of oil and gas for each county;
- Development of a methodology and calculator to estimate county-level emissions from each identified source type; and
- Performance of emissions estimation calculations for a 2008 base year, including the preparation of emissions inventory calculation spreadsheets (including activity data and emission factors) and documentation of data, procedures, and results in a final project report. Additionally, the final emissions inventory was imported into National Emissions Inventory Input Format (NIF) 3.0 text files for import into the Texas Air Emissions Repository (TexAER).

This project required compilation of data for each emission source type found at upstream oil and gas production sites. Table 1-1 presents a list of each source type, including their associated Source Classification Code (SCC).

Table 1-1. Upstream Oil and Gas Production Source Types

SCC	Source Category Description
2310021101	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines <50 Hp
2310021102	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 50 TO 499 Hp
2310020600	Natural Gas Fired 2-Cycle Rich Burn Compressor Engines
2310021203	Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 500+ Hp
2310021301	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 Hp
2310021302	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50 TO 499 Hp
2310021402	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50-499 Hp W/ NSCR
2310021403	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ Hp W/ NSCR
2310000330	Oil and Gas Exploration and Production Artificial Lift Engines
2310021400	Dehydrators
2310011020	Oil Storage Tanks

Table 1-1. Upstream Oil and Gas Production Source Types (Cont.)

SCC	Source Category Description
2310021010	Condensate Storage Tanks
2310011201	Oil Loading
2310021030	Condensate Loading
2310111700	Oil Well Completions
2310121700	Gas Well Completions
2310011450	Oil Wellhead Blowdowns
2310021600	Gas Wellhead Blowdowns
2310121401	Pneumatic Devices
2310011505	Fugitives - Oil Well Valves
2310011504	Fugitives - Oil Well Pumps
2310011506	Fugitives - Oil Wells Other
2310011501	Fugitives - Oil Well Connectors
2310011502	Fugitives - Oil Well Flanges
2310011503	Fugitives - Oil Well Open Ended Lines
2310021505	Fugitives - Gas Well Valves
2310021504	Fugitives - Gas Well Pumps
2310021506	Fugitives - Gas Wells Other
2310021501	Fugitives - Gas Well Connectors
2310021502	Fugitives - Gas Well Flanges
2310021503	Fugitives - Gas Well Open Ended Lines
2310011100	Heaters - Oil Wells
2310021100	Heaters - Gas Wells

Section 2 of this report provides a summary of the literature review task undertaken to identify existing studies pertaining to oil and gas production area sources. Section 3 provides a summary of the efforts implemented to identify oil and gas source operators and owners in each county, and the development of survey materials that may be used to obtain detailed information needed to estimate emissions. Section 4 presents detailed information on the emissions calculation method used for each category, including a discussion of all variables used in the emissions calculation and how data for each variable were obtained. The quantitative results of this project are presented in Section 5, discussion of preparation of TexAER input files is provided in Section 6, conclusions and recommendations based on the results of this project are presented in Section 7, and Section 8 provides a reference list of information sources used to prepare this report and the emissions inventory.

Table 1-2 presents a state-wide summary of criteria pollutant (and total HAP) emissions by source category, and Table 1-3 presents a summary of criteria pollutant (and total HAP) emissions for each county. As can be seen in these tables, emissions in 2008 from this area source category on a state-wide basis are significant with over 200,000 tons of NO_x, 1,500,000 tons of VOC, and 30,000 tons of HAP. The main source of NO_x emissions are compressor engines, while the main source of VOC and HAP emissions are oil and condensate storage tanks.

Table 1-2. State-wide Emissions Inventory for 2008 by Source Category

SCC	Source Category Description	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
2310000330	Artificial Lift	23,169.14	46,369.72	154.04	154.04	9.56	440.12	140.49
2310011020	Storage Tanks: Crude Oil						282,420.05	5,060.01
2310011100	Heater Treater	9,267.25	11,032.44	838.47	838.47	21.32	606.78	208.67
2310011201	Tank Truck/Railcar Loading: Crude Oil						26,810.72	479.91
2310011450	Wellhead						116,245.65	
2310011501	Fugitives: Connectors						2,956.39	
2310011502	Fugitives: Flanges						135.46	
2310011503	Fugitives: Open Ended Lines						605.72	
2310011504	Fugitives: Pumps						4,326.59	
2310011505	Fugitives: Valves						7,821.14	
2310011506	Fugitives: Other						12,480.55	
2310020600	Compressor Engines	133.77	464.56	13.58	13.58	0.21	81.40	29.00
2310021010	Storage Tanks: Condensate						864,087.90	17,281.71
2310021030	Tank Truck/Railcar Loading Condensate						7,235.50	144.71
2310021100	Gas Well Heaters	7,564.83	9,005.75	684.44	684.44	0.04	495.32	170.34
2310021101	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines <50 Hp	140.52	209.25	9.72	9.72	0.16	43.38	15.46
2310021102	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 50 To 499 Hp	2,907.93	13,776.30	352.37	352.37	5.71	2,012.02	716.78
2310021203	Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 500+ Hp	14,746.41	27,288.73	76.95	76.95	15.94	3,817.42	2,337.58
2310021301	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 Hp	93.37	1,175.69	3.86	3.86	0.25	5.61	5.50

Table 1-2. State-wide Emissions Inventory for 2008 by Source Category (Cont.)

SCC	Source Category Description	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
2310021302	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50 To 499hp	38,988.69	86,462.54	226.24	226.24	14.83	1,487.26	1,451.93
2310021400	Gas Well Dehydrators	904.59	293.36				6,344.85	5,255.17
2310021402	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50-499hp W/ Nscr	767.55	3,321.00	35.02	35.02	2.05	17.73	17.46
2310021403	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ Hp W/ Nscr	29,646.80	47,837.57	175.33	175.33	11.26	794.33	775.73
2310021501	Fugitives: Connectors						1,161.52	
2310021502	Fugitives: Flanges						1,199.68	
2310021503	Fugitives: Open Ended Lines						916.82	
2310021504	Fugitives: Pumps						476.31	
2310021505	Fugitives: Valves						7,387.52	
2310021506	Fugitives: Other						8,732.37	
2310021600	Gas Well Venting						8,601.78	
2310121700	Gas Well Completion: All Processes						10,139.56	
2310111700	Oil Well Completion: All Processes						19,425.44	
2310121401	Gas Well Pneumatic Pumps						169,209.86	
	Total:	**128,330.85**	**247,236.91**	**2,570.01**	**2,570.01**	**81.34**	**1,568,522.73**	**34,090.45**

Table 1-3. State-wide Emissions Inventory for 2008 by County

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Anderson	241.28	444.72	5.31	5.31	0.16	2,858.24	52.77
Andrews	1,825.99	3,291.18	49.14	49.14	1.57	31,691.46	444.20
Angelina	161.97	311.11	2.15	2.15	0.08	629.30	25.94
Aransas	165.25	317.00	2.28	2.28	0.09	6,574.04	144.42
Archer	614.91	1,088.88	18.74	18.74	0.58	2,719.03	24.45
Armstrong	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atascosa	321.56	578.81	8.71	8.71	0.27	2,237.28	31.44
Austin	127.18	237.83	2.42	2.42	0.07	2,040.58	43.74
Bailey	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bandera	0.21	0.37	0.01	0.01	0.00	5.14	0.03
Bastrop	74.21	128.49	2.56	2.56	0.06	1,286.18	16.32
Baylor	26.78	47.39	0.82	0.82	0.03	189.33	1.96
Bee	581.15	1,101.85	9.42	9.42	0.31	4,717.44	125.89
Bell	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bexar	531.99	941.46	16.28	16.28	0.51	2,120.86	7.60
Blanco	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Borden	166.31	300.48	4.40	4.40	0.14	4,107.39	62.92
Bosque	3.45	6.30	0.08	0.08	0.00	17.43	0.34
Bowie	5.13	9.25	0.14	0.14	0.00	148.70	2.69
Brazoria	207.73	199.95	6.59	6.59	0.28	14,003.43	292.15
Brazos	240.26	444.10	5.18	5.18	0.16	3,781.19	74.41
Brewster	0.00	0.00	0.00	0.00	0.00	5.88	0.00
Briscoe	0.00	0.00	0.00	0.00	0.00	12.33	0.01
Brooks	690.71	1,318.85	10.17	10.17	0.35	16,242.00	374.16
Brown	204.73	339.96	8.55	8.55	0.14	1,626.85	6.71
Burleson	366.21	669.08	8.80	8.80	0.28	3,881.39	67.20

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Burnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Caldwell	676.24	1,197.43	20.61	20.61	0.64	3,452.64	22.69
Calhoun	189.99	360.25	3.07	3.07	0.10	7,473.42	160.35
Callahan	182.61	321.30	5.76	5.76	0.16	983.48	9.65
Cameron	1.68	3.12	0.03	0.03	0.00	10.26	0.20
Camp	30.41	55.01	0.79	0.79	0.03	259.21	4.96
Carson	569.73	1,021.51	15.74	15.74	0.41	1,954.76	34.12
Cass	54.95	98.13	1.55	1.55	0.04	662.46	11.89
Castro	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chambers	84.76	94.63	2.75	2.75	0.11	4,424.08	90.13
Cherokee	364.58	682.18	6.78	6.78	0.18	2,911.32	72.93
Childress	1.69	2.99	0.05	0.05	0.00	57.40	0.71
Clay	231.82	409.65	7.14	7.14	0.21	1,476.89	16.60
Cochran	445.16	791.68	13.17	13.17	0.41	6,168.35	67.45
Coke	109.55	200.99	2.54	2.54	0.08	1,010.20	15.88
Coleman	173.73	295.58	6.51	6.51	0.13	1,363.81	9.92
Collin	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Collingsworth	50.04	76.34	2.77	2.77	0.02	742.63	2.58
Colorado	319.38	601.84	5.54	5.54	0.16	4,980.62	115.78
Comal	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Comanche	34.22	53.57	1.76	1.76	0.02	438.42	1.97
Concho	72.58	128.12	2.23	2.23	0.06	821.04	9.65
Cooke	495.43	884.64	14.25	14.25	0.45	3,467.02	50.26
Coryell	0.00	0.00	0.00	0.00	0.00	3.13	0.00
Cottle	95.67	180.55	1.63	1.63	0.05	2,376.44	52.30
Crane	1,739.98	3,208.47	38.61	38.61	1.26	17,274.91	291.73

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Crockett	2,274.88	4,015.15	68.61	68.61	1.15	28,501.91	414.45
Crosby	85.55	151.51	2.61	2.61	0.08	1,056.14	9.67
Culberson	72.79	137.98	1.20	1.20	0.04	284.44	8.75
Dallam	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dallas	28.04	80.04	0.21	0.21	0.02	24.60	4.23
Dawson	275.48	492.78	7.84	7.84	0.25	5,344.51	72.02
Deaf Smith	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delta	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Denton	1,763.52	4,690.36	29.51	29.51	1.14	13,254.59	416.58
Dewitt	676.49	1,300.83	9.00	9.00	0.35	11,617.04	287.72
Dickens	49.70	88.22	1.49	1.49	0.05	1,446.43	20.78
Dimmit	197.89	353.20	5.65	5.65	0.15	2,515.16	31.86
Donley	0.53	0.77	0.03	0.03	0.00	15.82	0.17
Duval	1,111.17	2,101.02	18.70	18.70	0.63	12,897.27	314.00
Eastland	285.26	476.94	11.51	11.51	0.18	3,654.84	39.72
Ector	1,798.24	3,277.22	44.40	44.40	1.47	26,211.12	388.97
Edwards	270.78	492.35	6.60	6.60	0.13	1,377.01	25.49
El Paso	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ellis	51.17	144.09	0.47	0.47	0.04	52.43	7.56
Erath	161.14	295.43	3.68	3.68	0.07	1,556.95	32.84
Falls	4.01	7.09	0.12	0.12	0.00	21.49	0.09
Fannin	0.00	0.00	0.00	0.00	0.00	11.86	0.00
Fayette	356.62	659.40	7.64	7.64	0.23	5,607.61	115.67
Fisher	107.82	193.50	2.99	2.99	0.09	1,365.54	16.44
Floyd	0.42	0.75	0.01	0.01	0.00	2.97	0.03
Foard	27.94	43.90	1.42	1.42	0.01	414.38	2.57

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Fort Bend	169.68	171.80	5.51	5.51	0.22	8,072.59	166.58
Franklin	69.40	127.99	1.52	1.52	0.05	1,389.52	28.31
Freestone	3,821.60	7,289.51	56.95	56.95	1.93	9,858.72	475.09
Frio	139.12	246.28	4.21	4.21	0.12	1,393.74	14.40
Gaines	1,165.52	2,133.47	27.65	27.65	0.92	27,788.32	460.84
Galveston	86.46	76.28	2.61	2.61	0.12	17,475.45	358.12
Garza	445.72	790.41	13.45	13.45	0.42	6,133.80	63.01
Gillespie	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glasscock	416.67	761.54	10.00	10.00	0.32	5,431.20	84.49
Goliad	731.21	1,386.08	11.85	11.85	0.37	7,851.72	199.63
Gonzales	51.40	92.76	1.37	1.37	0.04	578.12	8.62
Gray	825.55	1,440.69	27.11	27.11	0.64	4,163.88	45.84
Grayson	201.98	365.62	5.22	5.22	0.16	1,707.03	31.65
Gregg	1,423.90	2,592.32	34.92	34.92	1.00	10,980.44	227.68
Grimes	334.10	638.29	4.87	4.87	0.17	1,264.12	50.60
Guadalupe	402.11	711.73	12.29	12.29	0.38	2,576.45	22.66
Hale	62.99	114.67	1.57	1.57	0.05	2,698.37	46.20
Hall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton	3.12	5.33	0.11	0.11	0.00	36.47	0.47
Hansford	377.68	676.20	10.32	10.32	0.17	2,601.06	43.25
Hardeman	52.13	92.68	1.54	1.54	0.05	1,230.36	19.89
Hardin	258.68	348.83	7.85	7.85	0.30	22,648.65	447.94
Harris	176.00	181.67	5.65	5.65	0.23	8,801.29	184.44
Harrison	1,879.59	3,514.48	35.19	35.19	0.93	25,383.90	583.58
Hartley	39.06	70.27	1.04	1.04	0.02	399.51	6.56
Haskell	53.83	95.30	1.64	1.64	0.05	443.81	5.44

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Hays	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hemphill	2,092.63	3,936.72	37.08	37.08	1.03	32,774.76	754.74
Henderson	453.75	854.13	7.99	7.99	0.24	2,535.12	73.92
Hidalgo	3,264.69	6,276.64	43.49	43.49	1.68	56,554.95	1,407.72
Hill	308.20	597.97	3.53	3.53	0.16	233.61	34.41
Hockley	1,004.10	1,795.93	28.58	28.58	0.91	22,011.88	308.12
Hood	926.80	1,777.59	12.89	12.89	0.47	9,914.41	269.97
Hopkins	20.84	37.79	0.53	0.53	0.02	298.78	5.06
Houston	164.62	308.00	3.11	3.11	0.10	1,587.91	35.84
Howard	803.87	1,436.74	23.00	23.00	0.73	9,904.95	107.63
Hudspeth	0.12	0.17	0.01	0.01	0.00	3.29	0.03
Hunt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hutchinson	903.43	1,601.32	27.09	27.09	0.72	4,039.66	49.29
Irion	531.51	961.89	13.77	13.77	0.40	5,877.27	82.51
Jack	646.65	1,121.02	21.80	21.80	0.42	6,701.91	92.20
Jackson	303.15	569.09	5.55	5.55	0.17	9,879.64	204.59
Jasper	205.58	394.00	2.87	2.87	0.11	6,405.78	143.58
Jeff Davis	0.00	0.00	0.00	0.00	0.00	1.29	0.03
Jefferson	287.19	182.64	8.05	8.05	0.46	55,659.21	1,163.27
Jim Hogg	266.50	500.41	4.83	4.83	0.14	4,021.10	92.33
Jim Wells	127.37	226.90	3.61	3.61	0.06	1,576.61	26.20
Johnson	4,495.48	12,647.53	43.01	43.01	3.19	5,209.18	684.81
Jones	167.32	296.69	5.05	5.05	0.16	1,277.91	14.79
Karnes	171.32	323.25	2.95	2.95	0.10	3,454.12	76.12
Kaufman	4.50	8.03	0.14	0.14	0.00	62.82	1.05
Kendall	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Kenedy	665.44	1,286.34	8.13	8.13	0.35	4,087.71	143.43
Kent	203.51	375.70	4.48	4.48	0.16	4,304.19	73.92
Kerr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kimble	2.94	4.50	0.16	0.16	0.00	41.29	0.17
King	112.59	198.82	3.47	3.47	0.10	2,010.47	35.20
Kinney	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kleberg	494.21	948.96	6.71	6.71	0.25	8,845.84	217.77
Knox	46.18	81.72	1.41	1.41	0.04	354.81	4.00
La Salle	259.22	470.95	6.38	6.38	0.13	4,078.69	76.37
Lamar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lamb	15.10	27.13	0.42	0.42	0.01	686.85	11.01
Lampasas	0.16	0.20	0.01	0.01	0.00	4.24	0.00
Lavaca	924.67	1,764.89	13.68	13.68	0.47	12,277.67	311.64
Lee	307.30	564.26	7.08	7.08	0.23	2,650.76	49.84
Leon	1,079.72	2,070.29	15.01	15.01	0.58	5,733.49	197.49
Liberty	331.40	341.24	9.92	9.92	0.45	27,316.75	570.30
Limestone	1,393.87	2,655.14	21.17	21.17	0.71	4,377.56	180.91
Lipscomb	1,125.34	2,104.13	21.36	21.36	0.58	17,104.94	381.52
Live Oak	378.16	709.70	6.91	6.91	0.20	6,807.99	149.58
Llano	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loving	1,567.71	3,023.10	20.15	20.15	0.89	6,348.57	251.69
Lubbock	89.19	158.04	2.71	2.71	0.08	1,825.32	23.15
Lynn	18.52	33.00	0.54	0.54	0.02	350.40	4.52
Madison	117.26	216.26	2.56	2.56	0.07	1,290.52	26.07
Marion	96.78	174.38	2.56	2.56	0.06	1,407.02	25.69
Martin	596.73	1,088.02	14.69	14.69	0.49	10,928.66	168.72

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Mason	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Matagorda	609.79	1,168.96	8.47	8.47	0.32	19,098.24	428.64
Maverick	182.47	323.89	5.42	5.42	0.15	3,715.58	42.08
McCulloch	14.65	25.47	0.50	0.50	0.01	109.65	1.15
McLennan	8.65	15.30	0.26	0.26	0.01	27.43	0.12
McMullen	493.90	900.42	11.92	11.92	0.29	6,027.42	110.63
Medina	275.72	487.25	8.50	8.50	0.26	1,235.77	4.54
Menard	27.00	47.52	0.85	0.85	0.02	266.84	2.69
Midland	1,610.04	2,951.97	37.75	37.75	1.27	20,938.23	333.93
Milam	218.91	387.83	6.65	6.65	0.21	1,216.87	9.32
Mills	0.36	0.51	0.02	0.02	0.00	6.38	0.02
Mitchell	502.49	890.13	15.28	15.28	0.48	6,645.63	65.00
Montague	551.48	987.06	15.59	15.59	0.49	3,448.92	48.39
Montgomery	73.56	81.80	2.86	2.86	0.08	2,890.56	54.67
Moore	744.02	1,343.19	19.29	19.29	0.40	3,502.87	63.64
Morris	0.21	0.37	0.01	0.01	0.00	2.01	0.03
Motley	3.80	6.72	0.12	0.12	0.00	52.75	0.49
Nacogdoches	1,527.76	2,897.04	24.29	24.29	0.77	12,723.39	353.60
Navarro	170.24	301.61	5.16	5.16	0.16	1,444.51	18.73
Newton	78.50	145.69	1.63	1.63	0.05	1,601.94	31.72
Nolan	133.50	240.21	3.63	3.63	0.11	1,931.63	25.88
Nueces	605.47	1,127.23	11.99	11.99	0.31	15,740.17	332.51
Ochiltree	561.88	1,020.35	13.94	13.94	0.31	5,760.68	108.67
Oldham	5.68	10.02	0.17	0.17	0.00	247.24	3.74
Orange	67.79	71.25	2.06	2.06	0.09	8,467.82	172.90
Palo Pinto	455.72	785.82	15.70	15.70	0.21	7,033.45	105.26

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Panola	3,784.21	7,052.88	73.18	73.18	1.82	50,362.96	1,170.88
Parker	1,225.52	3,294.01	19.49	19.49	0.80	9,840.76	290.06
Parmer	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pecos	4,534.56	8,670.50	66.30	66.30	2.63	21,760.89	703.44
Polk	415.68	797.76	5.69	5.69	0.22	29,650.93	625.12
Potter	350.79	632.33	9.25	9.25	0.21	1,799.21	27.27
Presidio	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rains	59.61	115.43	0.71	0.71	0.03	38.47	6.62
Randall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reagan	1,209.82	2,204.56	29.89	29.89	0.99	11,808.61	158.58
Real	1.91	3.34	0.06	0.06	0.00	16.74	0.15
Red River	9.57	16.96	0.29	0.29	0.01	159.73	2.26
Reeves	575.50	1,077.94	10.88	10.88	0.36	3,146.28	72.34
Refugio	652.55	1,218.19	12.72	12.72	0.40	9,671.07	197.77
Roberts	881.18	1,659.43	15.47	15.47	0.45	15,296.54	346.65
Robertson	3,591.03	6,960.37	41.87	41.87	1.90	4,202.14	427.68
Rockwall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Runnels	145.66	262.06	3.96	3.96	0.12	1,177.54	15.82
Rusk	2,394.04	4,447.78	48.27	48.27	1.34	26,428.99	597.16
Sabine	2.04	3.67	0.06	0.06	0.00	19.20	0.14
San Augustine	159.66	309.99	1.77	1.77	0.09	452.69	23.22
San Jacinto	182.43	350.28	2.47	2.47	0.09	6,462.64	144.35
San Patricio	303.08	570.53	5.36	5.36	0.16	12,721.07	267.75
San Saba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schleicher	297.16	521.39	9.30	9.30	0.15	3,975.13	56.43
Scurry	920.14	1,696.28	20.52	20.52	0.72	16,745.60	282.63

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Shackelford	446.66	787.83	13.87	13.87	0.39	2,584.60	27.41
Shelby	788.21	1,506.84	11.24	11.24	0.40	4,681.48	153.59
Sherman	382.36	689.34	9.93	9.93	0.17	2,226.58	38.78
Smith	600.16	1,117.21	11.83	11.83	0.32	6,759.09	157.15
Somervell	69.05	132.73	0.93	0.93	0.04	261.32	10.71
Starr	1,801.98	3,435.69	27.08	27.08	0.92	39,905.70	922.75
Stephens	548.00	962.55	17.22	17.22	0.36	6,028.28	86.04
Sterling	507.62	898.57	15.24	15.24	0.35	5,045.87	54.84
Stonewall	125.21	222.61	3.72	3.72	0.12	1,647.78	17.01
Sutton	1,536.07	2,640.40	53.45	53.45	0.57	14,703.05	158.36
Swisher	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tarrant	4,070.91	11,441.36	39.54	39.54	2.88	4,929.92	620.02
Taylor	92.16	163.25	2.80	2.80	0.09	693.08	8.42
Terrell	890.56	1,697.22	13.46	13.46	0.45	4,554.08	153.52
Terry	217.93	388.12	6.39	6.39	0.20	5,118.11	70.81
Throckmorton	221.50	393.95	6.55	6.55	0.20	1,242.06	15.21
Titus	42.19	74.68	1.29	1.29	0.04	506.68	8.03
Tom Green	170.07	304.64	4.76	4.76	0.14	1,945.37	23.40
Travis	3.37	5.97	0.10	0.10	0.00	14.43	0.07
Trinity	10.94	19.88	0.27	0.27	0.01	193.38	3.42
Tyler	463.76	896.18	5.69	5.69	0.25	57,953.39	1,201.05
Upshur	604.48	1,126.42	11.73	11.73	0.30	10,582.53	238.20
Upton	1,602.98	2,998.03	30.90	30.90	1.09	32,833.54	647.89
Uvalde	0.20	0.26	0.02	0.02	0.00	4.37	0.01
Val Verde	210.53	394.38	3.90	3.90	0.10	620.76	21.64
Van Zandt	193.81	352.82	4.81	4.81	0.15	1,204.59	23.27

Table 1-3. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Victoria	287.47	535.68	5.67	5.67	0.16	3,296.01	69.83
Walker	13.49	24.74	0.31	0.31	0.01	85.26	1.73
Waller	88.01	106.67	2.83	2.83	0.11	2,859.24	56.46
Ward	1,288.64	2,381.97	28.00	28.00	0.94	9,588.88	230.25
Washington	256.76	485.36	4.31	4.31	0.14	2,513.65	64.54
Webb	3,123.82	5,806.41	62.66	62.66	1.48	28,275.41	664.71
Wharton	692.11	1,309.84	11.43	11.43	0.37	15,986.48	354.54
Wheeler	2,223.92	4,231.74	34.40	34.40	1.15	40,674.02	955.94
Wichita	1,185.96	2,099.33	36.23	36.23	1.13	5,040.04	46.60
Wilbarger	174.53	308.95	5.33	5.33	0.17	1,147.90	13.03
Willacy	353.53	681.05	4.59	4.59	0.19	8,274.58	193.92
Williamson	9.07	16.05	0.28	0.28	0.01	53.29	0.33
Wilson	129.98	230.01	3.98	3.98	0.12	757.55	6.10
Winkler	917.14	1,698.44	19.52	19.52	0.63	7,815.47	141.18
Wise	2,749.59	5,099.17	55.75	55.75	1.35	24,225.59	597.53
Wood	239.16	438.82	5.52	5.52	0.18	4,200.35	82.03
Yoakum	1,074.18	1,960.14	26.21	26.21	0.88	25,649.46	414.59
Young	556.32	978.60	17.57	17.57	0.50	3,394.26	35.11
Zapata	4,438.24	8,472.07	65.54	65.54	2.24	13,384.86	594.31
Zavala	64.75	114.70	1.94	1.94	0.05	1,016.76	14.24
Total:	**128,330.85**	**247,236.91**	**2,570.01**	**2,570.01**	**81.34**	**1,568,522.73**	**34,090.45**

2.0 AVAILABLE EMISSIONS ESTIMATION METHODOLOGY REVIEW

One of the objectives of this project was to conduct a literature review of available studies, reports, and research activities relevant to the development of a 2008 base year area source emissions inventory for upstream oil and gas production sites. From this review, a preferred emission estimation approach for each category was selected. In the project Work Plan, this work was referred to as Task 2. The existing studies which were reviewed, and a summary of the available and recommended emission estimation approaches for each source type were presented in a memo submitted to TCEQ on April 26, 2010. This memo included summaries of the data required to implement the preferred approach, and ERG's recommendations how best to obtain the needed data. In addition, any data gaps identified that impacted the ability to develop a 2008 inventory estimate for each source type were described and possible methods for addressing the data gaps (through the use of existing or default data) were presented.

Appendix A contains a copy of this memo summarizing the activities conducted under this part of the project.

3.0 IDENTIFICATION OF OIL AND GAS OWNERS/OPERATORS AND SURVEY DEVELOPMENT

As mentioned above, one of the objectives of this project was the development of survey materials that may be used to obtain the detailed, source-specific data needed to estimate county-level emissions for each source type. Additionally, identification of the producers of oil and gas for each county was needed to assist in possible future implementation of a field survey to obtain the required data. In the project Work Plan, this work was referred to as Task 3. Both of these objectives were met and this information was provided to TCEQ in a memo submitted on July 9, 2010.

Appendix B contains a copy of this memo summarizing the activities conducted under this part of the project.

4.0 EMISSIONS CALCULATION METHODOLOGY

This section presents a discussion of each source type included in the 2008 baseline area source emissions inventory of upstream oil and gas production sites. Each source type is discussed separately, including a process description, a description of the emissions estimation methodology used to calculate emissions, a description of the derivation of all activity data and input parameters used in the calculation, presentation of all data used in the calculation, the equations used to calculate emissions for each source type, and an example calculation for each source type.

4.1 Compressor Engines

Natural gas fueled spark-ignited internal combustion engines are normally used to drive gas field compressors. The compressors are used to boost the pressure of well-head natural gas so that it can be injected into higher pressure gathering lines. These compressor engines burn well-head natural gas and can represent a significant NO_x area emissions source category as they generally operate 8,760 hours per year with minimum down-time.

Emissions from compressor engines were calculated using a methodology similar to that employed in the Houston Advanced Research Council's (HARC) study "Natural Gas Compressor Engine Survey and Engine NO_x Emissions at Gas Production Facilities" (HARC, 2005).[1] For this 2008 inventory, the calculation methodology uses annual natural gas production by county along with vender-derived county-level emission factors to determine emissions from compressor engines at gas production facilities. ERG combined engine data from the HARC study with two 2007 TCEQ engine surveys conducted on the counties located in the Dallas - Forth Worth (DFW) metropolitan area and Southeast Texas. The two TCEQ surveys were completed as efforts to amend the state clean air plan for ozone. Engine operators reported engine models and sizes, and other data to TCEQ. Using these data, ERG calculated county-level emissions from compressor engines with the following equation:

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[1] The HARC 2005 report was updated in 2006 to include more engine size categories and to add the year 2000 to the previous inventory; however, these updates did not change the calculation methodology used in the original 2005 report.

$$E_{ik} = TGP_i \times \left(\frac{F_{1i} * F_{2j} * EF_{jk} * C_i}{907{,}180} \right)$$

where:

E_{ik} is the emissions for county i, and pollutant k [tons/yr]
TGP_i is the total gas production in county i [Mscf/yr]
F_{1i} is the fraction of wells requiring compression in county i
F_{2j} is the fraction of compression load represented by engines of type j
EF_{jk} is the emission factor for engine type j, and pollutant k [g/Hp-hr]
C_i is the compression requirements for county i [Hp-hr/Mscf]
907,180 is the conversion factor from grams to tons of emissions

Total gas production in county i, TGP_i:

Natural gas production data by county (TGP_i) was provided for 2008 by the TRC for 241 counties. Burnet, Castro, Collin, Comal, Dallam, Deaf Smith, Delta, El Paso, Gillespie, Hall, Kendall, Lamar, Llano, Mason, Parmer, Presidio, Randall, San Saba, and Swisher counties had no gas or oil production in 2008.

Fraction of wells requiring compression in county i, F_{1i}:

Upon initial well completion, not all wells require compression. Therefore, the fraction of wells requiring compression (F_{1i}) was estimated in the HARC study as the fraction of active wells greater than one year old. Using the same assumption for this 2008 inventory, ERG determined the fraction of wells active in 2008 that were greater than one year old using the following equation:

$$\text{Fraction of Wells} > 1\text{ Year Old} = 1 - \left(\frac{\text{(Wells Completed in 2007)}}{\text{(Total Active Wells on February 5, 2008)}} \right)$$

For each Texas Railroad Commission (TRC) District, results are shown in Table 4-1. ERG determined the number of wells completed in 2007 using TRC annual drilling, completion, and plugging summaries which are available at: http://www.rrc.state.tx.us/data/drilling/drillingsummary/index.php. Total active wells by district for January 1, 2008 are not readily available from the TRC website; therefore, in order to determine total active wells, ERG used gas well distribution data showing the number of regular producing gas wells by county. Gas well distribution data by county is only available from the TRC website on a bi-annual (February and September) basis and can be found at:

http://www.rrc.state.tx.us/data/wells/wellcount/index.php. Using the February 2008 TRC report, ERG summed the county specific numbers for regular producing gas wells by TRC district.

The fraction of wells greater than one year old are likely to be slightly different than what is shown below because each well that was completed in 2007 could have been completed on any day of that year. Using the methodology explained above, ERG has assumed that all wells completed in 2007 were completed on February 5, 2007. ERG applied the fractions shown in the Table 4-1 to the counties in each respective district.

Table 4-1. Fraction of Wells >1 Year Old

TRC District	Wells Completed in 2007	Total Active Wells on February 5, 2008	Fraction of Wells >1 Year Old (F_{1i})
1	176	2,513	0.9300
2	515	3,293	0.8436
3	317	3,977	0.9203
4	1,070	13,098	0.9183
5	644	7,008	0.9081
6	1,957	13,706	0.8572
7B	121	6,769	0.9821
7C	947	13,101	0.9277
8	225	3,909	0.9424
8A	36	265	0.8642
9	1,781	7,739	0.7699
10	854	12,647	0.9325
Total	8,643	88,025	0.9018

Fraction of compression load represented by engines of type j, F_{2j}:

Fraction of compression load by engine type (F_{2j}) was determined by the HARC report for eight engine types (i.e. 2-cycle lean, 50-499 Hp; 4-cycle lean, 50-499 Hp; etc.) in three areas categorized by their attainment status, including the Texas attainment areas, the Houston nonattainment area, and the Dallas nonattainment area. For this 2008 inventory, in an effort to achieve more accurate emissions data results, ERG combined data from the two 2007 TCEQ engine surveys with the HARC survey data and determined the distribution or fraction of compression load by engine type for the most reported engines (comprising 80% of the population) for each of the three categories used in the HARC report.

In order to prevent duplication, 103 engines from the HARC study were removed prior to combining the data with the two 2007 TCEQ engine surveys. These engines were removed because they were located in thirteen counties (Austin, Ellis, Hardin, Houston, Jasper, Jefferson, Newton, Polk, San Augustine, San Jacinto, Trinity, Tyler, and Walker) that overlapped with the 2007 survey data. The 2007 data had a greater population (335) of engines for these counties than the HARC study. ERG also removed the following engines from the two 2007 TCEQ engine survey data sets:

- Fifty-five engines from the DFW survey and two engines from the Southeast survey that lacked engine characteristic data;
- Two engines from the HARC study that were labeled as electric motors;
- Three engines from the HARC study that were identified as not being located at a gas well; and
- One engine from the DFW survey identified as no longer operational.

After combining the data sets (and removing certain engines as discussed above), a total of 2,880 engines were included for the analysis as detailed in Table 4-2 below.

Table 4-2. Engine Count by Survey

Specific Survey	Number of Engines
HARC Survey	1,252
2007 TCEQ DFW Survey	1,321
2007 TCEQ SE Survey	307
Total	2,880

In order to ensure engines were grouped appropriately, ERG performed extensive internet research as well as phone interviews with engine manufactures to standardize engine make and model naming conventions. Additionally, some assumptions were made such as all Caterpillar engines reported in the survey data are natural gas fired (many respondents had reported engine models without using the term “G” in front of the model number which defines the engine as a natural gas fired engine). ERG also assumed that any potential (future) engines identified in the 2007 DFW survey would be located in the Dallas nonattainment area. Minor gap-filling was also performed on the combined dataset which included completing any empty “Engine Cycle (2 or 4)” data fields based on the known engine make and model.

Using the combined dataset, ERG determined an average size (horsepower) for each specific engine model and then calculated the fraction of compression load by engine type (F_{2j})

for three categories (Texas attainment areas, the Dallas nonattainment area, and the Houston nonattainment area) as shown in Tables 4-3 through 4-5. Due to minimal engine data in the Jefferson, Hardin, and Orange nonattainment counties, these counties were combined into the Houston nonattainment area.

Emission factor for engine type j, and pollutant k, EF_{jk}:

Emission factors for each unique engine make and model (based on approximately the top 80% most reported engines in each of the three attainment status categories) are shown in Tables 4-3 through 4-5. The NO_x, CO, and VOC emission factors for the engines located in attainment counties (Table 4-3) were each determined through extensive internet research as well as phone interviews with specific engine manufactures. Manufacture emissions data was averaged across all performance data given for a specific engine.

NO_x emission factors for the engines located in nonattainment counties (Table 4-5) are based on Texas's rules for the Houston-Galveston-Brazoria eight-hour ozone nonattainment area (30 TAC, Chapter 117, Subchapter D, Division 1 and 2). These rules regulate certain minor sources of NO_x, including some stationary, gas-fired reciprocating internal combustion engines. Considering the Houston-Galveston-Brazoria rule, all stationary, gas-fired reciprocating internal combustion engines greater than 50 horsepower are restricted to 0.5 g/Hp-hr. Considering the Dallas-Fort Worth rule, rich burn engines greater than 50 horsepower are restricted to 0.5 g/Hp-hr, lean burn engines installed or moved before June 1, 2007 are limited to 0.7 g/Hp-hr, and lean burn engines installed or moved after June 1, 2007 are limited to 0.5 g/Hp-hr. ERG calculated that ~16% percent of lean burn engines operating in DFW counties in 2008 could have potentially been installed after June 1, 2007. Therefore, an adjusted NO_x emission factor of 0.67 g/Hp-hr [(0.50 * .16) + (0.70 * .84)] was applied to any lean burn engines in Table 4-4. However, the compliance date for the Dallas-Fort Worth rule was not until after 2008, therefore the attainment area NO_x emission factor in Table 4-3 was used for these counties for this 2008 base year inventory.

CO and VOC emission factors for the engines located in nonattainment counties (Tables 4-4 and 4-5) were determined through extensive internet research as well as phone interviews with specific engine manufactures. However, ERG assumed any four stroke rich burn engine, greater than 50 Hp and located in a nonattainment area, would have non-selective catalytic

Table 4-3. Emission Factor Data for Texas Attainment Areas

Engine Make & Model	SCC	Number of Engines [Lean / Rich]	Engine Horsepower (Hp)	Compression Load by Engine Type (F_{2j})	Fuel Consumption (MMBtu/Hp-hr)	Emission Factor (EF_{jk}) (g/Hp-hr)				
						PM	NOx	CO	VOC	SO_2
CAT G3306 NA	2310021302	0 / 165	145	8.98%	0.007775	3.35E-02	13.48	13.46	0.22	2.07E-03
CAT G3304 NA	2310021302	0 / 130	95	4.64%	0.007567	3.26E-02	21.08	1.6	0.24	2.02E-03
Wauk VRG330	2310021302	0 / 107	68	2.73%	0.008038	3.46E-02	12.951	1.104	0.05 (1)	2.14E-03
CAT G3306 TA	2310021302	0 / 67	203	5.11%	0.008098	3.49E-02	16.57	16.57	0.12	2.16E-03
Wauk F817 G	2310021302	0 / 42	87	1.37%	0.007253	3.13E-02	16.0	1.0	1.7 (2)	1.93E-03
AJAX DPC-60	2310021102	39 / 0	58	0.85%	0.009000	1.57E-01	4.4	1.7	0.8	2.40E-03
AJAX DPC-115	2310021102 /2310020600	31 / 2	110	1.36%	0.009000	1.57E-01	4.4	2.4	0.9	2.40E-03
Wauk F1197 G	2310021302	0 / 32	183	2.20%	0.007253	3.13E-02	20.0	1.0	0.20 (1)	1.93E-03
CAT G3406 NA (3)	2310021302	0 / 31	290	3.37%	0.007407	3.19E-02	23.2267	6.14	0.17	1.98E-03
CAT G3516 TALE	2310021203	30 / 0	1245	14.02%	0.007365	2.58E-04	2.0	1.805	0.28	1.96E-03
CAT G3306 NA HCR (4)	2310021302	0 / 29	145	1.58%	0.007775	3.35E-02	13.48	13.46	0.22	2.07E-03
AJAX DPC-360	2310021102 /2310020600	27 / 1	346	3.64%	0.008400	1.46E-01	6.3	1.4	1.0	2.24E-03
AJAX DPC-180	2310021102	28 / 0	173	1.82%	0.008400	1.46E-01	6.3	1.4	1.0	2.24E-03
AJAX DPC-140	2310021102	26 / 0	134	1.31%	0.008200	1.43E-01	10.5	1.3	0.7	2.19E-03
AJAX DPC-280	2310021102	25 / 0	269	2.52%	0.008200	1.43E-01	11.4	1.3	0.7	2.19E-03
Wauk VRG220 (5)	2310021301	0 / 24	45	0.41%	0.008038	3.46E-02	12.951	1.104	0.05 (1)	2.14E-03
AJAX DPC-80	2310021102	22 / 0	77	0.64%	0.008900	1.55E-01	4.4	2.8	0.9	2.37E-03
CAT G342 NA (6)	2310021302	0 / 21	225	1.77%	0.008588	3.70E-02	0.101	0.317	0.086 (1)	2.29E-03
AJAX C-42	2310021101 /2310020600	19 / 1	40	0.30%	0.009900	1.72E-01	4.4	3.3	0.8	2.64E-03
GEMINI G26	2310021301	0 / 19	26	0.19%	0.008038	3.46E-02	12.951	1.104	0.05 (1)	2.14E-03
Wauk L7042 GL (7)	2310021203	19 / 0	1357	9.68%	0.007238	2.53E-02	1.0	2.85	0.95 (1)	1.93E-03
CAT G342 TA (6)	2310021302	0 / 16	225	1.35%	0.008588	3.70E-02	0.101	0.317	0.086 (1)	2.29E-03
Wauk VRG310 (5)	2310021302	0 / 16	68	0.41%	0.008038	3.46E-02	12.951	1.104	0.05 (1)	2.14E-03
CAT G399 TA (10)	2310021403	0 / 16	802	4.82%	0.008710	3.75E-02	0.7756	0.1592	0.0086 (8)	2.32E-03
Wauk L7042 GSI (10)	2310021403	0 / 15	1357	7.64%	0.007558	3.26E-02	1.6	1.3	0.025 (1)	2.02E-03
CAT G398 TA (9, 10)	2310021403	0 / 15	605	3.41%	0.008710	3.75E-02	0.7756	0.1592	0.0086 (8)	2.32E-03
CAT G3406 TA	2310021302	0 / 14	290	1.52%	0.007407	3.19E-02	23.2267	6.14	0.17	1.98E-03
CAT G3512 TALE	2310021203	14 / 0	932	4.90%	0.007385	2.58E-04	2.0	2.04	0.295	1.97E-03
CAT G3406 (11)	2310021302	0 / 14	290	1.52%	0.007407	3.19E-02	23.2267	6.14	0.17	1.98E-03
Wauk L7042 G (10)	2310021403	0 / 14	961	5.05%	0.007180	3.09E-02	1.6	1.3	0.025 (1)	1.91E-03

Table 4-3. Emission Factor Data for Texas Attainment Areas (Cont.)

Engine Make & Model	SCC	Number of Engines [Lean / Rich]	Engine Horsepower (Hp)	Compression Load by Engine Type (F_{2j})	Fuel Consumption (MMBtu/Hp-hr)	Emission Factor (EF_{jk}) (g/Hp-hr)				
						PM	NOx	CO	VOC	SO_2
AJAX DPC-230	2310021102 /2310020600	10 / 1	221	0.91%	0.008700	1.52E-01	4.4	2.4	0.90	2.32E-03
TOTAL	**--**	**1082**	**--**	**100%**	**Weighted Average EFs**	**0.04**	**7.57**	**3.85**	**0.35**	**2.07E-03**

1. Non-Methane Hydrocarbon.
2. Total Hydrocarbon.
3. There is no emission factor data available distinguishing CAT G4306 NA from G3406 TA, thus it was assumed that emission factors were the same for both models.
4. There is no emission factor data available distinguishing CAT G3306 NA HCR from G3306 NA, thus it was assumed that emission factors were the same for both models.
5. Based on discussions with Waukesha, the VRG220 and VRG310 models have the same emission factors as the VRG330.
6. Emissions data based on AP-42 background document with no HAP control. Emission factor data did not differentiate between a G342 TA or NA engine, thus same emission factors were assumed for both models.
7. No emission factor data could be found for this engine. Because it is a 4-stroke and has similar horsepower to the Wauk VRG220, it was assumed that emission factors were the same for both models.
8. Assumed to be equal to CAT G342 NA.
9. No emission factor data could be found for this engine. Since it is a similar model manufactured in the same time period, it was assumed that emission factors were the same as CAT G399 TA.
10. Engines are documented as having non-selective catalytic reduction (NSCR) control technology. ERG has applied a 90% reduction to the emission factors for CO and VOC for these engines
11. There is some ambiguity in the survey data as to whether this engine is a CAT G3406 NA or TA; however, the emissions are the same for the G3406 TA and NA versions.

Table 4-4. Emission Factor Data for Dallas Nonattainment Areas

Engine Make & Model	SCC	Number of Engines [Lean / Rich]	Engine Horsepower (Hp)	Fraction of Compression Load by Engine Type (F_{2j})	Fuel Consumption (MMBtu/Hp-hr)	Emission Factor (EF_{jk}) (g/Hp-hr)				
						PM	NO_x (1)	CO (1)	VOC (1)	SO_2
CAT G3306 NA	2310021402	0 / 281	145	6.10%	0.007775	3.35E-02	0.50	1.346	0.022	2.07E-03
CAT G3304 NA HCR (2)	2310021402	0 / 72	95	1.02%	0.007567	3.26E-02	0.50	0.16	0.024	2.02E-03
Cummins G8.3	2310021402	0 / 64	112	1.07%	0.008228	3.55E-02	0.50	0.946	0.001 (3)	2.19E-03
CAT G3516 TALE	2310021203	60 / 0	1245	11.18%	0.007364	2.58E-04	0.67	1.805	0.28	1.96E-03
CAT G3606 TALE LCR (4)	2310021203	59 / 0	1835	16.21%	0.006612	2.31E-04	0.67	2.5625	0.605	1.76E-03
CAT G3306 NA HCR (5)	2310021402	0 / 58	145	1.26%	0.007775	3.35E-02	0.50	1.346	0.022	2.07E-03
Wauk L7044 GSI	2310021403	0 / 50	1540	11.53%	0.007665	3.30E-02	0.50	1.03	0.02 (6)	2.04E-03
Wauk L5794 GSI	2310021403	0 / 49	1265	9.28%	0.007430	3.20E-02	0.50	0.88	0.03 (3)	1.98E-03
CAT G3304 NA	2310021402	0 / 46	95	0.65%	0.007567	3.26E-02	0.50	0.16	0.024	2.02E-03
Wauk L7042 GSI	2310021403	37 / 0	1357	7.52%	0.007557	2.64E-04	0.67	13.0	0.25 (3)	2.02E-03
CAT G3516	2310021203	0 / 29	1050	4.56%	0.007700	3.32E-02	0.50	1.31	0.029 (3)	2.05E-03
CAT G3516 TALE AFRC (7)	2310021203	29 / 0	1245	5.41%	0.007364	2.58E-04	0.67	1.805	0.28	1.96E-03
Cummins 8.3 GTA	2310021402	0 / 28	183	0.77%	0.007380	3.18E-02	0.50	0.205	0.007 (3)	1.97E-03
CAT G3608 TALE	2310021203	28 / 0	2408	10.09%	0.006592	2.31E-04	0.67	2.56	0.5975	1.76E-03
CAT G3606 TALE	2310021203	26 / 0	1835	7.14%	0.006612	2.31E-04	0.67	2.56	0.605	1.76E-03
Cummins G5.9	2310021402	0 / 25	84	0.31%	0.007914	3.41E-02	0.50	1.451	0.022 (3)	2.11E-03
AJAX DPC-180	2310021102/ 2310020600	7 / 17	173	0.62%	0.008400	1.46E-01	0.55	1.4	1.0	2.24E-03
CAT G3306 TA	2310021402	0 / 19	203	0.58%	0.008098	3.49E-02	0.50	1.657	0.012	2.16E-03
CAT G3508 TALE	2310021203	17 / 0	670	1.71%	0.007510	2.63E-04	0.67	1.84	0.3	2.00E-03
CAT G3512 TALE	2310021203	17 / 0	932	2.37%	0.007385	2.58E-04	0.67	2.04	0.295	1.97E-03
AJAX DPC-140	2310021102/ 2310020600	3 / 11	134	0.28%	0.008200	1.43E-01	0.54	1.3	0.7	2.19E-03
AJAX DPC-115	2310021102/ 2310020600	5 / 8	110	0.21%	0.009000	1.57E-01	0.57	2.4	0.9	2.40E-03
Wauk VRG330	2310021402	0 / 12	68	0.12%	0.008038	3.46E-02	0.50	0.110	0.005 (3)	2.14E-03
TOTAL	**--**	**1048**	**--**	**100%**	**Weighted Average EFs**	**0.02**	**7.57**	**2.62**	**0.30**	**1.93E-03**

1. ERG assumed any four stroke rich burn engine, greater than 50 Hp and located in a nonattainment area, would have non-selective catalytic reduction (NSCR) control technology. ERG has applied a 90% reduction to the emission factors for CO and VOC for these engines. As the compliance date for 30 TAC, Chapter 117, Subchapter D Division 2 is not until after 2008, the attainment area NOx emission factor is used.
2. There is no emission factor data available distinguishing CAT G3304 NA HCR from G3304 NA, thus it was assumed that emission factors were the same for both models.
3. Non-Methane Hydrocarbon.
4. There is no emission factor data available distinguishing CAT G3606 TALE LCR from G3606 TALE, thus it was assumed that emission factors were the same for both models. Furthermore, although data received from the 2007 DFW survey reported the CAT G3606 TALE LCR model has a rich burn engine; based on further research, ERG determined that this engine is a lean burn engine.
5. There is no emission factor data available distinguishing CAT G3306 NA HCR from G3306 NA, thus it was assumed that emission factors were the same for both models.
6. Value is estimated because no data is available.
7. There is no emission factor data available for this model engine with an air fuel ratio control, thus emission factors were assumed to be the same as the CAT G3516 TALE. Furthermore, several of these engines were reported as rich burn in the data received from the 2007 DFW survey; however, based on further research, ERG determined that this engine can only be a lean burn engine.

Table 4-5. Emission Factor Data for Houston Nonattainment Areas

Engine Make & Model	**SCC**	**Number of Engines [Lean / Rich]**	**Engine Horsepower (Hp)**	**Fraction of Compression Load by Engine Type (F_{2j})**	**Fuel Consumption (MMBtu/Hp-hr)**	**Emission Factor (EF_{jk}) (g/Hp-hr)**				
						PM	**NO$_x$ (1)**	**CO (1)**	**VOC (1)**	**SO$_2$**
CAT G3304 NA	2310021402	0 / 26	95	5.49%	0.007567	3.26E-02	0.50	0.16	0.024	2.02E-03
CAT G3306 NA	2310021402	0 / 24	145	7.73%	0.007775	3.35E-02	0.50	1.346	0.022	2.07E-03
Wauk VRG330	2310021402	0 / 23	68	3.47%	0.008038	3.46E-02	0.50	0.1104	0.005 (2)	2.14E-03
CAT G379 NA (3)	2310021402	0 / 14	327	10.17%	0.008710	3.75E-02	0.50	0.1592	0.009 (4)	2.32E-03
Wauk F1197 G	2310021402	0 / 13	183	5.28%	0.007253	3.13E-02	0.50	0.1	0.020 (2)	1.93E-03
CAT G3306 TA	2310021402	0 / 13	203	5.86%	0.008098	3.49E-02	0.50	1.657	0.012	2.16E-03
CAT G342 NA (5)	2310021402	0 / 10	225	5.00%	0.008588	3.70E-02	0.101	0.0317	0.009 (2)	2.29E-03
CAT G3406 TA	2310021402	0 / 9	290	5.80%	0.007407	3.19E-02	0.50	0.614	0.017	1.98E-03
Wauk F817 G	2310021402	0 / 7	87	1.35%	0.007253	3.13E-02	0.50	0.1	0.17 (6)	1.93E-03
AJAX C-42	2310021101	5 / 0	40	0.44%	0.009900	1.72E-01	4.4 (8)	3.3	0.8	2.64E-03
CAT G398 TA (3)	2310021403	0 / 5	605	6.72%	0.008710	3.75E-02	0.50	0.1592	0.009 (4)	2.32E-03
AJAX DPC-140	2310021102	5 / 0	134	1.49%	0.008200	1.43E-01	0.50	1.3	0.7	2.19E-03
SUPERIOR 8GTLB	2310021203	4 / 0	1100	9.77%	0.008788	3.07E-04	0.50	3.6	0.4	2.34E-03
CAT G379 TA (3)	2310021402	0 / 4	417	3.70%	0.008710	3.75E-02	0.50	0.1592	0.009 (4)	2.32E-03
CAT G3516 TALE	2310021203	3 / 0	1245	8.30%	0.007364	2.58E-04	0.50	1.805	0.28	1.96E-03
Wauk F11 G	2310021402	0 / 3	119	0.79%	0.007600	3.27E-02	0.50	0.079	0.027 (2)	2.03E-03
CAT G3306	2310021402	0 / 3	183	1.22%	0.007579	3.27E-02	0.50	0.146	0.012	2.02E-03
Wauk VRG220 (7)	2310021301	0 / 3	45	0.30%	0.008038	3.46E-02	12.951 (8)	1.104	0.05 (2)	2.14E-03
Wauk VRG330 TA	2310021402	0 / 3	100	0.67%	0.007307	3.15E-02	0.50	0.1587	0.002 (2)	1.95E-03
Wauk L7042 GL	2310021203	3 / 0	1357	9.04%	0.007237	2.53E-04	0.50	2.85	0.95 (2)	1.93E-03
Wauk L7042 G	2310021403	0 / 3	961	6.40%	0.007180	3.09E-02	0.50	1.3	0.025 (2)	1.91E-03
CAT G342 TA (5)	2310021402	0 / 2	225	1.00%	0.008588	3.70E-02	0.101	0.0317	0.009 (2)	2.29E-03
TOTAL		**199**		**100%**	**Weighted Average EFs**	**0.03**	**0.53**	**1.17**	**0.17**	**2.12E-03**

1. NOx emission factors were adjusted for 30 TAC, Chapter 117, Subchapter D, Division 2 nonattainment rule. Also, ERG assumed any four stroke rich burn engine, greater than 50 Hp and located in a nonattainment area, would have non-selective catalytic reduction (NSCR) control technology. ERG has applied a 90% reduction to the emission factors for CO and VOC for these engines.
2. Non-Methane Hydrocarbon.
3. No emission factors could be found for these engines. Since they are similar models manufactured in the same time period, it was assumed that emission factors were the same as CAT G399 TA.
4. Assumed to be equal to CAT G342 NA.
5. Emission factors are based on AP-42 background document testing with no HAP emission control. Emissions data did not differentiate between a G342 TA or NA engine, so it was assumed that they have the same emission factors. No control device is needed since NOx emissions are below Texas mandated emission standards.
6. Total Hydrocarbon.
7. Based on discussions with Waukesha, the VRG220 and VRG310 models have the same emission factors as the VRG330.
8. The AJAX C-42 and Wauk VRG220 engines are less than 50 Hp and therefore are not subject to 30 TAC, Chapter 117, Subchapter D, Division 2.

reduction (NSCR) control technology. AP-42 Section 3.2 (US EPA, 2000) recommends applying an efficiency of 90% to the uncontrolled emissions of CO for engines equipped with NSCR technology; other studies (EPRI 2005) state the technology can also achieve 85 to 90% reduction of VOCs. Therefore, the CO and VOC emission factors in Tables 4-4 and 4-5 reflect a 90% control efficiency adjustment.

All PM and SO_2 emission factors were obtained from AP-42 Section 3.2 (US EPA, 2000). PM emission factors are based on whether each engine is a 2 or 4 stroke lean-burn engine or a 4 stroke rich-burn engine. The PM emission factor represents both PM_{10} and $PM_{2.5}$. The SO_2 emission factor assumes the sulfur content in natural gas is 0.002 grams per standard cubic foot.

By applying the emissions data (EF_{jk}) in Tables 4-3 through 4-5 to the fraction of compression load by engine type (F_{2j}), a single set of weighted emission factors was calculated for each pollutant in each attainment status category.

Compression requirements for county i, C_i:

A compressor's operating behavior is generally dependent on the relationship between pressure ratio and volume or mass flow rate. In particular, the operating behavior for a compressor engine located at a gas well is based on the compressor suction and discharge pressures required to convey the natural gas from the well head to the gathering lines. These pressures, or the compression ratio, along with the natural gas flow-rate through the compressor, define the engine load in terms of the amount of mechanical work that is required to compress the natural gas produced by the well. This mechanical work, in terms of horsepower-hour (Hp-hr), is directly proportional to the volume of fuel, in terms of thousand cubic feet (Mscf), that must be burned by the compressor engine and the relationship is termed a *compression requirement* (Hp-hr/Mscf). Special compressor calculators can be used to convert inlet and outlet pressures into *compression requirements* which can then be used to determine emissions created by compressor engines. Because of this direct relationship of mechanical work to volume of fuel burned, one would expect a 100 Hp engine to burn almost an equal amount of fuel as two (2) 50 Hp engines when compressing the same volume of natural gas produced by the same well. Therefore, it is not necessary to know the specific numbers of engines, or their individual sizes when calculating emissions from compressors at the county level.

The 2005 HARC report developed compression requirements ranging between 3.1 and 3.5 (Hp-hr/Mscf) for three distinct districts in eastern Texas, including one attainment area and two nonattainment areas (Houston and Dallas) by obtaining typical well pressures and gathering line pressures through a field study. The engines in this particular field survey were operated at loads ranging from about 10% to 70% of full load, and averaged 40% load. Additionally, compression requirements deduced from two Pollution Solutions studies are relatively in-line with the compression requirements used in the 2005 HARC report. More specifically, a 191 Hp-day/Mscf compression requirement determined in a 2005 Pollutions Solutions study, when adjusted[2] for the findings in a 2008 Pollution Solutions study, yields a *compression requirement* of 2.97 (Hp-hr/Mscf).

Compression requirements calculated by specific Texas studies are shown in Table 4-6. Those compression requirements were applied to counties in each respective TRC District and an average was calculated for application to the rest of Texas.

Table 4-6. Average Compression Requirements (Hp-hr/Mscf)

Study	TRC District 2	TRC District 3	TRC District 6	All Other Texas Areas
HARC 2005	3.5	3.1	3.1	--
2005 and 2008 Pollution Solutions (1)	--	--	2.97	--
Final	**3.5**	**3.1**	**3.03**	**3.21** **(2)**

1. Included Gregg, Harrison, Rusk, Smith, Upshur, and Panola Counties.
2. TRC districts 2, 3, and 6 averaged together.

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[2] In a 2002 emissions inventory (Pollution Solutions, 2005) entitled "Tyler/Longview/Marshall Flexible Attainment Region Emission Inventory", the author developed a *compression requirement* (Hp-day/MSCF) through survey data assuming the compressor engines were operating under full load or maximum installed horsepower. This assumption caused an overestimation of the amount of fuel that was consumed by the compressor engines and consequently overestimated the amount of emissions from these engines. A more recent study by Pollution Solutions (2008) entitled "2005 and 2007 Compressor Engine Emissions and Load Factors Report" determined average load factors for three engine categories, all of which were less than 100%. For engines less than 240 Hp, the load factor was 70%. For engines between 240-500 Hp, the load factor was 69%. For engines greater than 500 Hp, the load factor was 58%. Applying the load factors reduced the estimated 2005 emissions of NO_x by 34% and similar reductions were seen for VOC and CO.

HAP Emissions for Compressor Engines

HAP emissions from compressor engines were calculated using VOC and PM speciation data as follows:

$$E_{VOC\text{-}HAP} = E_{VOC} \text{ x } (E_{\%VOC\text{-}HAP}/100)$$

where:

$E_{VOC\text{-}HAP}$ = Speciated VOC-HAP emissions [tons/yr]
E_{VOC} = VOC emissions [tons/yr]
$E_{\%VOC\text{-}HAP}$ = % HAP composition of VOC emissions

and

$$E_{PM\text{-}HAP} = E_{PM} \text{ x } (E_{\%PM\text{-}HAP}/100)$$

where:

$E_{PM\text{-}HAP}$ = Speciated PM-HAP emissions [tons/yr]
E_{PM} = PM emissions [tons/yr]
$E_{\%PM\text{-}HAP}$ = % HAP composition of PM emissions

Appendix C contains the VOC and PM HAP speciation data.

Emissions for county i, and pollutant k, EF_{ik}:

Appendix D presents county-level emissions for compressor engines corresponding to county-level natural gas production, based on the input variables discussed above. Tables 4-7 through 4-9 depict the distribution of emissions for various engine types by Source Classification Code (SCC) as found in the Texas attainment areas, the Houston nonattainment area, and the Dallas nonattainment area. ERG applied these distributions in order to determine compressor engine emissions by SCC and county (see Appendix D). Table 4-10 defines each SCC used for Compressor Engines.

Table 4-7. Distribution of Compressor Engine Emissions by SCC for Texas Attainment Counties

SCC	PM	NO_x	CO	VOC	SO_2
2310020600	1.10%	0.16%	0.11%	0.75%	0.34%
2310021101	1.15%	0.13%	0.17%	0.59%	0.36%
2310021102	44.40%	9.21%	3.80%	29.00%	13.93%
2310021103	0%	0%	0%	0%	0%
2310021201	0%	0%	0%	0%	0%
2310021202	0%	0%	0%	0%	0%
2310021203	7.23%	4.76%	11.53%	37.84%	26.92%
2310021301	0.48%	0.77%	0.12%	0.08%	0.61%
2310021302	28.83%	58.22%	51.62%	21.66%	36.53%
2310021303	0%	0%	0%	0%	0%
2310021401	0%	0%	0%	0%	0%
2310021402	0%	0%	0%	0%	0%
2310021403	16.81%	26.75%	32.64%	10.08%	21.30%

Table 4-8. Distribution of Compressor Engine Emissions by SCC for Dallas Nonattainment Counties

SCC	PM	NO_x	CO	VOC	SO_2
2310020600	5.93%	0.72%	0.46%	2.39%	0.92%
2310021101	0%	0%	0%	0%	0%
2310021102	2.42%	0.29%	0.20%	0.99%	0.38%
2310021103	0%	0%	0%	0%	0%
2310021201	0%	0%	0%	0%	0%
2310021202	0%	0%	0%	0%	0%
2310021203	24.14%	63.66%	49.49%	87.85%	56.38%
2310021301	0%	0%	0%	0%	0%
2310021302	0%	0%	0%	0%	0%
2310021303	0%	0%	0%	0%	0%
2310021401	0%	0%	0%	0%	0%
2310021402	20.38%	9.82%	4.88%	0.75%	12.77%
2310021403	47.13%	25.51%	44.97%	8.02%	29.55%

Table 4-9. Distribution of Compressor Engine Emissions by SCC for Houston Nonattainment Counties

SCC	PM	NO_x	CO	VOC	SO_2
2310020600	0%	0%	0%	0%	0%
2310021101	2.79%	3.68%	1.25%	2.03%	0.55%
2310021102	7.76%	1.40%	1.65%	5.96%	1.54%
2310021103	0%	0%	0%	0%	0%
2310021201	0%	0%	0%	0%	0%
2310021202	0%	0%	0%	0%	0%
2310021203	0.27%	25.54%	64.67%	84.77%	26.66%
2310021301	0.38%	7.32%	0.28%	0.09%	0.30%
2310021302	0%	0%	0%	0%	0%
2310021303	0%	0%	0%	0%	0%
2310021401	0%	0%	0%	0%	0%
2310021402	72.39%	49.69%	24.15%	5.90%	57.84%
2310021403	16.41%	12.36%	8.00%	1.25%	13.11%

Table 4-10. Compressor Engine SCC Definitions

SCC	Definition
2310020600	GENERIC NATURAL GAS FIRED COMPRESSOR ENGINES (All 2-CYCLE RICH BURN)
2310021101	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines <50 Hp
2310021102	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 50 To 499 Hp
2310021103	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 500+ Hp
2310021201	Natural Gas Fired 4-Cycle Lean Burn Compressor Engines <50 Hp
2310021202	Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 50-499 Hp
2310021203	Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 500+ Hp
2310021301	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 Hp
2310021302	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50 To 499 Hp
2310021303	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ Hp
2310021401	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 Hp W/ Nscr
2310021402	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50-499 Hp W/ Nscr
2310021403	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ Hp W/ Nscr

Example Calculation for Compressor Engines

Using the equation provided above, ERG calculated NO_x emissions in Anderson County from natural gas fired 2-cycle lean burn compressor engines less than 50 Hp as follows:

$$E_{ik} = TGP_i \times \left(\frac{F_{1i} * F_{2j} * EF_{jk} * C_i}{907{,}180} \right)$$

where:

E_{ik} = NO_x emissions in Anderson County [tons/year]
TGP_i = 12,044,998 (the total gas production in Anderson County) [Mscf/yr]
F_{1i} = 0.8572 (the fraction of wells requiring compression in Anderson County)
F_{2j} = 0.0013 (the fraction of compression load represented by natural gas fired 2-cycle lean burn compressor engines)

EF_{jk} = 7.57 (the NO_x emission factor for natural gas fired 2-cycle lean burn compressor engines) [g/Hp-hr]
C_i = 3.03 (the compression requirements for Anderson County) [Hp-hr/Mscf]
907,180 is the conversion factor from grams to tons of emissions

Therefore:
E_{ik} = 12,044,998 [Mscf] x ((0.8572 * 0.0013 * 7.57 [g NO_x/Hp-hr] * 3.03 [Hp-hr/Mscf])/907,180)
E_{ik} = 0.339373 [tons NO_x/yr]

4.2 Artificial Lift (Pumpjack) Engines

A pumpjack is used to mechanically lift liquid out of the well if there is not enough bottom hole pressure for the liquid to flow all the way to the surface. The pumpjack tends to be driven by an electric motor; however, in isolated locations without access to electricity, combustion engines are used. The most common “off-grid” pumpjack engines run on casing gas produced from the well, but pumpjacks have been run on many types of fuel, such as propane (LPG) and diesel. Generally, pumpjacks have smaller engines than wellhead compressor engines.

Emissions from pumpjack engines were calculated using a methodology similar to that employed in a 2008 CENRAP study entitled: “Recommendations for Improvements to the CENRAP States’ Oil and Gas Emission Inventories” (Bar-Ilan, et al., 2008). For this 2008 inventory, ERG calculated county-level emissions from pumpjack engines with the following equation:

$$E_{ik} = W_i \times f_{pumpjack} \times (1 - e_{pumpjack}) \times \left(\frac{EF_k * HP * LF * t_{annual}}{907{,}180} \right)$$

where:
E_{ik} is the emissions for county i, and pollutant k [tons/yr]
W_i is the total number of active oil wells in county i [wells]
$f_{pumpjack}$ is the fraction of oil wells with artificial lift engines
$e_{pumpjack}$ is the fraction of artificial lift engines that are electrically operated
EF_k is the emission factor for pollutant k [g/Hp-hr]
HP is the horsepower of the engine [Hp]
LF is the load factor of the engine while operating
t_{annual} is the annual number of hours the engine is used [hr/yr]
907,180 is the conversion factor from grams to tons of emissions

Total number of active oil wells in county i, W_i:

Total active oil wells by county for the full 2008 year are not readily available from the TRC website. However, oil well distribution data by county is available from the TRC website on a bi-annual (February and September) basis and can be found at: http://www.rrc.state.tx.us/data/wells/wellcount/index.php. ERG used the September 2008 TRC report to get a count of regular producing oil wells by county.

Fraction of oil wells with artificial lift engines, $f_{pumpjack}$:

The fraction of oil wells requiring artificial lift was estimated as the fraction of active oil wells greater than one year old. Typically, oil wells in their first year of existence do not require an artificial lift engine because the wells have enough bottom hole pressure for the oil to flow freely all the way to the surface. This trend was confirmed through phone interviews with five companies specializing in artificial lift engines (four engineering consultants with expertise in oil and gas production, and one company that sells, installs, and repairs pumpjacks and pumpjack engines). It was the general consensus among the interviewees that the majority of oil wells located in Texas are older than one year and thus would require some sort of artificial lift engine.

ERG determined the fraction of oil wells active in 2008 that were greater than one year old using the following equation:

$$\text{Fraction of Oil Wells} > 1\text{ Year Old} = 1 - \left(\frac{\text{(Oil Wells Completed in 2007)}}{\text{(Total Active Oil Wells on February 5, 2008)}} \right)$$

ERG determined the number of oil wells completed in 2007 using TRC annual drilling, completion, and plugging summaries which are available at: http://www.rrc.state.tx.us/data/drilling/drillingsummary/index.php. ERG used oil well distribution data showing the number of regular producing oil wells by county. Oil well distribution data by county is only available from the TRC website on a bi-annual (February and September) basis and can be found at: http://www.rrc.state.tx.us/data/wells/wellcount/index.php. Using the February 2008 TRC report, ERG summed the county specific numbers for regular producing oil wells.

The fraction of oil wells greater than one year old was determined to be 0.967 (1 – (5,084 / 153,831) = 0.967). The actual fraction may be slightly different because each oil well that was completed in 2007 could have been completed on any day of that year. However, using the methodology explained above, ERG has assumed that all wells completed in 2007 were completed on February 5, 2007.

Fraction of artificial lift engines that are electrically operated, $e_{pumpjack}$:

ERG assumed that 70% of the artificial lift systems located in Texas operate with an electric motor as opposed to a fuel driven engine. This assumption was based on phone interviews with four companies specializing in artificial lift engines, three of which were engineering consultants with expertise in oil and gas production, and one company that sells, installs, and repairs pumpjacks and pumpjack engines. From these interviews, it was ascertained that it is most common to run pumpjack engines on electricity as this is the most cost effective option, thus if an oil well has access to electricity, electricity would typically be used to power the artificial lift engine. Fractions of artificial lift engines that are electrically operated ranged from 50 to 90 percent among interviewees. Therefore, ERG used a conservative estimate of 70%.

Emission factor for pollutant k, EF_k:

Through various phone interviews, ERG determined that the most popular pumpjack engines located in Texas are those in the Arrow C series. These engines burn natural gas and range from about 5 to 32 horsepower (depending on the model number). Criteria pollutant emission factors for the Arrow C engine models were provided by the manufacturer and are shown in Table 4-11. A single set of averaged emission factors was calculated for each pollutant assuming equal fuel usage by each engine size for all pollutants.

The New Source Performance Standard (NSPS), Subpart JJJJ limits emissions of NO_x, CO, and VOC from stationary spark ignition internal combustion engines less than 500 horsepower that were manufactured after July 1, 2008. Also, stationary spark ignition engines that were modified or reconstructed after June 12, 2006 are subject to the rule. As a conservative estimate, ERG assumed all pumpjack engines were manufactured prior to July 1, 2008 and/or were not modified or reconstructed after June 12, 2006. Therefore, no pumpjack engines in this analysis are considered subject to the emission limitations of NSPS, Subpart JJJJ.

All PM and SO_2 emission factors were obtained from AP-42 Section 3.2 (US EPA, 2000). The PM emission factor is 9.50E-03 lb/MMBtu (based on a 4 stroke rich-burn engine). The PM emission factor represents both PM_{10} and $PM_{2.5}$. The SO_2 emission factor is 5.88E-04 lb/MMBtu and assumes the sulfur content in natural gas is 0.002 grams per standard cubic foot. Both of these emission factors have been converted to g/Hp-hr using the fuel consumption rate of the engine.

Table 4-11. Common Pumpjack Engine Emission Factors

Arrow C Series Model	Horsepower (Hp)	Fuel Consumption (MMBtu/Hp-hr)	Emission Factor for Engine Type j, and Pollutant k (g/Hp-hr) (EF_{jk})				
			PM	NO_x	CO	VOC	SO_2
C-46	11	0.0126	0.054	9.26	20.19	0.006	3.36E-03
C-66	15.8	0.0117	0.050	14.54	4.03	0.332	3.12E-03
C-96	21.4	0.0121	0.052	11.87	5.05	0.142	3.23E-03
C-106	34	0.0092	0.040	23.32	0.222	0.094	2.46E-03
Average	**20.55**	**0.21**	**0.049**	**14.75**	**7.37**	**0.14**	**3.04E-03**

Horsepower of the engine, *HP*:

ERG determined an average horsepower per pumpjack engine (20.55 Hp) by assuming that all pumpjack engines located in Texas were of the Arrow C series types listed in Table 4-11, with the engine population distributed evenly across the four engine models.

Load factor of the engine while operating, *LF*:

A 2006 study entitled: "Ozone Precursors Emission Inventory for San Juan and Rio Arriba Counties, New Mexico" (Pollack, et al., 2006) assumed the maximum power delivered by a pumpjack engine to be 100 percent of available engine power and the minimum power to be a 10 percent load representative of idling. With these bounds and the approximate form of the power curve, the report estimated an average loading of 71 percent. For this 2008 inventory, ERG also used 71 percent as the load factor.

Annual number of hours the engine is used, t_{annual}:

The 2006 New Mexico study assumed that pumpjack engines operate nearly without interruption year-round (8,760 hours per year). However, this assumption would likely be an over estimate for Texas pumpjack engines as many of the oil wells located in Texas have intermittent activity and are not producing oil 24 hours per day. For this reason, ERG assumed a pumpjack engine only runs half the year, or 4,380 hours. ERG also verified this assumption through phone interviews with companies specializing in artificial lit engines. For future work, ERG recommends surveying operators to verify this assumption. Another way to verify this assumption would be to use oil well production data from the TRC as well as individual oil well pumpjack engine size information (most likely from survey data) to estimate the amount of hours each engine would need to operate in order to pump the stated oil production.

HAP Emissions for Pumpjack Engines:

HAP emissions from pumpjack engines were calculated using VOC and PM speciation data as follows:

$$E_{VOC\text{-}HAP} = E_{VOC} \times (E_{\%VOC\text{-}HAP} / 100)$$

where:

$E_{VOC\text{-}HAP}$ = Speciated VOC-HAP emissions [tons/yr]
E_{VOC} = VOC emissions [tons/yr]
$E_{\%VOC\text{-}HAP}$ = % HAP composition of VOC emissions

and

$$E_{PM\text{-}HAP} = E_{PM} \times (E_{\%PM\text{-}HAP} / 100)$$

where:

$E_{PM\text{-}HAP}$ = Speciated PM-HAP emissions [tons/yr]
E_{PM} = PM emissions [tons/yr]
$E_{\%PM\text{-}HAP}$ = % HAP composition of PM emissions

Appendix C contains the VOC and PM HAP speciation data.

Emissions for county i, and pollutant k, E_{ik}:

Appendix E presents county-level pumpjack engine emissions corresponding to the number of active oil wells located in each county, based on the input variables discussed above.

Example Calculation for Pumpjack Engines

Using the equation provided above, ERG calculated NO_x emissions in Anderson County from pumpjack engines as follows:

where:

$$E_{ik} = W_i \times f_{pumpjack} \times \left(1 - e_{pumpjack}\right) \times \left(\frac{EF_k * HP * LF * t_{annual}}{907{,}180}\right)$$

E_{ik} = NO_x emissions in Anderson County [tons/yr]
W_i = 456 (the total number of active oil wells in Anderson County) [wells]
$f_{pumpjack}$ = 1 (the fraction of oil wells in Anderson County with artificial lift engines)
$e_{pumpjack}$ = 0.70 (the fraction of artificial lift engines in Anderson County that are electrically operated)
EF_k = 14.75 (the emission factor for NO_x) [g/Hp-hr]
HP = 20.55 (the horsepower of the engine) [Hp]
LF = 0.71 (the load factor of the engine while operating)
t_{annual} = 4,380 (is the annual number of hours the engine is used) [hr/yr]
907,180 is the conversion factor from grams to tons of emissions

Therefore:
E_{ik} = 456 x 1 x (1 - 0.70) x ((14.75 [g NO_x/Hp-hr] x 20.55 [Hp] x 0.71 x 4,380 [hr/yr])/907,180))
E_{ik} = 142.14 [tons NO_x/yr]

4.3 Dehydrators

A dehydrator is used to remove moisture from produced raw natural gas prior to transferring it to the gas transmission pipeline. Dehydrators operate by contacting the natural gas with a hygroscopic liquid such as triethylene glycol. The water vapor in the gas stream becomes dissolved in the glycol liquid solvent, removing the water from the natural gas. During the absorption process, the glycol also absorbs some methane and VOC. The glycol is then depressurized in a flash vessel and the water vapor is removed from the glycol in a glycol regenerator. Some dehydrators do not employ a flash vessel. In those dehydrators, depressurization occurs in the regenerator. Methane, VOC, and HAPs are emitted from the dehydrator during both of these steps.

Depending upon the dehydrator equipment, these emissions may be recaptured and recycled, or controlled by flaring. Not all dehydrators are controlled. The glycol is normally circulated by use of electric pumps. The glycol regeneration process requires heating the glycol-water mixture in a glycol regenerator boiler. The regenerator boiler has similar emissions characteristics to typical combustion units. On-site gas is typically used as the fuel resulting in emissions of CO and NO_x.

4.3.1 *Dehydrator Flash Vessels and Regenerator Vents*

Emissions from dehydrator flash vessels and regenerator vents were calculated using a methodology similar to that employed in the 2008 CENRAP study (Bar-Ilan, et al., 2008). In place of the CENRAP emission factors, ERG derived estimates of dehydrator emission factors for VOC, benzene, toluene, ethylbenzene, and xylene from emissions data submitted to TCEQ by operators of dehydrators in use at point sources in Texas. For this 2008 inventory, ERG calculated county-level emissions from dehydrator flash vessel and glycol regenerator vent emissions with the following equation:

$$E_{ik} = TGP_i \times EF_k \times \left(\frac{1}{2{,}000} \right)$$

where:

E_{ik} is the emissions for county i, and pollutant k [tons/yr]
TGP_i is the total production of natural gas from gas wells in county i [MMscf/yr]
EF_k is the emission factor for pollutant k [lb/MMscf]
2,000 is the conversion factor from pounds to tons of emissions

Total production of natural gas from gas wells in county i, TGP_i:

Natural gas production data by county (TGP_i) was provided for 2008 by the TRC. 57 counties had no gas production in 2008.

Emission factor for pollutant k, EF_k:

In place of the CENRAP emission factors, ERG derived estimates of dehydrator emission factors for VOC, benzene, toluene, ethylbenzene, and xylene from emissions data submitted to TCEQ by operators of dehydrators in use at point sources in Texas. These emissions estimates were prepared by the operators using Gly-Calc software. Data on the presence of flash vessels, control devices, and control efficiencies was also derived from the TCEQ emissions data, indicating that a wide variety of equipment configurations, as well as control technologies, are in use for natural gas production in Texas. There were 82 complete samples in the dataset, spanning the full range of gas-producing regions in Texas. Statewide weighted averages for these five pollutants were derived from the emissions data, and are shown in Table 4-12 below.

These emission factors may produce emissions estimates that are lower than actual emissions at the area-source dehydrators in the state. TCEQ recognizes that the types of control technologies in use at dehydrators located at point sources may be different than the control technologies in use at dehydrators located at smaller area sources. Control requirements are different and incentives for recapturing and/or controlling VOC and HAP emissions may be different for operators of (larger) point sources and (smaller) area sources. However, this dataset of dehydrator emissions represents the full range of uncontrolled and controlled dehydrators in Texas and is a good composite representation of statewide dehydrator emissions.

Table 4-12. Statewide Emission Factors for VOC, Benzene, Toluene, Ethylbenzene, and Xylene from Dehydrator Flash Vessels and Regenerator Vents in Texas

Pollutant	Emission Factor (lb/MMscf)	Number of Samples
VOC	1.63	82
Benzene	0.38	68
Toluene	0.20	64
Ethylbenzene	0.02	45
Xylene	0.75	60

<u>Emissions for county i, and pollutant k, E_{ik}:</u>

Appendix E presents county-level dehydrator flash vessel and regenerator emissions corresponding to the production of natural gas at wells located in each county, based on the input variables discussed above.

<u>Example Calculation for Dehydrator Flash Vessels and Regeneration Vents</u>

Using the equation provided above, ERG calculated Benzene emissions in Anderson County from dehydrator flash vessels and regeneration vents as follows:

$$E_{ik} = TGP_i \times EF_k \times \left(\frac{1}{2{,}000} \right)$$

where:

E_{ik} = (the Benzene emissions for Anderson County) [tons/yr]
TGP_i = 12,045 (the total production of natural gas from gas wells in Anderson County) [MMCF/yr]
EF_k = 0.38 (the emission factor for Benzene) [lb/MMscf]

2,000 is the conversion factor from pounds to tons of emissions

Therefore:

E_{ik} = 12,045 [MMCF/yr] x 0.38 [lb/MMscf] x (1/2,000)
E_{ik} = 2.29 [tons/yr]

4.3.2 *Glyol Regenerator Boilers*

Emissions from glycol regenerator boilers were calculated using the methodology and emission factors employed in the 2008 CENRAP study (Bar-Ilan, et al., 2008). For this 2008 inventory, ERG calculated county-level emissions from dehydrator regenerator boilers with the following equation:

$$E_{ik} = TGP_i \times EF_k \times \left(\frac{1}{2{,}000} \right)$$

where:

E_{ik} is the emissions for county i, and pollutant k [tons/yr]
TGP_i is the total production of natural gas from gas wells in county i [MMscf/yr]
EF_k is the emission factor for pollutant k [lb/MMscf]
2,000 is the conversion factor from pounds to tons of emissions

Total production of natural gas from gas wells in county i, TGP_i:

Natural gas production data by county (TGP_i) was provided for 2008 by the TRC. 57 counties had no gas production in 2008.

Emission factor for pollutant k, EF_k:

ERG used the CENRAP emission factors for regenerator boiler emissions. The CENRAP emission factors are in terms of pounds of pollutant emitted for each million cubic feet (MMscf) of gas produced. These emission factors are shown in Table 4-13 below.

Table 4-13. Emission Factors for NO_x and CO Emissions from Dehydrator Regenerator Boilers

Pollutant	Emission Factor (lb/MMscf)
NO_x	0.052
CO	0.105

Emissions for county i, and pollutant k, E_{ik}:

Appendix E presents county-level dehydrator regenerator boiler emissions corresponding to the production of natural gas at wells located in each county, based on the input variables discussed above.

Example Calculation for Glycol Regenerator Boilers:

Using the equation provided above, ERG calculated NO_x emissions in Anderson County from glycol regenerator boilers as follows:

$$E_{ik} = TGP_i \times EF_k \times \left(\frac{1}{2{,}000} \right)$$

where:

E_{ik} = NO_x emissions in Anderson County [tons/yr]
TGP_i = 12,045 (the total production of natural gas from gas wells in Anderson County) [MMscf/yr]
EF_k = 0.052 (the emission factor for NO_x) [lb/MMscf]
2,000 is the conversion factor from pounds to tons of emissions

Therefore:

E_{ik} = 12,045 [MMscf/yr] x 0.052 [lb/MMscf] x (1/2,000)
E_{ik} = 0.31 [tons NO_x/yr]

4.3.3 *Dehydrator Emission Control Device*

Emissions from dehydrator control devices were calculated using the basic methodology employed in the 2008 CENRAP study (Bar-Ilan, et al., 2008). Like the 2008 CENRAP study, ERG used the emission factors from AP 42, Chapter 13.5 for NO_x and CO. ERG also used the heat value of the gas flared from the CENRAP study. ERG derived estimates of the amount of gas flared for each unit of gas produced from the emissions data submitted to TCEQ by operators of dehydrators in use at point sources in Texas. For this 2008 inventory, ERG calculated county-level emissions from dehydrator emission control devices with the following equation:

$$E_{ik} = TGP_i \times f_{flared} \times \frac{1}{D} \times HV \times EF_k \times \frac{1}{2{,}000}$$

where:

E_{ik} is the emissions for county i, and pollutant k [tons/yr]
TGP_i is the total production of natural gas from gas wells in county i [MMscf/yr]
F_{flared} is the fraction of produced gas that is flared [lbs flared/MMscf produced]
D is the density of the gas flared [lbs/MMscf]

HV is the heat value of the gas flared [MMBtu/MMscf]
EF_k is the emission factor for pollutant k [lbs/MMBtu]
2,000 is the conversion factor from pounds to tons of emissions

Total production of natural gas from gas wells in county i, TGP_i:

Natural gas production data by county (TGP_i) was provided for 2008 by the TRC. 57 counties had no gas production in 2008.

Fraction of produced gas that is flared, F_{flared}:

ERG derived estimates of the amount of gas flared for each unit of gas produced from the emissions data submitted to TCEQ by operators of dehydrators in use at point sources in Texas. The sum of the reported emissions from flash vessels and regenerator vents before controls, in tons of total hydrocarbons, was tallied for all 82 samples in the dataset. This figure was compared with the total production of natural gas reported in those 82 samples, producing a weighted average. Because emissions are reported in pounds, and production is reported in Millions of standard cubic feet (MMscf), the units for this fraction are pounds of gas flared per million standard cubic feet of gas produced (lbs flared/MMscf produced). The dehydrator emissions data indicated that 1 ton (2,000 pounds) of gas is flared for each 149.2 million standard cubic feet (MMscf) of gas produced.

Density of the gas flared, D:

ERG derived estimates of the density of the gas flared by assuming it was equivalent to the density of the dry gas produced by the dehydrator. This data was taken from the dehydrator emissions reports submitted to TCEQ. The amount of dry gas produced, in pounds per hour, was divided by the flow rate of gas produced, in cubic feet per hour, producing a density for dry gas in units of pounds per cubic foot. The sum of the amount of dry gas produced was tallied for all 82 samples in the dataset, and was divided by the sum of the flow rate of gas produced, producing a weighted average, with units of pounds per standard cubic foot (lbs/scf). This figure was then multiplied by 10^6 standard cubic feet per MMscf, to yield a factor with units of pounds per million standard cubic feet (lbs/MMscf). The dehydrator emissions data indicated that the density of the gas produced is 0.047 pounds per standard cubic foot or 46,952 (lbs/MMscf).

Heat value of the gas flared, *HV*:

The heat value of the gas flared is taken from the 2008 CENRAP study. This value is equivalent to 1,209 Btu per standard cubic feet of gas (Btu/scf).

Emission factor for pollutant k, EF_k:

ERG used the CENRAP emission factors for dehydrator control emissions. Although the dehydrator emissions data from TCEQ showed that a small percentage of dehydrator flash vessel and regenerator vent emissions are controlled by incinerators, the vast majority (over 90%) are burned in flares. ERG chose to use the simplifying assumption that all dehydrator flash vessel and regenerator vent emissions that are controlled by combustion are directed to flares. The emission factors for flares are taken directly from AP 42, Chapter 13.5. The emission factors are in terms of pounds of pollutant emitted for each million Btu (lbs/MMBtu) of gas flared. These emission factors are shown in Table 4-14 below.

Table 4-14. Emission Factors for NO_x and CO Emissions from Dehydrator Controls (Flares)

Pollutant	Emission Factor (lb/MMBtu)
NO_x	0.068
CO	0.37

Emissions for county i, and pollutant k, E_{ik}:

Appendix E presents county-level dehydrator control emissions corresponding to the production of natural gas at wells located in each county, based on the input variables discussed above.

Example Calculation for Dehydrator Controls:

Using the equation provided above, ERG calculated NO_x emissions in Anderson County from dehydrator controls as follows:

$$E_{ik} = TGP_i \times f_{flared} \times \frac{1}{D} \times HV \times EF_k \times \frac{1}{2,000}$$

where:

E_{ik} = NO_x emissions for Anderson County [tons/yr]
TGP_i = 12,045 (the total production of natural gas from gas wells in Anderson County) [MMscf/yr]
F_{flared} = 13 (the fraction of produced gas that is flared) [lbs flared/MMscf produced]
D = 46,952 (the density of the gas flared) [lbs/MMscf]
HV = 1,209 (the heat value of the gas flared) [MMBtu/MMscf]
EF_k = 0.068 (the NO_x emission factor) [lbs/MMBtu]
2,000 is the conversion factor from pounds to tons of emissions

Therefore:

E_{ik} = 12,045 [MMscf/yr] x 13.41 [lbs flared/MMscf produced] x (1/46,952 [lbs/MMscf]) x 1,209 [MMBtu/MMscf] x 0.068 [lbs/MMBtu] x (1/2,000)
E_{ik} = 0.14 [tons NO_x/yr]

4.4 Oil and Condensate Storage Tanks

Storage tanks are used in a variety of applications in the oil and gas industry. An oil and gas well may produce oil, natural gas, or a mixture of the two. When oil and gas are brought to the surface, the liquids produced may contain a mixture of liquid and gaseous organic compounds, nitrogen, carbon dioxide, water, sand, and other impurities. The mixture is typically passed through a three-phase separator, which allows the water, oil and gas to separate. The liquid oil and water components are then piped to storage tanks. If the well produces gas, it is possible that liquids may condense out of the gas as the pressure is decreased. The hydrocarbon liquid produced at gas wells is known as condensate. Oil and condensate are piped to storage tanks until they can be transported offsite. Tanks are typically vented to the atmosphere.

Oil and condensate storage tank emissions at wellhead and gathering sites are composed of flashing losses, working losses, and breathing losses. Flashing losses occur when a produced liquid (crude oil or condensate) with entrained gases experiences a pressure drop, as during the transfer of liquid hydrocarbons from a wellhead or separator to a storage tank. As the pressure on the liquid drops, some of the lighter compounds dissolved in the liquid are released or "flashed". Some compounds that are liquids at the initial pressure and temperature, change phase from a liquid to a gas and are also released or "flashed" from the liquid in the storage tank. Working losses occur when vapors are displaced from a tank during the filling and unloading cycles, and when the fluid is agitated during filling of the tank. Breathing losses (also called standing losses) occur due to the normal evaporation of liquid in a tank. Breathing losses are vapors that are produced in response to the daily temperature change.

Emissions from oil and condensate storage tanks were calculated using the methodology and emission factor data developed in the 2009 TERC study "VOC Emissions From Oil and Condensate Storage Tanks" (TERC, 2009). These emission factors were multiplied by county-specific oil and gas production data obtained from the TRC. The calculations assume that venting emissions are uncontrolled by flares or vapor recovery units. For this 2008 inventory, ERG calculated county-level emissions from oil storage tank and condensate storage tank vent emissions with the following equations:

$$E_{ik} = TOP_i \times EF_{ik} \times \left(\frac{1}{2{,}000} \right)$$

and

$$E_{ik} = TCP_i \times EF_{ik} \times \left(\frac{1}{2{,}000} \right)$$

where:

E_{ik} is the emissions for county i, and pollutant k [tons/yr]
TOP_i is the total production of oil from oil wells in county i [BBL/yr]
TCP_i is the total production of condensate from gas wells in county i [BBL/yr]
EF_{ik} is the emission factor for county i, and pollutant k [lb/BBL]
2,000 is the conversion factor from pounds to tons of emissions

Total production of oil from oil wells in county i, TOP_i:

Oil production data by county (TOP_i) was provided for 2008 by the TRC. 42 counties had no oil production in 2008.

Total production of condensate from gas wells in county i, TCP_i:

Condensate production data by county (TOP_i) was provided for 2008 by the TRC. 80 counties had no condensate production in 2008.

Emission factor for county i, and pollutant k, EF_{ik}:

VOC Emission Factors: The VOC emission factors for oil storage tank batteries and condensate storage tank batteries are taken from the 2009 TERC study and are in units of pounds per barrel of oil/condensate produced and are shown in Table 4-15 below.

HAP Emission Factors: Benzene, toluene, ethylbenzene, and xylene are a constituent of the vapors emitted from oil and condensate storage tanks. The benzene, toluene, ethylbenzene, and xylene emission factors are derived from the data published in the 2009 TERC study. Tables 3-4 and 3-5 in the TERC study showed the measured vent gas speciation profiles for oil tanks and condensate tanks, respectively. This data was used in combination with the measured weight percent VOC data from those same tables and the VOC emission factors taken from that study to calculate emission factors for benzene, toluene, ethylbenzene, and xylene from both oil and condensate storage tanks in terms of lbs per barrel of oil or condensate produced. These emission factors are in units of pounds per barrel of oil/condensate produced and are shown in Table 4-15 below.

Table 4-15. Emission Factors for VOC, Benzene, Toluene, Ethylbenzene, and Xylene from Oil Storage Tanks and Condensate Storage Tanks in Texas

Pollutant	**Emission Factors (lb/BBL)**	
	Oil	Condensate
VOC	1.60	33.3
Benzene	0.00533	0.187
Toluene	0.0083	0.319
Ethylbenzene	0.003	0.018
Xylene	0.012	0.141

Emissions for county i, and pollutant k, E_{ik}:

Appendix E present county-level oil storage tank and condensate storage tank vent emissions corresponding to the production of oil and condensate at oil wells and natural gas wells located in each county, based on the input variables discussed above.

Example Calculation for Oil and Condensate Storage Tanks:

Using the equation provided above, ERG calculated VOC emissions in Anderson County from oil storage tanks as follows:

$$E_{ik} = TOP_i \times EF_{ik} \times \left(\frac{1}{2{,}000} \right)$$

where:

E_{ik} = VOC emissions for Anderson County [tons/yr]
TOP_i = 678,901 (the total production of oil from oil wells in Anderson County) [BBL/yr]
EF_{ik} = 1.60 (the VOC emission factor for Anderson County) [lb/BBL]

2,000 is the conversion factor from pounds to tons of emissions

Therefore:

E_{ik} = 678,901 [BBL/yr] x 1.6 [lb/BBL] x (1/2,000)

E_{ik} = 543 [tons/yr]

4.5 Oil and Condensate Loading

Oil and condensate stored in field storage tanks is transferred to trucks and railcars and shipped to refineries for further processing. Fugitive VOC emissions are released from these loading processes as the vapors in the receiving vessel are displaced by the liquids from the storage tanks. These vapors are normally vented to the atmosphere.

Emissions from oil and condensate loading were calculated using the emission estimation methodology in the 2009 TCEQ study. This methodology is taken from AP 42, Chapter 5.2 - Transportation and Marketing of Petroleum Liquids. Emission factors for loading losses were calculated at the county level. These emission factors were multiplied by county-specific 2008 oil and condensate production data obtained from the TRC to derive county-specific emission estimates. ERG obtained monthly temperature data for the counties in which the oil and condensate are produced. Per the 2007 TCEQ study, ERG used AP-42 data for crude oil (50 lb/lb-mole) at 60 degrees F to approximate the molecular weight of tank vapors for oil. ERG used AP-42 data for gasoline (Reid Vapor Pressure (RVP) 7) (68 lb/lb-mole) at 60 degrees F to approximate the molecular weight of tank vapors for condensate. The AP-42 equation was used to calculate temperature-dependent emission factors for loadout losses for each county. Truck or railcar loading emissions were calculated by multiplying the emission factor by county-level oil and condensate production data. The calculations assume that venting emissions are uncontrolled by flares or vapor recovery units. The AP-42 equation to calculate loading emission factors is shown in the following equation.

$$LL_{ik} = 12.46 \times \left(\frac{S * P_i * M}{T_i} \right)$$

where:

LL_{ik} is the loading loss [lb/1,000 gal of liquid loaded] for county i, and pollutant k
S is the saturation factor (based on type of loading operation)
P_i is the true vapor pressure of liquid loaded [psia] for county i
M is the molecular weight of tank vapors [lb/lb-mole]
T_i is the temperature of bulk liquid loaded [^{o}R] for county i

Saturation factor, *S*:

The saturation factor is taken from Table 5.2-1 of Chapter 5.2 of AP-42 and is based on submerged or splash loading of liquid with dedicated vapor balance service. This assumes that tank vapors from the truck or railcar being loaded are vented back into the tank being emptied.

True vapor pressure of the liquid being loaded, for county i, P_i:

The true vapor pressure for oil is estimated to be equivalent to the true vapor pressure for crude oil RVP 5. The true vapor pressure for condensate is estimated to be equivalent to the true vapor pressure for gasoline RVP 7. The true vapor pressure for these liquids at various temperatures are shown in Table 4-16 below. The true vapor pressure for the county-specific average temperature is calculated for oil loading with the equation.

$$P_i = (0.057 \times T_i) - 0.58$$

where:

P_i is the true vapor pressure of liquid loaded [psia] for county i
T_i is the temperature of bulk liquid loaded [^{o}F] for county i

The true vapor pressure for the county-specific average temperature is calculated for condensate loading with the equation.

$$P_i = (0.077 \times T_i) - 1.03$$

where:

P_i is the true vapor pressure of liquid loaded [psia] for county i
T_i is the temperature of bulk liquid loaded [^{o}F] for county i

These formulas are derived from linear interpolation of the slope and intercept of the line formed between the values for the true vapor pressure of crude oil RVP 5 (representing oil) and gasoline RVP 7 (representing condensate) at 55 degrees Fahrenheit and 75 degrees Fahrenheit.

Molecular weight of the tank vapors, *M*:

The molecular weight of the tank vapors for oil is estimated to be equivalent to the molecular weight of crude oil RVP 5. The molecular weight of the tank vapors for condensate is estimated to be equivalent to the molecular weight of gasoline RVP 7. The molecular weight of these liquids at 60 degrees Fahrenheit are shown in Table 4-16 below. The data in Table 4-16 is taken directly from AP-42, Chapter 7.1.

Table 4-16. Molecular Weight and True Vapor Pressure of Selected Petroleum Liquids

Petroleum Liquid	**Molecular Weight at 60° F (lb/lb-mole)**	**True Vapor Pressure (psia)**						
		40° F	50° F	60° F	70° F	80° F	90° F	100° F
Crude Oil RVP 5	50	1.8	2.3	2.8	3.4	4.0	4.8	5.7
Gasoline RVP 7	68	2.3	2.9	3.5	4.3	5.2	6.2	7.4

Temperature of the bulk liquid loaded, T_i:

The average 2008 temperature data, degrees Fahrenheit, for 115 Texas counties was obtained from the National Weather Service and from several state/local monitoring sites. These data were used to estimate the average temperature in the adjacent 139 counties. The average liquid temperature is assumed to be equivalent to the average ambient air temperature.

Loading loss for county i, and pollutant k, LL_{ik}:

The loading loss is the county-specific emission factor and has units of pounds per 1,000 gallons of oil or condensate loaded (lbs/1,000 gal).

For this 2008 inventory, ERG calculated county-level emissions from oil loading emissions and condensate loading emissions with the following equations:

$$E_{ik} = TOP_i \times LL_k \times 42 \times \left(\frac{1}{2{,}000}\right)$$

and

$$E_{ik} = TCP_i \times LL_{ik} \times 42 \times \left(\frac{1}{2{,}000}\right)$$

where:

E_{ik} is the loading emissions for county i, and pollutant k [tons/yr]
TOP_i is the total production of oil from oil wells in county i [BBL/yr]
TCP_i is the total production of condensate from gas wells in county i [BBL/yr]
LL_{ik} is the loading loss (emission factor) for pollutant k [lb/1,000 gal loaded]
42 is the conversion factor from barrels to gallons
2,000 is the conversion factor from pounds to tons of emissions

Total production of oil from oil wells in county i, TOP_i:

Oil production data by county (TOP_i) was provided for 2008 by the TRC. 42 counties had no oil production in 2008.

Total production of condensate from gas wells in county i, TCP_i:

Condensate production data by county (TOP_i) was provided for 2008 by the TRC. 80 counties had no condensate production in 2008.

Loading loss, LL_{ik}:

The loading loss is the emission factor calculated above and has units of pounds per 1,000 gallons of oil or condensate loaded.

HAP Emission Factors: Benzene, toluene, ethylbenzene, and xylene are a constituent of the vapors emitted during oil and condensate loading. The benzene, toluene, ethylbenzene, and xylene emission factors for oil loading and condensate loading in all oil and gas producing basins in Texas are derived from the data published in the 2009 TERC study. Tables 3-4 and 3-5 in the TERC study showed the measured vent gas speciation profiles for oil tanks and condensate tanks, respectively. This data was used in combination with the measured weight percent VOC data from those same tables and the VOC emission factors taken from that study to calculate emission factors for benzene, toluene, ethylbenzene, and xylene from both oil and condensate loading. These emission factors are in terms of units of HAP emitted per units of VOC emitted. and are shown in Table 4-17 below.

Table 4-17. Emission Factors for Benzene, Toluene, Ethylbenzene, and Xylene from Oil and Condensate Loading in Texas

Pollutant	All Texas Basins Emission Factors (lb HAP/lb VOC)	
	Oil	Condensate
Benzene	0.0033	0.2808
Toluene	0.0052	0.479
Ethylbenzene	0.00187	0.027
Xylene	0.0075	0.212

Loading emissions for county i, for pollutant k, E_{ik}:

Emissions for oil and condensate loading racks for each county are calculated by multiplying a county-specific loading loss factor by the county-specific oil and condensate production. Appendix E present county-level oil condensate loading rack emissions corresponding to the production of oil and condensate at oil wells and natural gas wells located in each county, based on the input variables discussed above.

Example Calculation for Oil and Condensate Loading:

Using the equations provided above, ERG calculated VOC emissions in Anderson County from oil loading as follows:

$$LL_{ik} = 12.46 \times \left(\frac{S * P_i * M}{T_i} \right)$$

where:

LL_{ik} = (the loading loss [lb/1,000 gal of liquid loaded] for Anderson County, and pollutant k)
S = 1.00 (the saturation factor (based on type of loading operation))
P_i = 3.1 (the true vapor pressure of liquid loaded for Anderson County) [psia]
M = 50 (the molecular weight of tank vapors) [lb/lb-mole]
T_i = 524.27 (the temperature of bulk liquid loaded for Anderson County) [^{o}R]

$$E_{ik} = TOP_i \times LL_k \times 42 \times \left(\frac{1}{2{,}000} \right)$$

where:

E_{ik} = loading VOC emissions for county i, and pollutant k [tons/yr]
TOP_i = 678,901 (the total production of oil from oil wells in Anderson County) [BBL/yr]
LL_{ik} = the loading loss (emission factor) for VOC [lb/1,000 gal loaded]
42 is the conversion factor from barrels to gallons
2,000 is the conversion factor from pounds to tons of emissions

Therefore:

LL_{ik} = 12.46 x ((1.00 x 3.1 [psia] x 50 [lb/lb-mole])/524.27 [^{o}R])
LL_{ik} = 3.684 [lb/1,000 gal of liquid loaded]

E_{ik} = 678,901 [BBL/yr] x 3.684 [lb/1,000 gal of liquid loaded] x 42 x (1/2,000)
E_{ik} = 52.52 [tons VOC/yr]

4.6 Well Completions

Following drilling and casing, a well must be "completed." Completion is the process which enables the well to produce oil or gas. To complete the production well, casing is installed and cemented and the drilling rig is removed from the site. As the well is completed, an initial mixture of gas, hydrocarbon liquids, water, sand, and other materials comes to the surface. Standard practice during the completion process has been to vent or flare the natural gas released, some of which is VOC. This category addresses VOC emissions associated with the completion process at oil and gas wells. County-level emissions from this source were estimated for the purpose of this inventory.

Emissions from well completions were calculated using the methodology from the 2008 CENRAP study (Bar-Ilan, et al., 2008). Emissions from well completions are estimated on the basis of the volume of gas vented during completion and the average VOC content of that gas, obtained from a gas composition analyses. Emissions rates are evaluated at standard temperature and pressure (STP).

The calculation methodology for completion emissions follows the following equations:

$$E_{completion,i} = \left(\frac{P \times (V_{vented})}{(R / MW_{gas}) \times T \times 0.000035} \right) \times \frac{f_i}{907200}$$

where:

$E_{completion,i}$ is the emissions of pollutant i from a single completion event [ton/event]
P is atmospheric pressure [1 atm]
V_{vented} is the volume of vented gas per completion [MCF/event]
R is the universal gas constant [0.082 L-atm/mol-^{o}K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 ^{o}K]
0.000035 is the conversion factor from Mscf to liters
f_i is the mass fraction of pollutant i in the vented gas
907,200 is the conversion factor from grams to tons of emissions

The total emissions from all completions occurring in a county can be evaluated following:

$$E_{completion,TOTAL} = E_{completion,i} \times S_{county}$$

where:

$E_{completion,TOTAL}$ are the total emissions county-wide from completions [tons/year]
$E_{completion,i}$ are the completion emissions from a single completion event [tons/event]
S_{county} is the county-wide new well and recompleted well count

No data were available to account for the number of completions that were completed using green completion or add-on control technologies. While these technologies exist and are used to reduce emissions, no data is currently available to estimate the extent at which they are employed in Texas. Also, the 2008 CENRAP study did not contain data on green completions or add-on control technologies.

Volume of vented gas per completion, V_{vented}:

ERG was unable to obtain estimates for the volume of vented gas per completion from the TRC. Therefore, ERG used the average volume vented presented in the 2008 CENRAP study. This data was presented on a basin-level basis. The data obtained is summarized in Table 4-18 below.

Table 4-18. 2008 CENRAP Data for Volume of Gas Vented per Completion

Basin	Volume of Gas Vented per Completion (MCF/event)
Anadarko	1,737
Bend Arch-Fort Worth	637
East Texas	2,417
Palo Duro [a]	1,198
Permian	0
Perman/Marathon Thrust Belt [a]	1,198
Western Gulf	1,200

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

The data were applied to each county in Texas based on the county's corresponding basin.

Mass fraction for a single pollutant, f_i:

ERG used the average basin-level mass fraction for VOCs obtained from the 2008 CENRAP study (3.6% for gas wells and 14.1% for oil wells).

Number of completions controlled by flares, c_{flare} and the number of green completions, c_{green}:

ERG was unable to obtain estimates for the number of completions controlled by flares and the number of green completions. Therefore, ERG used default values presented in the 2008 CENRAP study, which was 0 for both parameters.

County-level new/recompleted well count, S_{county}:

ERG obtained county-level data for the number of new and recompleted wells from the TRC for each county included in this analysis. The TRC data indicated a total of 15,946 new/recompletions were finished in 2008. Of these, 3,032 were designated as gas wells and 2,687 were designated as oil wells. The remaining 10,227 wells were classified as O/G (as they may end up producing oil, gas or a combination of both). For the purposes of emissions calculations, ERG assigned the wells classified as O/G to the oil and gas categories by assuming that the percentage of oil and gas well completions in each county was identical to the percentage of producing oil and gas wells in each county. For example, if 75% of the producing wells in a single county were oil wells, then 75% of the wells classified as O/G were designated as oil wells. If there were no producing wells in a county, the completion was assumed to be an oil well completion to represent worst-case emissions. As a result of this analysis, there were an estimated 8,702 gas well competions and 7,244 oil well completions in 2008.

Emissions by county $E_{completion,TOTAL}$:

Appendix E presents county-level well completion emissions corresponding to the number of wells completed in each county, based on the input variables discussed above.

Example Calculation for Well Completions:

Using the equations provided above, ERG calculated VOC emissions in Anderson County from oil well completions as follows:

$$E_{completion,voc} = \left(\frac{P \times (V_{vented})}{(R/MW_{gas}) \times T \times 0.000035} \right) \times \frac{f_i}{907200}$$

where:

$E_{completion,voc}$ = the VOC emissions in Anderson County from a single oil well completion event [ton/event]
P = 1 (atmospheric pressure) [atm]
V_{vented} = 2,417 (the volume of vented gas per completion for Anderson County (East Texas Basin)) [MCF/event]
R = 0.082 (the universal gas constant) [L-atm/mol-^{o}K]
MW_{gas} = 27 (the molecular weight of the gas) [g/mol]
T = 298 (the atmospheric temperature) [^{o}K]
0.000035 is the conversion factor from Mscf to liters
f_i = 0.141 (the mass fraction of pollutant i in the vented gas)
907,200 is the conversion factor from grams to tons of emissions

Therefore:

$E_{completion,voc}$ = ((1 atm x 2,417 [MCF/event])/((0.082 [L-atm/mol-^{o}K]/27 [g/mol]) x 298 [^{o}K] x 0.000035) x 0.141/907200
$E_{completion,voc}$ = 11.86 [tons VOC/event]

The total emissions from all completions occurring in Anderson County can be evaluated following:

$$E_{completion,TOTAL} = E_{completion,voc} \times S_{county}$$

where:

$E_{completion,TOTAL}$ = the total VOC emissions from completions in Anderson County [tons VOC/year]
$E_{completion,voc}$ = 11.86 (completion emissions from a single completion event) [tons VOC/event]
S_{county} = 45.94 (the county-wide new well and recompleted well count for Anderson County) [oil well completion events/yr]

Therefore:

$E_{completion,voc}$ = 11.86 [tons VOC/event] x 50 [oil well completion events/yr]
$E_{completion,voc}$ = 544.76 [tons VOC/yr]

4.7 Wellhead Blowdowns

Wellhead blowdowns refer to the practice of venting gas from wells that have developed some kind of cap or obstruction before any additional intervention work can be done on the wells. Typically, wellhead blowdowns are conducted on wells that have been shut in for a period of time and the operator desires to bring the well back into production. Wellhead blowdowns are also sometimes conducted to remove fluid caps that have built up in producing gas wells. Because gas is directly vented from the blowdown event, blowdowns can be a source of VOC emissions. County-level emissions from this source were estimated for the purpose of this inventory.

Emissions from wellhead blowdowns were calculated using the methodology from the 2008 CENRAP study (Bar-Ilan, et al., 2008). Emissions from wellhead blowdowns are estimated on the basis of the volume of gas vented during a blowdown, and the average VOC content of that gas, obtained from a gas composition analyses. The emissions are also estimated based on the frequency of blowdowns. Emissions rates are evaluated at standard temperature and pressure (STP).

The calculation methodology for blowdown emissions is identical to the method for completion emissions, and follows the following equations:

$$E_{blowdown,i} = \left(\frac{P \times (V_{vented})}{(R / MW_{gas}) \times T \times 0.000035} \right) \times \frac{f_i}{907200}$$

where:

$E_{completion,i}$ is the emissions of pollutant i from a single blowdown event [ton/event]
P is atmospheric pressure [1 atm]
V_{vented} is the volume of vented gas per blowdown [MCF/event]
R is the universal gas constant [0.082 L-atm/mol-^{o}K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 ^{o}K]
0.000035 is the conversion factor from Mscf to liters
f_i is the mass fraction of pollutant i in the vented gas
907,200 is the conversion factor from grams to tons of emissions

The total emissions from all blowdowns occurring in a county can be evaluated following:

$$E_{blowdown,TOTAL} = E_{blowdown,i} \times N_{blowdown} \times N_{wells}$$

where:

$E_{blowdown,TOTAL}$ are the total emissions county-wide from blowdowns [tons/year]
$E_{blowdown,I}$ are the blowdown emissions from a single blowdown event [tons/event]
$N_{blowdown}$ is the number of blowdowns per well in the county
N_{wells} is the total number of active wells in the county

No data were available to account for the number of blowdowns using green completion or add-on control technologies. While these technologies exist and are used to reduce emissions, no data is currently available to estimate the extent at which they are employed in Texas. Also, the 2008 CENRAP study did not contain data on green blowdowns or add-on control technologies. Therefore, we have assumed 0 for these parameters.

Volume of vented gas per blowdown, V_{vented}:

ERG was unable to obtain estimates for the volume of vented gas per blowdown from the TRC. Therefore, ERG used the average volume vented presented in the 2008 CENRAP study. This data was presented on a basin-level basis. The data obtained is summarized in Table 4-19 below.

Table 4-19. 2008 CENRAP Data for Volume of Gas Vented per Blowdown per Wellhead

Basin	Volume of Gas Vented per Blowdown per Wellhead (MCF/event/wellhead)
Anadarko	7.28
Bend Arch-Fort Worth	38.9
East Texas	31.67
Palo Duro [a]	60.35
Permian	50
Perman/Marathon Thrust Belt [a]	60.35
Western Gulf	173.9

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

The data were applied to each county in Texas based on the county's corresponding basin.

Mass fraction for a single pollutant, f_i:

ERG used the average basin-level mass fraction for VOCs obtained from the 2008 CENRAP study (3.6% for gas wells and 14.1% for oil wells).

County-level number of blowdowns per well, $N_{blowdown}$:

ERG was unable to obtain estimates for the number of blowdowns per well from the TRC. Therefore, ERG used the average volume vented presented in the 2008 CENRAP study. This data was presented on a basin-level basis. The data obtained is summarized in Table 4-20 below.

Table 4-20. 2008 CENRAP Data for Wellhead Blowdown Frequency

Basin	Blowdown Frequency (events/wellhead/yr)
Anadarko	3.3
Bend Arch-Fort Worth	1.54
East Texas	1.09
Palo Duro [a]	5
Permian	5
Perman/Marathon Thrust Belt [a]	5
Western Gulf	0.71

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

The data were applied to each county in Texas based on the county's corresponding basin.

County-level well count, N_{wells}:

ERG obtained county-level data for the number of wells from the TRC for each county included in this analysis. The TRC data (for onshore wells only) indicated a total of 91,732 gas wells and 153,831 oil wells for the State of Texas.

Number of blowdowns controlled by flares, c_{flare} and the number of green blowdowns, c_{green}:

ERG was unable to obtain estimates for the number of blowdowns controlled by flares and the number of green blowdowns. Therefore, ERG used default values presented in the 2008 CENRAP study, which was 0 for both parameters.

Emissions by county $E_{blowdown,TOTAL}$:

Appendix E presents county-level wellhead blowdown emissions corresponding to the number of wells in each county, based on the input variables discussed above.

Example Calculation for Wellhead Blowdowns

Using the equations provided above, ERG calculated VOC emissions in Anderson County from oil wellhead blowdowns as follows:

$$E_{blowdown,voc} = \left(\frac{P \times (V_{vented})}{(R / MW_{gas}) \times T \times 0.000035} \right) \times \frac{f_i}{907200}$$

where:

$E_{blowdown,voc}$ = the VOC emissions in Anderson County from a single oil wellhead blowdown event [ton/event]
P = 1 (atmospheric pressure) [atm]
V_{vented} = 31.7 (the volume of vented gas per blowdown for Anderson County (East Texas Basin)) [MCF/event]
R = 0.082 (the universal gas constant) [L-atm/mol-^{o}K]
MW_{gas} = 27 (the molecular weight of the gas) [g/mol]
T = 298 (the atmospheric temperature) [^{o}K]
0.000035 is the conversion factor from Mscf to liters
f_i = 0.141 (the mass fraction of pollutant i in the vented gas)
907,200 is the conversion factor from grams to tons of emissions

Therefore:

$E_{blowdown,voc}$ = ((1 [atm] x 31.7 [MCF/event])/((0.082 [L-atm/mol-^{o}K]/27 [g/mol]) x 298 [^{o}K] x 0.000035) x 0.141/907200
$E_{blowdown,voc}$ = 0.1554 [tons/event]

The total emissions from all blowdowns occurring in Anderson County can be evaluated following:

$$E_{blowdown,TOTAL} = E_{blowdown,voc} \times N_{blowdown} \times N_{wells}$$

where:

$E_{blowdown,TOTAL}$ = the total VOC emissions county-wide from blowdowns [tons/year]
$E_{blowdown,voc}$ =0.1554 (the VOC blowdown emissions from a single blowdown event) [tons/event]
$N_{blowdown}$ =1.09 (the number of blowdowns per well in Anderson County (East Texas Basin)) [events/wellhead/yr]
N_{wells} = 456 (the total number of active wells in Anderson County) [wells]

Therefore:

$E_{blowdown,\ TOTAL}$ = 0.1554 [tons VOC/event] x 1.09 [events/wellhead/yr] x 456 [wells]
$E_{blowdown,\ TOTAL}$ = 77.24 [tons VOC/yr]

4.8 Pneumatic Devices

Pneumatic devices are used for a variety of gas well processes and are powered by high-pressure produced gas. These devices include transducers, liquid level controllers, pressure controllers and positioners. During the normal operation of these devices, they release or bleed natural gas to the atmosphere making them a source of VOC emissions. County-level emissions from these sources are estimated for the purpose of this inventory.

Emissions from pneumatic devices were calculated using the methodology from the 2008 CENRAP study (Bar-Ilan, et al., 2008). In this emission estimation approach, emissions from pneumatic devices at a single well site are calculated using the following equation:

$$E_{pneumatic,j} = \frac{f_j}{907200}\left(\sum_i V_i \times N_i \times t_{annual}\right) \times \frac{P}{\left(\frac{R}{MW_{gas}}\right) \times T \times 0.000035}$$

where:

$E_{pneumatic,j}$ is the total emissions of pollutant *j* from all pneumatic devices for a typical well [ton/well-year]
907,200 is the conversion factor from grams to tons of emissions
f_j is the mass fraction of pollutant *j* in the vented gas
V_i is the volumetric bleed rate from device *i* [scf/hr/device]
N_i is the total number of device *i* owned by the participating companies
t_{annual} is the number of hours per year that devices are operating
P is the atmospheric pressure [1 atm]
R is the universal gas constant [0.082 L-atm/mol-^{o}K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 ^{o}K]
0.000035 is the conversion factor from Mscf to liters

County-wide emissions are calculated using the following equation:

$$E_{pneumatic,TOTAL} = E_{pneumatic,j} \times N_{well}$$

where:

$E_{pneumatic,TOTAL}$ is the total pneumatic device emissions in the county [ton/yr]
$E_{pneumatic,j}$ is the pneumatic device emissions for a single well of pollutant j [ton/yr]
N_{well} is the total number of active wells in the county for a given year

Emissions rates are evaluated at STP.

Number of active wells in a given county for 2008, N_{well}:

Total active wells by county for the full 2008 year are not readily available from the TRC website. However, well distribution data by county is available from the TRC website on a bi-annual (February and September) basis and can be found at: http://www.rrc.state.tx.us/data/wells/wellcount/index.php. ERG used the September 2008 TRC report to get a count of regular producing wells by county.

Volumetric bleed rate from device i, V_i:

Bleed rates for various devices are presented in a 2004 EPA Natural Gas Star program study. We have used these when calculating emissions from pneumatic devices at gas production sites. This data is summarized in Table 4-21.

Total number of devices, N_i:

The 2008 CENRAP study obtained basin-level data for the total number of devices per well from survey data. The same value for each device type was used for each basin in the CENRAP report. ERG used this basin level data as a basis for the number of devices per well. This data is summarized in Table 4-21.

Number of hours per year that devices are operating, t_{annual}:

ERG has assumed the annual operating hours for these devices is 8,760.

Molecular weight of gas, MW_{gas}:

The 2008 CENRAP study obtained basin-level data for the gas molecular weight from survey data. Where survey data was not available for a specific basin, the average of all CENRAP basins was used. ERG used this basin level data as a basis for the gas molecular weight. ERG calculated a weighted average based on the total number of wells in each basin. This data is summarized in Table 4-21.

Mass fraction of pollutant j in the vented gas, f_j:

The 2008 CENRAP study obtained basin-level data for the mass fraction of VOC from survey data. Where survey data was not available for a specific basin, the average of all CENRAP basins was used. ERG used this basin level data as a basis for the VOC mass fraction. ERG calculated a weighted average based on the total number of wells in each basin. This data is summarized in Table 4-21.

Table 4-21. CENRAP Basin-Level Data for Pneumatic Devices at Gas Wells

Basin	**Number of Devices/Bleed Rate (scf/hr)**					**Gas Molecular Weight (g/mol)**	**VOC Content (fraction)**
	Liquid Level Controller	**Positioner**	**Pressure Controller**	**Transducer**	**Other**		
Anadarko	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	21	0.1
East Texas	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	19	0.13
Fort Worth	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	19	0.14
Permian	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	19	0.14
Western Gulf	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	19	0.02
Palo Duro[a]	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	20	0.11
Marathon Thrust Belt[a]	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	20	0.11
Weighted Average	2 / 31	0 / 15.2	1 / 16.8	0 / 13.6	0 / 0	19.68	0.1054

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

Emissions by county $E_{pneumatic,TOTAL}$:

Appendix E presents county-level pneumatic device emissions corresponding to the number of active oil and gas wells in each county, based on the input variables discussed above.

Example Calculation for Pneumatic Devices:

Using the equations provided above, ERG calculated VOC emissions in Anderson County from pneumatic devices as follows:

For one well:

$$E_{pneumatic,j} = \frac{f_j}{907200}\left(\sum_i V_i \times N_i \times t_{annual}\right) \times \frac{P}{\left(\frac{R}{MW_{gas}}\right) \times T \times 0.000035}$$

Where:

$E_{pneumatic,j}$ = VOC emissions from one well in Anderson County [tons/well-year]
907,200 is the conversion factor from grams to tons of emissions
f_j = 0.1054 (the VOC fraction in the vented gas in Anderson County)
V_i = 0.031 for liquid level controllers and 0.0168 for pressure controllers (bleed rate for devices present in wells in Anderson County) [Mcf/device-hr]
N_i = 2 for liquid level controllers and 1 for pressure controllers (number of devices present in wells in Anderson County)
t_{annual} = 8,760 (annual operating hours of wells in Anderson County) [hr/yr]
P = 1 (standard pressure) [atm]
T = 298 (standard temperature) [^{o}K]
R = 0.082 (universal gas constant) [L-atm/mol-^{o}K]
MW_{gas} = 19.68 (molecular weight of vented gas at wells in Anderson County) [g/mol]
0.000035 is the conversion factor from Mscf to liters

Therefore:

$E_{pneumatic,j}$ = (0.1504/907,200) x ((0.031 [Mcf/device-hr] * 2 [devices] * 8,760 [hrs]) + (0.0168 [MCF/device-hr] * 1 [device] * 8,760 [hrs])) x (1/((0.082 [L-atm/mol-^{o}K] / 19.68 [g/mol]) * 298 [^{o}K] * 0.000035))
$E_{pneumatic,j}$ = 1.845 [tons VOC/well-yr]

For all wells in Anderson County:

$$E_{pneumatic,TOTAL} = E_{pneumatic,j} \times N_{well}$$

Where:

$E_{pneumatic,TOTAL}$ = VOC emissions from all gas wells in Anderson County [tons/yr]
$E_{pneumatic,j}$ = 1.845 [tons VOC/well-yr]
N_{well} = 133 (number of wells in Anderson County)

Therefore:

$E_{pneumatic,TOTAL}$ = 1.845 [tons VOC/well-yr] x 133 [wells]
$E_{pneumatic,TOTAL}$ = 245 [tons VOC/yr]

4.9 Fugitive Emissions (Equipment Leaks)

All oil and gas producing sites have a system of pumps and piping to transport oil and gas from the wellhead to the processing area. These pumps and piping networks are constructed with many individual components including flanges, valves, seals, and connectors. As a result of high operating pressures, varying fitting tightness, and age and condition, each of these components has the potential to release fugitive emissions while oil and gas product flows through them. County-level emissions from these sources are estimated for the purpose of this inventory.

Emissions from fugitive components were calculated using the methodology from the 2008 CENRAP study (Bar-Ilan, et al., 2008). In this methodology, fugitive emissions from a single well site may be calculated using the following equation:

$$E_{fugitive,j} = \sum_i EF_i \times N_i \times t_{annual} \times Y_j \times 0.0011$$

where:

$E_{fugitive,j}$ is the fugitive emissions for a single typical well for pollutant j [ton/yr/well]
EF_i is the emission factor of Total Organic Carbon (TOC) for a single component i [kg/hr/component]
N_i is the total number of components of type i
t_{annual} is the annual number of hours the well is in operation [hr/yr]
Y_j is the mass fraction of pollutant j to TOC in the vented gas
0.0011 is the conversion factor from tons to kilograms

County-wide fugitive emissions are calculated using the following equation:

$$E_{fugitive,TOTAL} = E_{fugitive,j} \times N_{well}$$

where:

$E_{fugitive,TOTAL}$ is the total fugitive emission in the county [ton/yr]
$E_{fugitive,j}$ is the fugitive emissions for a single well of pollutant j [ton/yr]
N_{well} is the total number of active wells in the county for a given year

Emissions rates are evaluated at STP.

Number of active wells in a given county for 2008, N_{well}:

Total active wells by county for the full 2008 year are not readily available from the TRC website. However, well distribution data by county is available from the TRC website on a bi-annual (February and September) basis and can be found at: http://www.rrc.state.tx.us/data/wells/wellcount/index.php. ERG used the September 2008 TRC report to get a count of regular producing wells by county.

Emission factor of TOC for a single component, EF_i:

AP-42 emissions factors were used to calculate fugitive emissions from equipment leaks at oil and gas production sites. Emissions factors are referenced from the AP-42 supporting document entitled “Protocol for Equipment Leak Emission Estimations” and summarized in Table 4-22 below.

Table 4-22. AP-42 Emissions Factors for Fugitive Components

Component Type	Emissions Factor (kg-TOC/hr)	
	Gas	Light Oil
Valves	0.0045	0.0025
Pump Seals	0.0024	0.013
Others	0.0088	0.0075
Connectors	0.0002	0.00021
Flanges	0.00039	0.00011
Open-ended Lines	0.002	0.0014

Total number of components, N_i:

The 2008 CENRAP study obtained basin-level data for the total number of components per well from survey data. ERG used this basin level data as a basis for the number of components per well. ERG calculated a weighted average based on the number of wells at each basin. This data is summarized in Table 4-23 for gas wells and Table 4-24 for oil wells. The CENRAP data did not contain information on component counts for “Pump Seals”, or “Others” (equipment such as dump lever arms, polish rod pumps, or hatches). Therefore, an estimate of 2 “Pump Seals” and 10 “Others” were used to gapfill the CENRAP data to complete the inventory (Maldonado, 2010).

Annual number of hours the well is in operation, t_{annual}:

ERG used 8,760 hours per year for the hours the well is in operation.

Mass fraction of pollutant j to TOC in the vented gas, Y_j:

The 2008 CENRAP study obtained basin-level data for the fraction of VOC to TOC in the vented gas from survey data. ERG used this basin level data as a basis for the fraction of VOC to TOC in the vented gas. ERG calculated a weighted average based on the number of wells at each basin. This data is summarized in Table 4-23 for gas wells and Table 4-24 for oil wells.

Table 4-23. CENRAP Basin-Level Data for Fugitives at Gas Wells

Basin	Number of Components Per Typical Well						Fraction of VOC in TOC
	Valves	Pump Seals	Others	Connectors	Flanges	Open-Ended Lines	
Anadarko	12	2	10	35	18	6	0.12
East Texas	12	2	10	35	18	6	0.14
Fort Worth	12	2	10	35	18	6	0.15
Permian	19	2	10	43	29	3	0.14
Western Gulf	24	2	10	118	59	3	0.02
Palo Duro[a]	16	2	10	53	28	5	0.11
Marathon Thrust Belt[a]	16	2	10	53	28	5	0.11
Weighted Average	16.54	2.00	10.00	58.53	31.00	4.62	0.11226

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

Table 4-24. CENRAP Basin-Level Data for Fugitives at Oil Wells

Basin	Number of Components Per Typical Well						Fraction of VOC in TOC
	Valves	Pump Seals	Others	Connectors	Flanges	Open-Ended Lines	
Anadarko	20	2	10	90	0	3	0.12
East Texas	20	2	10	90	0	3	0.14
Fort Worth	20	2	10	90	0	3	0.15
Permian	16	2	10	58	12	2	0.14

Table 4-24. CENRAP Basin-Level Data for Fugitives at Oil Wells (Cont.)

Basin	Number of Components Per Typical Well						Fraction of VOC in TOC
	Valves	Pump Seals	Others	Connectors	Flanges	Open-Ended Lines	
Western Gulf	18	2	10	95	25	2	0.02
Palo Duro[a]	19	2	10	85	7	3	0.11
Marathon Thrust Belt[a]	19	2	10	85	7	3	0.11
Weighted Average	18.80	2.00	10.00	84.60	7.40	2.60	0.11226

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

Emissions by county $E_{fugitive,TOTAL}$:

Appendix E presents county-level fugitive emissions corresponding to the number of active oil and gas wells in each county, based on the input variables discussed above.

Example Calculation for Fugitive Emissions (Equipment Leaks):

Using the equations provided above, ERG calculated VOC emissions in Anderson County from equipment leaks at oil wells as follows:

For one well:

$$E_{fugitive,j} = \sum_i EF_i \times N_i \times t_{annual} \times Y_j \times 0.0011$$

Where:

$E_{fugitive,j}$ = VOC emissions from one oil well in Anderson County [tons/well-year]
EF_i = AP-42 emissions factors 0.0025 for valves, 0.013 for pump seals, 0.0075 for others, 0.00021 for connectors, 0.00011 for flanges, and 0.0014 for open ended lines [kg-TOC/hr]
N_i = 18.80 for valves, 2.00 for pump seals, 10.00 for others, 84.60 for connectors, 7.40 for flanges, and 2.60 for open ended lines (number of fugitive areas present in oil wells in Anderson County)
t_{annual} = 8,760 (annual operating hours of oil wells in Anderson County) [hr/yr]
Y_j = 0.11226 (mass fraction of VOC in the TOC vented from the fugitive areas) [ton VOC/ton TOC]

Therefore:

$E_{fugitive,j}$ = 8,760 [hr/yr] x 0.11226 [ton VOC/ton TOC] x 0.0011 [tons/kg] x ((0.0025 * 18.80) + (0.013 * 2.00) + (0.0075 * 10.00) + (0.00021 * 84.60) + (0.00011 * 7.40) + (0.0014 * 2.60) [kg-VOC/well-hr]))
$E_{pneumatic,j}$ = 0.18413 [tons VOC/well-yr]

For all wells in Anderson County:

$$E_{fugitive,TOTAL} = E_{fugitive,j} \times N_{well}$$

Where:

$E_{fugitive,TOTAL}$ = VOC emissions from all oil wells in Anderson County [tons/yr]
$E_{fugitive,j}$ = 0.18413 [tons VOC/well-yr]
N_{well} = 456 (number of oil wells in Anderson County)

Therefore:

$E_{pneumatic,TOTAL}$ = 0.18413 [tons VOC/well-yr] x 456 wells
$E_{pneumatic,TOTAL}$ = 83.97 [tons VOC/yr]

4.10 Heaters and Boilers

The purpose of heaters and boilers at oil and gas production facilities is to provide thermal energy input to certain operations within the production process. They can be used as separator heaters (heater treaters) to provide heat input to separation units, as tank heaters to maintain storage tank temperatures, or as inline heaters to maintain temperature within pipes and connections. Heaters and boilers may also be used in dehydrators; however, these sources are covered under the dehydrator source methodology. Heaters and boilers are typically natural gas-fired external combustors and are a source of NO_x, CO, VOC and PM emissions. SO_2 emissions may also occur if the gas used to fire the heaters contains Hydrogen Sulfide (H_2S) which will be subsequently converted to SO_2 during combustion. County-level emissions from heater sources are estimated for the purpose of this inventory.

Emissions from heaters and boilers were calculated using the methodology from the 2008 CENRAP study (Bar-Ilan, et al., 2008). In this methodology, emissions from a single heater may be calculated using the following equation (excluding SO_2 emissions):

$$E_{heater} = \frac{EF_{heater} \times Q_{heater} \times t_{annual} \times hc}{\left(HV_{local} \times 2000\right)}$$

where:

E_{heater} is the emissions from a given heater [ton/yr]
EF_{heater} is the emission factor for a heater for a given pollutant [lb/MMscf]
Q_{heater} is the heater MMBtu/hr rating [$\text{MMBtu}_{\text{rated}}$/hr]
HV_{local} is the local natural gas heating value [$\text{MMBtu}_{\text{local}}$/MMscf]
t_{annual} is the annual hours of operation [hr/yr]
hc is the heater cycling fraction to account for the fraction of operating hours that the heater is firing.
2000 is the conversion factor from pounds to tons of emissions

SO_2 emissions from a single heater may be calculated using the following equation:

$$E_{heater,SO_2} = \frac{1.78 \times f_{H_2S}}{907200} \times \left(\frac{Q_{heater} \times t_{annual} \times hc}{HV_{local}} \times \frac{P}{\left(\frac{R}{MW_{gas}}\right) \times T \times 0.035} \right)$$

where:

$E_{heater,SO2}$ is the SO_2 emissions from a given heater [ton-SO_2/yr]
1.78 is the mass ratio of SO_2 to H_2S
f_{H2S} is the mass fraction of H_2S in the gas
907200 is the conversion factor from grams to tons of emissions
Q_{heater} is the heater MMBtu/hr rating [$\text{MMBtu}_{\text{rated}}$/hr]
t_{annual} is the annual hours of operation [hr/yr]
hc is the heater cycling fraction to account for the fraction of operating hours that the heater is firing.
HV_{local} is the local natural gas heating value [$\text{MMBtu}_{\text{local}}$/MMscf]
P is atmospheric pressure [1 atm]
R is the universal gas constant [0.082 L-atm/mol-^{o}K]
MW_{gas} is the molecular weight of the gas [g/mol]
$T = 298$ (standard temperature) [^{o}K]
0.035 is the conversion factor from cubic feet to liters

The total emissions generated by heaters and boilers from specific county are calculated using the following equation:

$$E_{heater,TOTAL} = E_{heater,i} \times N_{heater} \times \frac{W_{TOTAL,j}}{2000}$$

where:

$E_{heater,TOTAL}$ is the total heater emissions of pollutant i in county j [ton/yr]
$E_{heater,i}$ is the total emissions of pollutant i from a single heater [ton/yr]
$W_{TOTAL,j}$ is the total number of wells in county j
N_{heater} is the typical number of heaters per well in the county
2000 is the conversion factor from pounds to tons of emissions

Total number of wells in a given county for 2008, $W_{TOTAL,j}$:

Total active wells by county for the full 2008 year are not readily available from the TRC website. However, well distribution data by county is available from the TRC website on a bi-annual (February and September) basis and can be found at: http://www.rrc.state.tx.us/data/wells/wellcount/index.php. ERG used the September 2008 TRC report to get a count of regular producing wells by county.

Emission factor for a heater for a given pollutant, EF_{heater}:

ERG used EPA's AP-42 emissions factors when calculating emissions from heaters and boilers at oil and gas production sites. Emissions factors are referenced from Tables 1.4-1 and 1.4-2 of AP 42, Fifth Edition, Volume I, Chapter 1: External Combustion Sources and summarized in Table 4-25 below.

Table 4-25. AP-42 Emissions Factors for Natural Gas Fired Heaters

Pollutant	Emissions Factor (lb/MMscf)
NO_x	100
CO	84
PM_{10}	7.6[a]
VOC	5.5

[a] PM_{10} assumed to be equal to $PM_{2.5}$.

Heater MMBTU/hr rating, Q_{heater}:

The 2008 CENRAP study obtained basin-level data for the heater rating from survey data. ERG used this basin level data as a basis for the heater rating. ERG calculated a weighted average based on the number of wells at each basin. This data is summarized in Table 4-26 for gas wells and Table 4-27 for oil wells.

Local natural gas heating value, HV_{local}:

The 2008 CENRAP study obtained basin-level data for the local heating value from survey data. The same value was used for the gas well heating value and oil well heating value for each basin in the CENRAP report. The gas well value was 1,209 MMBtu/MMscf, and the oil well value was 1,655 MMBtu/MMscf. ERG used this basin level data as a basis for the local heating values.

Annual hours of operation, t_{annual}:

The 2008 CENRAP study obtained basin-level data for the annual heater operating hours from survey data. ERG used this basin level data as a basis for the annual operating hours. ERG calculated a weighted average based on the number of wells at each basin. This data is summarized in Table 4-26 for gas wells and Table 4-27 for oil wells.

Heater cycling fraction, hc:

The 2008 CENRAP study used a default value of 1 for heater cycling fraction. ERG also used this as a basis for the heater cycling fraction.

Mass fraction of H_2S, f_{H2S}:

The 2008 CENRAP study obtained basin-level data for the mass fraction of H_2S from survey data. ERG used this basin level data as a basis for the mass fraction of H_2S. ERG calculated a weighted average based on the number of wells at each basin. This data is summarized in Table 4-26 for gas wells and Table 4-27 for oil wells.

Molecular weight of gas, MW_{gas}:

The 2008 CENRAP study obtained basin-level data for the gas molecular weight from survey data. ERG used this basin level data as a basis for the gas molecular weight. ERG calculated a weighted average based on the number of wells at each basin. This data is summarized in Table 4-26 for gas wells and Table 4-27 for oil wells.

Typical number of heater per well, N_{heater}:

The 2008 CENRAP study obtained basin-level data for the average number of heaters per well from survey data. ERG used this basin level data as a basis for the average number of heaters per well. ERG calculated a weighted average based on the number of wells at each basin. This data is summarized in Table 4-26 for gas wells and Table 4-27 for oil wells.

Table 4-26. CENRAP Basin-Level Data for Heaters at Gas Wells

Basin	Heater Operating Parameters					Natural Gas Fuel Parameters	
	Number of heaters in a typical well setup	Heater Firing Rate [MMBtu/hr]	Annual Activity [hr]	Local Heating Value [MMBtu/MMscf]	Heater Cycling	MW_{gas} [g/mol]	H_2S Mass Fraction
Anadarko	0.94	0.92	4,601	1,209	1	21	-
East Texas	0.95	0.64	2,982	1,209	1	19	0.02
Fort Worth	1	0.50	4,380	1,209	1	20	-
Permian	0.54	0.69	4,121	1,209	1	19	0.0001
Western Gulf	1.1	0.46	4,297	1,209	1	19	-
Palo Duro[a]	0.91	0.64	4,076	1,209	1	20	0.005
Marathon Thrust Belt[a]	0.91	0.64	4,076	1,209	1	20	0.005
Weighted Average	0.91	0.64	4,076	1,209	1	20	0.005

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

Table 4-27. CENRAP Basin-Level Data for Heaters at Oil Wells

Basin	Heater Operating Parameters					Natural Gas Fuel Parameters	
	Number of heaters in a typical well setup	Heater Firing Rate [MMBtu/hr]	Annual Activity [hr]	Local Heating Value [MMBtu/MMscf]	Heater Cycling	MW_{gas} [g/mol]	H_2S Mass Fraction
Anadarko	0.94	0.92	4,601	1,655	1	23	-
East Texas	0.95	0.64	2,982	1,655	1	27	1.30
Fort Worth	1	0.50	4,380	1,655	1	25	-
Permian	0.54	0.69	4,121	1,655	1	34	6.50
Western Gulf	1.1	0.46	4,297	1,655	1	25	-
Palo Duro[a]	0.91	0.64	4,076	1,655	1	27	1.56

Table 4-27. CENRAP Basin-Level Data for Heaters at Oil Wells (Cont.)

Basin	Heater Operating Parameters					Natural Gas Fuel Parameters	
	Number of heaters in a typical well setup	Heater Firing Rate [MMBtu/hr]	Annual Activity [hr]	Local Heating Value [MMBtu/MMscf]	Heater Cycling	MW_{gas} [g/mol]	H_2S Mass Fraction
Marathon Thrust Belt[a]	0.91	0.64	4,076	1,655	1	27	1.56
Weighted Average	0.91	0.64	4,076	1,655	1	27	1.56

[a] Data for the Palo Duro and Permian/Marathon Thrust Belt Basins were not included in the CENRAP study. These values are an average of the values from the other basins.

<u>HAP Emissions for Heaters and Boilers</u>:

HAP emissions from heaters and boilers were calculated using VOC and PM speciation data as follows:

$$E_{VOC\text{-}HAP} = E_{VOC} \times (E_{\%VOC\text{-}HAP} / 100)$$

where:

$E_{VOC\text{-}HAP}$ = Speciated VOC-HAP emissions [tons/yr]
E_{VOC} = VOC emissions [tons/yr]
$E_{\%VOC\text{-}HAP}$ = % HAP composition of VOC emissions

and

$$E_{PM\text{-}HAP} = E_{PM} \times (E_{\%PM\text{-}HAP} / 100)$$

where:

$E_{PM\text{-}HAP}$ = Speciated PM-HAP emissions [tons/yr]
E_{PM} = PM emissions [tons/yr]
$E_{\%PM\text{-}HAP}$ = % HAP composition of PM emissions

Appendix C contains the VOC and PM HAP speciation data.

<u>Emissions by county $E_{heater,TOTAL}$</u>:

Appendix E presents county-level heater emissions corresponding to the number of active oil and gas wells in each county, based on the input variables discussed above.

Example Calculation for Heaters and Boilers:

Using the equations provided above, ERG calculated NO_x and SO_2 emissions in Anderson County from heaters and boilers at oil wells as follows:

For NO_x emissions from one heater:

$$E_{heater} = \frac{EF_{heater} \times Q_{heater} \times t_{annual} \times hc}{\left(HV_{local} \times 2000\right)}$$

Where:

E_{heater} = NO_x emissions from one heater in Anderson County [tons/year]
EF_{heater} = 100 (AP-42 emissions factor for NO_x) [lb/MMscf]
Q_{heater} = 0.64 (heater firing rate) [MMBtu/hr]
HV_{local} = 1,655 (local natural gas heating value) [$MMBTU_{local}$/MMscf])
t_{annual} = 4,076 (annual hours of heater operation) [hr/yr]
hc = 1 (heater cycling fraction to account for the fraction of operating hours that the heater is firing)
2000 is the conversion factor from pounds to tons of emissions

Therefore:

E_{heater} = (100 [lb/MMscf] * 0.64 [MMBtu/hr] * 4,076 [hr/yr] * 1)/(1,655 [MMBtu/MMscf] * 2000 [lb/ton])
E_{heater} = 0.07881 [tons NO_x /heater-yr]

For all wells in Anderson County:

$$E_{heater,TOTAL} = E_{heater,i} \times N_{heater} \times W_{TOTAL,j}$$

Where:

$E_{heater,TOTAL}$ = NO_x emissions from all oil wells in Anderson County [tons/yr]
$E_{heater,j}$ = 0.07881 [tons NO_x /heater-yr]
N_{heater} = 0.91 (average number of heaters per well)
$W_{TOTAL,j}$ = 456 (number of wells in Anderson County)

Therefore:

$E_{heater,TOTAL}$ = 0.07881 [tons NO_x /heater-yr] x 0.91 [heaters/well] x 456 [wells]
$E_{heater,TOTAL}$ = 32.70 [tons NO_x /yr]

For SO_2 emissions from one heater:

$$E_{heater,SO_2} = \frac{1.78 \times f_{H_2S}}{907200} \times \left(\frac{Q_{heater} \times t_{annual} \times hc}{HV_{local}} \times \frac{P}{\left(\frac{R}{MW_{gas}} \right) \times T \times 0.035} \right)$$

Where:

$E_{heater,SO2}$ = SO_2 emissions from one heater [ton-SO_2/yr]
f_{H2S} = 1.56 (mass fraction of H_2S in the gas)
Q_{heater} = 0.64 (heater firing rate) [MMBtu/hr]
HV_{local} = 1,655 (local natural gas heating value) [$MMBtu_{local}$/MMscf])
t_{annual} = 4,076 (annual hours of heater operation) [hr/yr]
hc = 1 (heater cycling fraction to account for the fraction of operating hours that the heater is firing)
P = 1 (standard pressure) [atm]
R = 0.082 (universal gas constant) [L-atm/mol-^{o}K]
T = 298 (standard temperature) [^{o}K]
MW_{gas} = 27 (molecular weight of the gas) [g/mol]

Therefore:

$E_{heater,SO2}$ = ((1.78 * 1.56)/907,200) x (((0.64 [MMbtu/hr] * 4,076 [hr/yr] * 1)/1,655 [MMBtu/MMscf]) x (1/((0.082 [L-atm/mol-^{o}K] /27 [g/mol]) * 298 [^{o}K] * 0.035))
$E_{heater,SO2}$ = 1.5231 x 10^{-4} [tons SO_2/heater-yr]

For all wells in Anderson County:

$$E_{heater,TOTAL} = E_{heater,i} \times N_{heater} \times W_{TOTAL,j}$$

Where:

$E_{heater,TOTAL}$ = SO_2 emissions from all oil wells in Anderson County [tons/yr]
$E_{heater,j}$ = 1.5231 x 10^{-4} [tons SO_2/heater-yr]
N_{heater} = 0.91 (average number of heaters per well)
$W_{TOTAL,j}$ = 456 (number of wells in Anderson County)

Therefore:

$E_{heater,TOTAL}$ = 1.5231 x 10^{-4} [tons SO_2/heater-yr] x 0.91 [heaters/well] x 456 wells
$E_{heater,TOTAL}$ = 0.0632 [tons SO_2/yr]

5.0 RESULTS

Detailed emission estimates developed for this project are found in Appendix D for compressor engines, and in Appendix E for the remainder of the source types. These Appendices contain county-level emissions for source category on an individual pollutant basis. Table 5-1 presents a state-wide summary of criteria pollutant (and total HAP) emissions by source category, Table 5-2 presents a summary of criteria pollutant (and total HAP) emissions for each county, and Table 5-3 presents a summary of state-wide speciated HAP emissions by source type.

As Table 5-1 indicates, natural gas compressor engines account for nearly 70 percent of state-wide NO_x emissions with pumpjack engines accounting for another 20 percent of total NO_x emissions. Oil and gas well heaters account for the remaining 10 percent, with a small contribution from glycol dehydrator boilers. The relative contribution of these sources to state-wide CO emissions are similar, with oil and gas well heaters comprising a slightly higher percentage of emissions at approximately 13 percent.

The majority of PM_{10} and $PM_{2.5}$ emissions are also from combustion sources, but the oil and gas well heaters are the primary source type, contributing nearly 60 percent to state-wide totals. The remainder of PM_{10} and $PM_{2.5}$ emissions come from compressor engines and pumpjack engines, with a small contribution from glycol dehydrator boilers.

The profile is quite different for VOC, where over 70 percent of emissions originate from oil and condensate storage tanks. Condensate tanks in particular comprise over 50 percent of state-wide VOC emissions from oil and gas area sources. The remainder of VOC is emitted from the combustion sources mentioned above, and other minor source types such as well completions and blowdowns, pneumatic devices (which contribute over 10% of the total VOC emissions), and equipment leak fugitives.

The relative profile of the contribution of each source type to state-wide HAP emissions is similar to that of VOC emissions. Oil and condensate storage tanks contribute over 65 percent of the state-wide total HAP emissions, with dehydrators contributing over 15 percent of the state-wide total HAP emissions. The remainder of HAP emissions come from combustion sources and oil and condensate loading racks.

Table 5-1. State-wide Emissions Inventory for 2008 by Source Category

SCC	Source Category Description	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
2310000330	Artificial Lift	23,169.14	46,369.72	154.04	154.04	9.56	440.12	140.49
2310011020	Storage Tanks: Crude Oil						282,420.05	5,060.01
2310011100	Heater Treater	9,267.25	11,032.44	838.47	838.47	21.32	606.78	208.67
2310011201	Tank Truck/Railcar Loading: Crude Oil						26,810.72	479.91
2310011450	Wellhead						116,245.65	
2310011501	Fugitives: Connectors						2,956.39	
2310011502	Fugitives: Flanges						135.46	
2310011503	Fugitives: Open Ended Lines						605.72	
2310011504	Fugitives: Pumps						4,326.59	
2310011505	Fugitives: Valves						7,821.14	
2310011506	Fugitives: Other						12,480.55	
2310020600	Compressor Engines	133.77	464.56	13.58	13.58	0.21	81.40	29.00
2310021010	Storage Tanks: Condensate						864,087.90	17,281.71
2310021030	Tank Truck/Railcar Loading Condensate						7,235.50	144.71
2310021100	Gas Well Heaters	7,564.83	9,005.75	684.44	684.44	0.04	495.32	170.34
2310021101	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines <50 Hp	140.52	209.25	9.72	9.72	0.16	43.38	15.46
2310021102	Natural Gas Fired 2-Cycle Lean Burn Compressor Engines 50 To 499 Hp	2,907.93	13,776.30	352.37	352.37	5.71	2,012.02	716.78
2310021203	Natural Gas Fired 4-Cycle Lean Burn Compressor Engines 500+ Hp	14,746.41	27,288.73	76.95	76.95	15.94	3,817.42	2,337.58
2310021301	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines <50 Hp	93.37	1,175.69	3.86	3.86	0.25	5.61	5.50

Table 5-1. State-wide Emissions Inventory for 2008 by Source Category (Cont.)

SCC	Source Category Description	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
2310021302	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50 To 499hp	38,988.69	86,462.54	226.24	226.24	14.83	1,487.26	1,451.93
2310021400	Gas Well Dehydrators	904.59	293.36				6,344.85	5,255.17
2310021402	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 50-499hp W/ Nscr	767.55	3,321.00	35.02	35.02	2.05	17.73	17.46
2310021403	Natural Gas Fired 4-Cycle Rich Burn Compressor Engines 500+ Hp W/ Nscr	29,646.80	47,837.57	175.33	175.33	11.26	794.33	775.73
2310021501	Fugitives: Connectors						1,161.52	
2310021502	Fugitives: Flanges						1,199.68	
2310021503	Fugitives: Open Ended Lines						916.82	
2310021504	Fugitives: Pumps						476.31	
2310021505	Fugitives: Valves						7,387.52	
2310021506	Fugitives: Other						8,732.37	
2310021600	Gas Well Venting						8,601.78	
2310121700	Gas Well Completion: All Processes						10,139.56	
2310111700	Oil Well Completion: All Processes						19,425.44	
2310121401	Gas Well Pneumatic Pumps						169,209.86	
	Total:	**128,330.85**	**247,236.91**	**2,570.01**	**2,570.01**	**81.34**	**1,568,522.73**	**34,090.45**

Table 5-2. State-wide Emissions Inventory for 2008 by County

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Anderson	241.28	444.72	5.31	5.31	0.16	2,858.24	52.77
Andrews	1,825.99	3,291.18	49.14	49.14	1.57	31,691.46	444.20
Angelina	161.97	311.11	2.15	2.15	0.08	629.30	25.94
Aransas	165.25	317.00	2.28	2.28	0.09	6,574.04	144.42
Archer	614.91	1,088.88	18.74	18.74	0.58	2,719.03	24.45
Armstrong	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atascosa	321.56	578.81	8.71	8.71	0.27	2,237.28	31.44
Austin	127.18	237.83	2.42	2.42	0.07	2,040.58	43.74
Bailey	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bandera	0.21	0.37	0.01	0.01	0.00	5.14	0.03
Bastrop	74.21	128.49	2.56	2.56	0.06	1,286.18	16.32
Baylor	26.78	47.39	0.82	0.82	0.03	189.33	1.96
Bee	581.15	1,101.85	9.42	9.42	0.31	4,717.44	125.89
Bell	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bexar	531.99	941.46	16.28	16.28	0.51	2,120.86	7.60
Blanco	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Borden	166.31	300.48	4.40	4.40	0.14	4,107.39	62.92
Bosque	3.45	6.30	0.08	0.08	0.00	17.43	0.34
Bowie	5.13	9.25	0.14	0.14	0.00	148.70	2.69
Brazoria	207.73	199.95	6.59	6.59	0.28	14,003.43	292.15
Brazos	240.26	444.10	5.18	5.18	0.16	3,781.19	74.41
Brewster	0.00	0.00	0.00	0.00	0.00	5.88	0.00
Briscoe	0.00	0.00	0.00	0.00	0.00	12.33	0.01
Brooks	690.71	1,318.85	10.17	10.17	0.35	16,242.00	374.16
Brown	204.73	339.96	8.55	8.55	0.14	1,626.85	6.71
Burleson	366.21	669.08	8.80	8.80	0.28	3,881.39	67.20
Burnet	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Caldwell	676.24	1,197.43	20.61	20.61	0.64	3,452.64	22.69
Calhoun	189.99	360.25	3.07	3.07	0.10	7,473.42	160.35
Callahan	182.61	321.30	5.76	5.76	0.16	983.48	9.65
Cameron	1.68	3.12	0.03	0.03	0.00	10.26	0.20
Camp	30.41	55.01	0.79	0.79	0.03	259.21	4.96
Carson	569.73	1,021.51	15.74	15.74	0.41	1,954.76	34.12
Cass	54.95	98.13	1.55	1.55	0.04	662.46	11.89
Castro	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chambers	84.76	94.63	2.75	2.75	0.11	4,424.08	90.13
Cherokee	364.58	682.18	6.78	6.78	0.18	2,911.32	72.93
Childress	1.69	2.99	0.05	0.05	0.00	57.40	0.71
Clay	231.82	409.65	7.14	7.14	0.21	1,476.89	16.60
Cochran	445.16	791.68	13.17	13.17	0.41	6,168.35	67.45
Coke	109.55	200.99	2.54	2.54	0.08	1,010.20	15.88
Coleman	173.73	295.58	6.51	6.51	0.13	1,363.81	9.92
Collin	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Collingsworth	50.04	76.34	2.77	2.77	0.02	742.63	2.58
Colorado	319.38	601.84	5.54	5.54	0.16	4,980.62	115.78
Comal	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Comanche	34.22	53.57	1.76	1.76	0.02	438.42	1.97
Concho	72.58	128.12	2.23	2.23	0.06	821.04	9.65
Cooke	495.43	884.64	14.25	14.25	0.45	3,467.02	50.26
Coryell	0.00	0.00	0.00	0.00	0.00	3.13	0.00
Cottle	95.67	180.55	1.63	1.63	0.05	2,376.44	52.30
Crane	1,739.98	3,208.47	38.61	38.61	1.26	17,274.91	291.73
Crockett	2,274.88	4,015.15	68.61	68.61	1.15	28,501.91	414.45
Crosby	85.55	151.51	2.61	2.61	0.08	1,056.14	9.67

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Culberson	72.79	137.98	1.20	1.20	0.04	284.44	8.75
Dallam	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dallas	28.04	80.04	0.21	0.21	0.02	24.60	4.23
Dawson	275.48	492.78	7.84	7.84	0.25	5,344.51	72.02
Deaf Smith	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delta	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Denton	1,763.52	4,690.36	29.51	29.51	1.14	13,254.59	416.58
Dewitt	676.49	1,300.83	9.00	9.00	0.35	11,617.04	287.72
Dickens	49.70	88.22	1.49	1.49	0.05	1,446.43	20.78
Dimmit	197.89	353.20	5.65	5.65	0.15	2,515.16	31.86
Donley	0.53	0.77	0.03	0.03	0.00	15.82	0.17
Duval	1,111.17	2,101.02	18.70	18.70	0.63	12,897.27	314.00
Eastland	285.26	476.94	11.51	11.51	0.18	3,654.84	39.72
Ector	1,798.24	3,277.22	44.40	44.40	1.47	26,211.12	388.97
Edwards	270.78	492.35	6.60	6.60	0.13	1,377.01	25.49
El Paso	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ellis	51.17	144.09	0.47	0.47	0.04	52.43	7.56
Erath	161.14	295.43	3.68	3.68	0.07	1,556.95	32.84
Falls	4.01	7.09	0.12	0.12	0.00	21.49	0.09
Fannin	0.00	0.00	0.00	0.00	0.00	11.86	0.00
Fayette	356.62	659.40	7.64	7.64	0.23	5,607.61	115.67
Fisher	107.82	193.50	2.99	2.99	0.09	1,365.54	16.44
Floyd	0.42	0.75	0.01	0.01	0.00	2.97	0.03
Foard	27.94	43.90	1.42	1.42	0.01	414.38	2.57
Fort Bend	169.68	171.80	5.51	5.51	0.22	8,072.59	166.58
Franklin	69.40	127.99	1.52	1.52	0.05	1,389.52	28.31
Freestone	3,821.60	7,289.51	56.95	56.95	1.93	9,858.72	475.09

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Frio	139.12	246.28	4.21	4.21	0.12	1,393.74	14.40
Gaines	1,165.52	2,133.47	27.65	27.65	0.92	27,788.32	460.84
Galveston	86.46	76.28	2.61	2.61	0.12	17,475.45	358.12
Garza	445.72	790.41	13.45	13.45	0.42	6,133.80	63.01
Gillespie	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glasscock	416.67	761.54	10.00	10.00	0.32	5,431.20	84.49
Goliad	731.21	1,386.08	11.85	11.85	0.37	7,851.72	199.63
Gonzales	51.40	92.76	1.37	1.37	0.04	578.12	8.62
Gray	825.55	1,440.69	27.11	27.11	0.64	4,163.88	45.84
Grayson	201.98	365.62	5.22	5.22	0.16	1,707.03	31.65
Gregg	1,423.90	2,592.32	34.92	34.92	1.00	10,980.44	227.68
Grimes	334.10	638.29	4.87	4.87	0.17	1,264.12	50.60
Guadalupe	402.11	711.73	12.29	12.29	0.38	2,576.45	22.66
Hale	62.99	114.67	1.57	1.57	0.05	2,698.37	46.20
Hall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton	3.12	5.33	0.11	0.11	0.00	36.47	0.47
Hansford	377.68	676.20	10.32	10.32	0.17	2,601.06	43.25
Hardeman	52.13	92.68	1.54	1.54	0.05	1,230.36	19.89
Hardin	258.68	348.83	7.85	7.85	0.30	22,648.65	447.94
Harris	176.00	181.67	5.65	5.65	0.23	8,801.29	184.44
Harrison	1,879.59	3,514.48	35.19	35.19	0.93	25,383.90	583.58
Hartley	39.06	70.27	1.04	1.04	0.02	399.51	6.56
Haskell	53.83	95.30	1.64	1.64	0.05	443.81	5.44
Hays	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hemphill	2,092.63	3,936.72	37.08	37.08	1.03	32,774.76	754.74
Henderson	453.75	854.13	7.99	7.99	0.24	2,535.12	73.92
Hidalgo	3,264.69	6,276.64	43.49	43.49	1.68	56,554.95	1,407.72

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Hill	308.20	597.97	3.53	3.53	0.16	233.61	34.41
Hockley	1,004.10	1,795.93	28.58	28.58	0.91	22,011.88	308.12
Hood	926.80	1,777.59	12.89	12.89	0.47	9,914.41	269.97
Hopkins	20.84	37.79	0.53	0.53	0.02	298.78	5.06
Houston	164.62	308.00	3.11	3.11	0.10	1,587.91	35.84
Howard	803.87	1,436.74	23.00	23.00	0.73	9,904.95	107.63
Hudspeth	0.12	0.17	0.01	0.01	0.00	3.29	0.03
Hunt	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hutchinson	903.43	1,601.32	27.09	27.09	0.72	4,039.66	49.29
Irion	531.51	961.89	13.77	13.77	0.40	5,877.27	82.51
Jack	646.65	1,121.02	21.80	21.80	0.42	6,701.91	92.20
Jackson	303.15	569.09	5.55	5.55	0.17	9,879.64	204.59
Jasper	205.58	394.00	2.87	2.87	0.11	6,405.78	143.58
Jeff Davis	0.00	0.00	0.00	0.00	0.00	1.29	0.03
Jefferson	287.19	182.64	8.05	8.05	0.46	55,659.21	1,163.27
Jim Hogg	266.50	500.41	4.83	4.83	0.14	4,021.10	92.33
Jim Wells	127.37	226.90	3.61	3.61	0.06	1,576.61	26.20
Johnson	4,495.48	12,647.53	43.01	43.01	3.19	5,209.18	684.81
Jones	167.32	296.69	5.05	5.05	0.16	1,277.91	14.79
Karnes	171.32	323.25	2.95	2.95	0.10	3,454.12	76.12
Kaufman	4.50	8.03	0.14	0.14	0.00	62.82	1.05
Kendall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kenedy	665.44	1,286.34	8.13	8.13	0.35	4,087.71	143.43
Kent	203.51	375.70	4.48	4.48	0.16	4,304.19	73.92
Kerr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kimble	2.94	4.50	0.16	0.16	0.00	41.29	0.17
King	112.59	198.82	3.47	3.47	0.10	2,010.47	35.20

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Kinney	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kleberg	494.21	948.96	6.71	6.71	0.25	8,845.84	217.77
Knox	46.18	81.72	1.41	1.41	0.04	354.81	4.00
La Salle	259.22	470.95	6.38	6.38	0.13	4,078.69	76.37
Lamar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lamb	15.10	27.13	0.42	0.42	0.01	686.85	11.01
Lampasas	0.16	0.20	0.01	0.01	0.00	4.24	0.00
Lavaca	924.67	1,764.89	13.68	13.68	0.47	12,277.67	311.64
Lee	307.30	564.26	7.08	7.08	0.23	2,650.76	49.84
Leon	1,079.72	2,070.29	15.01	15.01	0.58	5,733.49	197.49
Liberty	331.40	341.24	9.92	9.92	0.45	27,316.75	570.30
Limestone	1,393.87	2,655.14	21.17	21.17	0.71	4,377.56	180.91
Lipscomb	1,125.34	2,104.13	21.36	21.36	0.58	17,104.94	381.52
Live Oak	378.16	709.70	6.91	6.91	0.20	6,807.99	149.58
Llano	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loving	1,567.71	3,023.10	20.15	20.15	0.89	6,348.57	251.69
Lubbock	89.19	158.04	2.71	2.71	0.08	1,825.32	23.15
Lynn	18.52	33.00	0.54	0.54	0.02	350.40	4.52
Madison	117.26	216.26	2.56	2.56	0.07	1,290.52	26.07
Marion	96.78	174.38	2.56	2.56	0.06	1,407.02	25.69
Martin	596.73	1,088.02	14.69	14.69	0.49	10,928.66	168.72
Mason	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Matagorda	609.79	1,168.96	8.47	8.47	0.32	19,098.24	428.64
Maverick	182.47	323.89	5.42	5.42	0.15	3,715.58	42.08
McCulloch	14.65	25.47	0.50	0.50	0.01	109.65	1.15
McLennan	8.65	15.30	0.26	0.26	0.01	27.43	0.12
McMullen	493.90	900.42	11.92	11.92	0.29	6,027.42	110.63

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Medina	275.72	487.25	8.50	8.50	0.26	1,235.77	4.54
Menard	27.00	47.52	0.85	0.85	0.02	266.84	2.69
Midland	1,610.04	2,951.97	37.75	37.75	1.27	20,938.23	333.93
Milam	218.91	387.83	6.65	6.65	0.21	1,216.87	9.32
Mills	0.36	0.51	0.02	0.02	0.00	6.38	0.02
Mitchell	502.49	890.13	15.28	15.28	0.48	6,645.63	65.00
Montague	551.48	987.06	15.59	15.59	0.49	3,448.92	48.39
Montgomery	73.56	81.80	2.86	2.86	0.08	2,890.56	54.67
Moore	744.02	1,343.19	19.29	19.29	0.40	3,502.87	63.64
Morris	0.21	0.37	0.01	0.01	0.00	2.01	0.03
Motley	3.80	6.72	0.12	0.12	0.00	52.75	0.49
Nacogdoches	1,527.76	2,897.04	24.29	24.29	0.77	12,723.39	353.60
Navarro	170.24	301.61	5.16	5.16	0.16	1,444.51	18.73
Newton	78.50	145.69	1.63	1.63	0.05	1,601.94	31.72
Nolan	133.50	240.21	3.63	3.63	0.11	1,931.63	25.88
Nueces	605.47	1,127.23	11.99	11.99	0.31	15,740.17	332.51
Ochiltree	561.88	1,020.35	13.94	13.94	0.31	5,760.68	108.67
Oldham	5.68	10.02	0.17	0.17	0.00	247.24	3.74
Orange	67.79	71.25	2.06	2.06	0.09	8,467.82	172.90
Palo Pinto	455.72	785.82	15.70	15.70	0.21	7,033.45	105.26
Panola	3,784.21	7,052.88	73.18	73.18	1.82	50,362.96	1,170.88
Parker	1,225.52	3,294.01	19.49	19.49	0.80	9,840.76	290.06
Parmer	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pecos	4,534.56	8,670.50	66.30	66.30	2.63	21,760.89	703.44
Polk	415.68	797.76	5.69	5.69	0.22	29,650.93	625.12
Potter	350.79	632.33	9.25	9.25	0.21	1,799.21	27.27
Presidio	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Rains	59.61	115.43	0.71	0.71	0.03	38.47	6.62
Randall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Reagan	1,209.82	2,204.56	29.89	29.89	0.99	11,808.61	158.58
Real	1.91	3.34	0.06	0.06	0.00	16.74	0.15
Red River	9.57	16.96	0.29	0.29	0.01	159.73	2.26
Reeves	575.50	1,077.94	10.88	10.88	0.36	3,146.28	72.34
Refugio	652.55	1,218.19	12.72	12.72	0.40	9,671.07	197.77
Roberts	881.18	1,659.43	15.47	15.47	0.45	15,296.54	346.65
Robertson	3,591.03	6,960.37	41.87	41.87	1.90	4,202.14	427.68
Rockwall	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Runnels	145.66	262.06	3.96	3.96	0.12	1,177.54	15.82
Rusk	2,394.04	4,447.78	48.27	48.27	1.34	26,428.99	597.16
Sabine	2.04	3.67	0.06	0.06	0.00	19.20	0.14
San Augustine	159.66	309.99	1.77	1.77	0.09	452.69	23.22
San Jacinto	182.43	350.28	2.47	2.47	0.09	6,462.64	144.35
San Patricio	303.08	570.53	5.36	5.36	0.16	12,721.07	267.75
San Saba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schleicher	297.16	521.39	9.30	9.30	0.15	3,975.13	56.43
Scurry	920.14	1,696.28	20.52	20.52	0.72	16,745.60	282.63
Shackelford	446.66	787.83	13.87	13.87	0.39	2,584.60	27.41
Shelby	788.21	1,506.84	11.24	11.24	0.40	4,681.48	153.59
Sherman	382.36	689.34	9.93	9.93	0.17	2,226.58	38.78
Smith	600.16	1,117.21	11.83	11.83	0.32	6,759.09	157.15
Somervell	69.05	132.73	0.93	0.93	0.04	261.32	10.71
Starr	1,801.98	3,435.69	27.08	27.08	0.92	39,905.70	922.75
Stephens	548.00	962.55	17.22	17.22	0.36	6,028.28	86.04
Sterling	507.62	898.57	15.24	15.24	0.35	5,045.87	54.84

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Stonewall	125.21	222.61	3.72	3.72	0.12	1,647.78	17.01
Sutton	1,536.07	2,640.40	53.45	53.45	0.57	14,703.05	158.36
Swisher	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tarrant	4,070.91	11,441.36	39.54	39.54	2.88	4,929.92	620.02
Taylor	92.16	163.25	2.80	2.80	0.09	693.08	8.42
Terrell	890.56	1,697.22	13.46	13.46	0.45	4,554.08	153.52
Terry	217.93	388.12	6.39	6.39	0.20	5,118.11	70.81
Throckmorton	221.50	393.95	6.55	6.55	0.20	1,242.06	15.21
Titus	42.19	74.68	1.29	1.29	0.04	506.68	8.03
Tom Green	170.07	304.64	4.76	4.76	0.14	1,945.37	23.40
Travis	3.37	5.97	0.10	0.10	0.00	14.43	0.07
Trinity	10.94	19.88	0.27	0.27	0.01	193.38	3.42
Tyler	463.76	896.18	5.69	5.69	0.25	57,953.39	1,201.05
Upshur	604.48	1,126.42	11.73	11.73	0.30	10,582.53	238.20
Upton	1,602.98	2,998.03	30.90	30.90	1.09	32,833.54	647.89
Uvalde	0.20	0.26	0.02	0.02	0.00	4.37	0.01
Val Verde	210.53	394.38	3.90	3.90	0.10	620.76	21.64
Van Zandt	193.81	352.82	4.81	4.81	0.15	1,204.59	23.27
Victoria	287.47	535.68	5.67	5.67	0.16	3,296.01	69.83
Walker	13.49	24.74	0.31	0.31	0.01	85.26	1.73
Waller	88.01	106.67	2.83	2.83	0.11	2,859.24	56.46
Ward	1,288.64	2,381.97	28.00	28.00	0.94	9,588.88	230.25
Washington	256.76	485.36	4.31	4.31	0.14	2,513.65	64.54
Webb	3,123.82	5,806.41	62.66	62.66	1.48	28,275.41	664.71
Wharton	692.11	1,309.84	11.43	11.43	0.37	15,986.48	354.54
Wheeler	2,223.92	4,231.74	34.40	34.40	1.15	40,674.02	955.94
Wichita	1,185.96	2,099.33	36.23	36.23	1.13	5,040.04	46.60

Table 5-2. State-wide Emissions Inventory for 2008 by County (Cont.)

County	CO (tons/yr)	NO_x (tons/yr)	PM_{10} (tons/yr)	$PM_{2.5}$ (tons/yr)	SO_2 (tons/yr)	VOC (tons/yr)	Total HAP (tons/yr)
Wilbarger	174.53	308.95	5.33	5.33	0.17	1,147.90	13.03
Willacy	353.53	681.05	4.59	4.59	0.19	8,274.58	193.92
Williamson	9.07	16.05	0.28	0.28	0.01	53.29	0.33
Wilson	129.98	230.01	3.98	3.98	0.12	757.55	6.10
Winkler	917.14	1,698.44	19.52	19.52	0.63	7,815.47	141.18
Wise	2,749.59	5,099.17	55.75	55.75	1.35	24,225.59	597.53
Wood	239.16	438.82	5.52	5.52	0.18	4,200.35	82.03
Yoakum	1,074.18	1,960.14	26.21	26.21	0.88	25,649.46	414.59
Young	556.32	978.60	17.57	17.57	0.50	3,394.26	35.11
Zapata	4,438.24	8,472.07	65.54	65.54	2.24	13,384.86	594.31
Zavala	64.75	114.70	1.94	1.94	0.05	1,016.76	14.24
Total:	**128,330.85**	**247,236.91**	**2,570.01**	**2,570.01**	**81.34**	**1,568,522.73**	**34,090.45**

Table 5-3. State-wide Speciated HAP Emissions by Source Category

Hazardous Air Pollutant	Source Category						
	Dehydrators	Pump Jacks	Oil and Gas Heaters	Tank Truck/Railcar Loading	Natural Gas Compressor Engines	Storage Tanks	Statewide Total
1,1,2,2-Tetrachloroethane		0.10			3.23		3.33
1,1,2-Trichloroethane		0.06			2.19		2.25
1,3-Butadiene		2.59			59.71		62.30
1,3-Dichloropropene		0.05			1.82		1.87
1,4-Dichlorobenzene		4.69	0.24		38.67		43.60
2,2,4-Trimethylpentane					7.95		7.95
2-Methylnaphthalene		0.09	0.005		2.91		3.01
3-Methylcholanthrene		0.01	0.0004		0.20		0.20
7,12-Dimethylbenz[a]Anthracene		0.06	0.003		1.74		1.81
Acenaphthene		0.36	0.001		0.23		0.59
Acenaphthylene		0.36	0.001		0.65		1.01
Acetaldehyde		10.91	1.78		481.46		494.14
Acrolein		10.28			366.67		376.95
Anthracene		0.48	0.00		0.37		0.86
Benz[a]Anthracene		0.36	0.00		0.28		0.64
Benzene	1,477.65	6.18	0.42	129.92	136.05	5,794.48	7,544.70
Benzo(g,h,i)Fluoranthene		0.24			0.00		0.24
Benzo[a]Pyrene		0.24	0.001		0.07		0.31
Benzo[b]Fluoranthene		0.36	0.001		0.12		0.48
Benzo[e]Pyrene					0.04		0.04
Benzo[g,h,i,]Perylene			0.001		0.11		0.11
Benzo[k]Fluoranthene		0.36	0.001		0.28		0.64
Biphenyl					6.74		6.74
Carbon Tetrachloride		0.07			2.53		2.60
Chlorobenzene		0.05			1.96		2.01
Chloroform		0.05			1.96		2.02
Chrysene		0.36	0.001		0.17		0.53
Dibenzo[a,h]Anthracene		0.24	0.001		0.19		0.43
Ethyl Benzene	88.89	0.10		54.19	3.18	1,003.02	1,149.37

Table 5-3. State-wide Speciated HAP Emissions by Source Category (Cont.)

Hazardous Air Pollutant	Source Category						
	Dehydrators	Pump Jacks	Oil and Gas Heaters	Tank Truck/Railcar Loading	Natural Gas Compressor Engines	Storage Tanks	Statewide Total
Ethylene Dibromide		0.08			3.05		3.14
Fluoranthene		0.60	0.002		0.28		0.88
Fluorene		0.56	0.002		0.72		1.29
Formaldehyde		80.13	15.03		3,263.20		3,358.36
Hexane			360.69		781.76		1,142.45
Indeno[1,2,3-c,d]Pyrene		0.36	0.001		0.28		0.64
Methanol		11.96			80.80		92.76
Methylene Chloride		0.16			3.82		3.98
m-Xylene		0.04			0.44		0.49
Naphthalene		0.38	0.12		9.87		10.37
o-Xylene		0.04			0.83		0.87
Phenanthrene		3.50	0.01		2.02		5.54
Phenol					0.76		0.76
Pyrene		1.00	0.004		0.42		1.42
Styrene		0.05			1.67		1.72
Toluene	786.98	2.18	0.68	208.89	56.08	9,756.68	10,811.49
Vinyl Chloride		0.03			1.03		1.06
Xylenes (Mixture of o, m, and p Isomers)	2,901.66	0.76		231.62	20.92	5,787.54	8,942.50
Statewide Total	**5,255.17**	**140.49**	**379.00**	**624.62**	**5,349.44**	**22,341.72**	**34,090.45**

6.0 FORMATTED TexAER FILES

Once the emissions inventory was completed, the data was prepared for electronic submittal to the Texas Air Emissions Repository (TexAER) using the National Emissions Inventory (NEI) Input Format (NIF) 3.0. Area source text-formatted input files were prepared for all onshore oil and gas area source categories for a 2008 base year. The NIF 3.0 files were created using information provided by TCEQ regarding the correct format and valid code listings for submittal to TexAER. Prior to submittal to TCEQ, the NIF 3.0 files were pre-processed using EPA's NIF Basic Format and Content Checker to check for errors and inconsistencies. Additionally, ERG performed a test upload to TexAER to ensure the files were complete and accurate and in a format consistent with the TexAER area source file data requirements. The formatted TexAER files are included as Appendix F.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This study presents a comprehensive, statewide 2008 emissions inventory for Texas for onshore, upstream oil and gas production area sources. Data used to prepare the emissions inventory were obtained from a variety of sources, including existing databases (such as the Texas Railroad Commission (TRC) oil and gas production data), point source emissions inventory reports submitted to TCEQ (for dehydrators), vendor data (for compression engines and pumpjack engines), and published emission factor and activity data from the Houston Advanced Research Center (HARC), the Central Regional Air Planning Association (CENRAP), and the U.S. Environmental Protection Agency (EPA).

Further improvements to this inventory could be made through collection of County-level activity data through use of the survey instrument developed as described in Section 3.0. Such a survey will help quantify the specific number, size, type, and location of the various equipment types used at upstream oil and gas production sites in Texas.

While characterization of emissions from all of the source types would benefit from detailed survey data, there are a few categories where minimal Texas-specific data was available. Specifically, this inventory was based on default profiles for several source categories that could be improved through implementation of the survey as follows:

- Well Completions and Well Blowdowns - survey data is needed to determine the volumes of gas released during these operations, the composition of the gas released, and the extent that these operations are controlled;
- Pneumatic Devices - survey data is needed to determine the number of devices used at each upstream oil and gas production site, the bleed rates for each equipment type, and the composition of the natural gas released from these sources;
- Fugitive Emissions (Equipment Leaks) - this could be a significant source category and there is some uncertainty as to the current estimate of the number and types of fugitive emission soruces (valves, flanges, etc.). As with well completions and well blowdowns, gas composition data is needed to be able to speciate the emissions from this source category; and
- Heaters and Boilers - survey data is needed to quantify the number and size of these small combustion units located at upstream oil and gas production sites.

Also, HAP emissions could be estimated for several source categories not currently included in the HAP inventory if HAP speciation data could be obtained for the chemical composition of the natural gas emitted during various processes. In particular, this data would be used to estimate HAP emissions from well completions, well blowdowns, pneumatic devices, and equipment leaks.

It is likely the current inventory may be overestimating emissions to some degree from some sources due to the lack of information on control device use. In particular, this data would be useful for well completions (flaring and “green completion” techniques), oil and condensate storage tanks and loading racks (vapor recovery units and flares), and engines (SCR and NSCR). Again, information submitted by the operators would help account for emission control measures providing more accurate emission estimates.

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Appendix A – Task 2 Memorandum

TECHNICAL MEMORANDUM

Date: April 26, 2010

To: Martha Maldonado
Project Representative
Texas Commission on Environmental Quality (TCEQ)

From: Richard Billings, Eastern Research Group (ERG)
Daryl Hudson (ERG)
Mike Pring (ERG)
Jason Renzaglia (ERG)
Brandon Smith (ERG)
Stephen Treimel (ERG)

Re: Oil and Gas Sources Inventory - Final Technical Memorandum for Task 2
TCEQ Contract No. 582-7-84003, Work Order No. 582-7-84003-FY10-26

1.0 Introduction

The purpose of this Work Order is to develop a 2008 base year air emissions inventory from upstream onshore oil and gas production sites for select counties in Texas. The inventory will address area source criteria pollutant emissions of volatile organic compounds (VOC), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and sulfur dioxide (SO_2); and certain toxic pollutant emissions such as formaldehyde, benzene, toluene, ethylbenzene, and xylene. In addition to compiling the emissions inventory, other goals of this Work Order are to identify the emission source types operating at oil and gas production sites, identify the best emissions determination methodology for each emission source type, and develop a methodology for estimating emissions from oil and gas production sites based on the oil and gas produced at the county level.

This Work Order builds on two previous studies ERG conducted for TCEQ to estimate emissions from oil and gas exploration and production activities. The first, implemented in 2007, focused on compiling a state-wide emissions inventory (including both onshore and offshore sources) for oil and gas exploration and production for a 2005 base year (ERG, 2007). The second study, conducted in 2009 for a 2008 base year, focused only on emissions from onshore oil and gas well drilling rig engines (ERG, 2009). Both of these studies included emission estimates for every county in Texas. In contrast, this current study will only address onshore area sources (those not included in the Texas point source inventory), and excludes the 23 counties in the Barnett Shale area (Archer, Bosque, Clay, Comanche, Cooke, Coryell, Dallas, Denton, Eastland, Ellis, Erath, Hill, Hood, Jack, Johnson, Montague, Palo Pinto, Parker, Shackelford, Somervell, Stephens, Tarrant, and Wise). TCEQ is currently developing an emissions inventory for oil and gas sources in the Barnett Shale, and offshore oil and gas platforms are currently under evaluation as part of TCEQ Work Order No. 582-07-84003-FY10-25.

The project is divided into four primary technical work tasks:

- Identification and review of existing studies pertaining to estimating emissions from oil and gas production sites and recommendation of an emission estimation approach for each identified source type;
- Collection of activity and emissions data through an industry survey and, as available, obtain data from existing studies and databases;
- Development of a methodology to estimate county-level emissions from each identified source type; and
- Performance of emissions estimation calculations, including documentation of data, procedures, and results in a final project report. The final emissions inventory will be compiled into National Emissions Inventory Input Format (NIF) 3.0 text files for import into Texas Air Emissions Repository (TexAER).

The purpose of this memo is to identify and summarize emission estimation methodologies available for oil and gas production sites as determined through a technical review and evaluation of recent studies of emission sources at oil and gas production sites. In the project Work Plan, this work is referred to as Task 2. The existing studies reviewed and a summary of the available and recommended emission estimation approaches for each source type are presented in this memo, including summaries of the data required to implement the preferred approach and ERG's recommendations how best to obtain the needed data. In addition, any data gaps identified that impact the ability to develop a 2008 inventory estimate for a category are described and possible methods for addressing the data gaps (through the use of existing or default data) are presented.

This discussion begins by presenting the list of oil and gas source types that are the focus of this project in Section 2.0, Identification of Source Categories. A specific list of source types was contained in the Work Order and these source types were the focus of the Task 2 analysis, although this analysis was not limited to only those source types. As other additional source types were identified in the course of reviewing the existing studies, they are also included in this analysis. In Section 3.0, the specific oil and gas emission source types addressed in the project are presented, along with a review of any relevant existing studies, and a recommended emission estimation approach. Section 4.0 includes the references used in preparation of this memorandum. Appendix A contains a list of acronyms and abbreviations used in the text of this document. Terms are also defined in the text the first time they are used.

2.0 Identification of Source Categories

The majority of the oil and gas production source categories analyzed in this project were also included in the previous TCEQ Oil and Gas study (ERG, 2007). Other oil and gas emissions sources were specified by TCEQ in the work order.

For the purposes of this project and this memorandum, the following oil and gas source types have been addressed:

- Well Completions
- Well Blowdowns
- Wellheads
- Pneumatic Devices
- Fugitive Emissions (Equipment Leaks)
- Artificial Lift (Pumpjack) Engines
- Heaters and Boilers
- Dehydrators
- Storage Tanks
- Oil and Condensate Loading Racks
- Compressor Engines
- Turbines

These types of sources are considered "upstream" sources, which include activities associated with searching for potential oil and gas fields, drilling of exploratory wells, and subsequently development and operating the wells that recover and bring the natural gas and/or oil to the surface. The majority of upstream sources are area sources and are not currently accounted for in the point sources inventory.

"Midstream" and "downstream" sources are associated with those operations that subsequently store, process, refine, market, and transport oil and gas products such as crude oil, natural gas, gasoline, and natural gas liquids. These types of sources are typically included in the point source emissions inventory, and consist of gas processing plants, pipeline compressor stations, and oil refineries. Point sources are not included in this inventory effort.

Table 1 provides a summary of the general source category types listed above, the specific operations or processes that generate air emissions, and identification of the pollutants associated with each source. Table 2 identifies the specific emission processes, and the list of available Source Classification Codes (SCCs) for association with each source type. The SCC list is based on a list of available SCC’s for oil and gas sources as provided to ERG by TCEQ.

The final list of SCC's used to compile the emissions inventory into the NIF 3.0 text files will be provided in the emissions inventory report. The structure of the SCC scheme for many of the source types included in this study allows for aggregation of emissions under one SCC, or the use of multiple SCC's if sufficient detailed data is obtained to disaggregate emissions into smaller sub-categories. For example, SCC 2310011500 may be used for "FUGITIVES: ALL PROCESSES" from oil production, or there are 6 separate SCC's that may be used to disaggregate fugitive emissions into sub-categories of "connectors", "flanges", "valves", "open ended lines", "pumps", and "other".

Table 1. Identification of Source Categories Addressed in the Texas Oil and Gas Emission Inventory

Oil & Gas Source Type	Specific Emission Sources	Potential Pollutants
Well Completions	Emissions from venting/flaring from the well completion phase	CO, NO_X, VOC
Well Blowdowns	Emissions from venting/flaring from well blowdowns	CO, NO_X, VOC
Wellheads	Emissions from wellhead assemblies and rod pumps	VOC
Pneumatic Devices	Fugitive emissions from pneumatic devices used during well exploration and production	VOC
Fugitive Emissions (Equipment Leaks)	Fugitive emissions from pumps and piping components	VOC
Artificial Lift Engines (Pumpjack Engines)	Combustion emissions from artificial lift engines associated with oil production	SO_2, NO_x, VOC, PM, CO
Heaters and Boilers	Emissions from natural gas-fired heaters and boilers	SO_2, NO_x, VOC, PM, CO
Dehydrators	Emissions from glycol dehydrator still vents and reboilers	VOC, Benzene, Toluene, Ethylbenzene, Xylene
Storage Tanks	Working, breathing, and flashing losses from oil and condensate storage tanks	VOC
Oil and Condensate Loading Racks	Fugitive emissions from truck and/or railcar loading	VOC
Compressor Engines	Combustion emissions from compressor engines associated with oil and gas production	SO_2, NO_x, VOC, PM, CO, Formaldehyde
Turbines	Combustion emissions from turbines associated with oil and gas production	SO_2, NO_x, VOC, PM, CO

Table 2. Assignment of SCCs to Texas Oil and Gas Sources[a]

SCC	Tier Description	Short Description
2270010010	OTHER OIL FIELD EQUIPMENT	DIESEL: INDUSTRIAL EQUIPMENT: OTHER OIL FIELD EQUIPMENT (DRILLING RIGS)
2310000000	TOTAL: ALL PROCESSES	OIL & GAS EXPLORATION AND PRODUCTION ALL PROCESSES
2310000330	ARTIFICIAL LIFT	OIL AND GAS EXPLORATION AND PRODUCTION ARTIFICIAL LIFT
2310001000	TOTAL: ALL PROCESSES	ON SHORE OIL & GAS EXPLORATION & PRODUCTION ALL PROCESSES
2310010000	TOTAL: ALL PROCESSES	CRUDE OIL PRODUCTION ALL PROCESSES
2310010100	OIL WELL HEATERS	OIL PRODUCTION WELL HEATERS
2310010200	TANKS - FLASHING & STANDING/ WORKING/ BREATHING	OIL PRODUCTION TANKS INCLUDING FLASHING
2310010300	PNEUMATIC DEVICES	OIL PRODUCTION PNEUMATIC DEVICES
2310010700	OIL WELL FUGITIVES	OIL AND GAS EXPLORATION AND PRODUCTION OIL WELL FUGITIVES
2310010800	OIL WELL TRUCK LOADING	OIL AND GAS EXPLORATION AND PRODUCTION OIL WELL TRUCK LOADING
2310011000	TOTAL: ALL PROCESSES	ON SHORE CRUDE OIL PRODUCTION ALL PROCESSES
2310011020	STORAGE TANKS: CRUDE OIL	ON SHORE OIL PRODUCTION CRUDE TANKS
2310011100	HEATER TREATER	ON SHORE OIL PRODUCTION HEATER TREATER
2310011201	TANK TRUCK/RAILCAR LOADING: CRUDE OIL	ON SHORE OIL PRODUCTION TRUCK/RAIL LOADING OF CRUDE
2310011450	WELLHEAD	ON SHORE OIL PRODUCTION WELLHEAD
2310011500	FUGITIVES: ALL PROCESSES	ON SHORE OIL PRODUCTION FUGITIVES ALL PROCESSES
2310011501	FUGITIVES: CONNECTORS	ON SHORE OIL PRODUCTION FUGITIVES CONNECTORS
2310011502	FUGITIVES: FLANGES	ON SHORE OIL PRODUCTION FUGITIVES FLANGES
2310011503	FUGITIVES: OPEN ENDED LINES	ON SHORE OIL PRODUCTION FUGITIVES OPEN ENDED LINES
2310011504	FUGITIVES: PUMPS	ON SHORE OIL PRODUCTION FUGITIVES PUMPS
2310011505	FUGITIVES: VALVES	ON SHORE OIL PRODUCTION FUGITIVES VALVES
2310011506	FUGITIVES: OTHER	ON SHORE OIL PRODUCTION FUGITIVES OTHER
2310020000	TOTAL: ALL PROCESSES	NATURAL GAS EXPLORATION AND PRODUCTION: ALL PROCESSES
2310020309	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES: ALL	ON-SHORE GAS PRODUCTION 4CYCLE RICH BURN COMPRESSORS
2310020600	COMPRESSOR ENGINES	GAS PRODUCTION COMPRESSOR ENGINES (FOR WRAP USE)
2310020700	GAS WELL FUGITIVES	NATURAL GAS PRODUCTION GAS WELL FUGITIVES
2310020800	GAS WELL TRUCK LOADING	NATURAL GAS PRODUCTION GAS WELL TRUCK LOADING

SCC	Tier Description	Short Description
2310021000	TOTAL: ALL PROCESSES	ON SHORE GAS PRODUCTION: ALL PROCESSES
2310021010	STORAGE TANKS: CONDENSATE	ON-SHORE GAS PRODUCTION: STORAGE TANKS: CONDENSATE
2310021030	TANK TRUCK/RAILCAR LOADING CONDENSATE	ON SHORE GAS PRODUCTION TRUCK AND RAIL LOADING OF CONDENSATE
2310021100	GAS WELL HEATERS	ON-SHORE GAS PRODUCTION HEATERS
2310021101	NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES <50 HP	ON-SHORE GAS PRODUCTION: NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES <50 HP
2310021102	NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES 50 TO 499 HP	ON-SHORE GAS PRODUCTION: NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES 50 TO 499 HP
2310021103	NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES 500+ HP	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES 500+ HP
2310021109	NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES: ALL	ON-SHORE GAS PRODUCTION: NATURAL GAS FIRED 2-CYCLE LEAN BURN COMPRESSOR ENGINES: ALL
2310021201	NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES <50 HP	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES <50 HP
2310021202	NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES 50-499HP	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES 50 HP - 499 HP
2310021203	NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES 500+ HP	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES 500+ HP
2310021209	NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE LEAN BURN COMPRESSOR ENGINES
2310021300	GAS WELL PNEUMATIC DEVICES	ON-SHORE GAS PRODUCTION PNEUMATIC DEVICES
2310021301	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES <50 HP	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES <50 HP
2310021302	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES 50 TO 499HP	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES 50 TO 499 HP
2310021303	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES 500+ HP	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES 500+ HP
2310021400	GAS WELL DEHYDRATORS	ON-SHORE GAS PRODUCTION DEHYDRATORS
2310021401	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES <50 HP W/ NSCR	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENG. <50HP W/ NON SPECIFIC CATALYTIC REDUCTION
2310021402	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES 50-499HP W/ NSCR	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENG. 50-499HP W/ NON SPECIFIC CATALYTIC REDUCTION

SCC	Tier Description	Short Description
2310021403	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES 500+ HP W/ NSCR	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENG. 500+ HP W/ NON SPECIFIC CATALYTIC REDUCTION
2310021409	NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES W/NSCR: ALL	ON-SHORE GAS PRODUCTION NATURAL GAS FIRED 4-CYCLE RICH BURN COMPRESSOR ENGINES WITH NON-SPECIFIC CATALYTIC REDUCTION: ALL
2310021450	WELLHEAD	ON-SHORE GAS PRODUCTION: WELLHEAD
2310021500	GAS WELL COMPLETION - FLARING & VENTING	ON SHORE GAS PRODUCTION WELL COMPLETION - FLARING AND VENTING
2310021501	FUGITIVES: CONNECTORS	ON-SHORE GAS PRODUCTION: FUGITIVES: CONNECTORS
2310021502	FUGITIVES: FLANGES	ON-SHORE GAS PRODUCTION: FUGITIVES: FLANGES
2310021503	FUGITIVES: OPEN ENDED LINES	ON-SHORE GAS PRODUCTION: FUGITIVES: OPEN ENDED LINES
2310021504	FUGITIVES: PUMPS	ON-SHORE GAS PRODUCTION: FUGITIVES: PUMPS
2310021505	FUGITIVES: VALVES	ON-SHORE GAS PRODUCTION: FUGITIVES: VALVES
2310021506	FUGITIVES: OTHER	ON-SHORE GAS PRODUCTION: FUGITIVES: OTHER
2310021509	FUGITIVES: ALL PROCESSES	ON-SHORE GAS PRODUCTION: FUGITIVES: ALL PROCESSES
2310021600	GAS WELL VENTING	ON-SHORE GAS PRODUCTION GAS WELL VENTING
2310030000	TOTAL: ALL PROCESSES	OIL AND GAS EXPLORATION AND PRODUCTION: NATURAL GAS LIQUIDS
2310030210	TANKS - FLASHING & STANDING/ WORKING/ BREATHING, UNCONTROLLED	OIL AND GAS PRODUCTION NATURAL GAS LIQUIDS TANKS INCLUDING FLASH UNCONTROLLED
2310030220	TANKS - FLASHING & STANDING/ WORKING/ BREATHING, CONTROLLED	OIL & GAS PRODUCTION NATURAL GAS LIQUIDS TANKS INCLUDING FLASH CONTROLLED
2310031000	TOTAL: ALL PROCESSES	ON-SHORE OIL AND GAS EXPLORATION AND PRODUCTION: NATURAL GAS LIQUIDS
2310111000	ALL PROCESSES	ON-SHORE OIL EXPLORATION: ALL PROCESSES
2310111401	OIL WELL PNEUMATIC PUMPS	ON-SHORE OIL EXPLORATION: OIL WELL PNEUMATIC PUMPS
2310111700	OIL WELL COMPLETION: ALL PROCESSES	ON-SHORE OIL EXPLORATION: OIL WELL COMPLETION: ALL PROCESSES
2310111701	OIL WELL COMPLETION: FLARING	ON-SHORE OIL EXPLORATION: OIL WELL COMPLETION: FLARING
2310111702	OIL WELL COMPLETION: VENTING	ON-SHORE OIL EXPLORATION: OIL WELL COMPLETION: VENTING
2310121000	ALL PROCESSES	ON-SHORE GAS EXPLORATION: ALL PROCESSES
2310121401	GAS WELL PNEUMATIC PUMPS	ON-SHORE GAS EXPLORATION: GAS WELL PNEUMATIC PUMPS
2310121700	GAS WELL COMPLETION: ALL PROCESSES	ON-SHORE GAS EXPLORATION: GAS WELL COMPLETION: ALL PROCESSES
2310121701	GAS WELL COMPLETION: FLARING	ON-SHORE GAS EXPLORATION: GAS WELL COMPLETION: FLARING

SCC	Tier Description	Short Description
2310121702	GAS WELL COMPLETION: VENTING	ON-SHORE GAS EXPLORATION: GAS WELL COMPLETION: VENTING

[a] SCCs were obtained from TCEQ.

3.0 Source Types

3.1 Well Completions

Following drilling and casing, a well must be "completed." Completion is the process which enables the well to produce oil or gas. To complete the production well, casing is installed and cemented and the drilling rig is removed from the site. As the well is completed, an initial mixture of gas, hydrocarbon liquids, water, sand, and other materials comes to the surface. Standard practice during the completion process has been to vent or flare the natural gas released, some of which is VOC. This category addresses VOC emissions associated with the completion process at oil and gas wells. County-level emissions from this source will be estimated for the purpose of this inventory.

3.1.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from well completions. The relevant sources reviewed are listed in Table 3.1.

Table 3.1 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Well Completion Emissions Estimates

Report Title	Geographic Coverage	Publication Date
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin (Bar-Ilan, et al., 2009a)	Piceance Basin, Colorado	January, 2009
Development of Emissions Inventories for Natural Gas Exploration and Product Activities in the Haynesville Shale (Grant, et al., 2009)	Haynesville Shale, Texas	August, 2009

3.1.2 Emission estimation approaches

The reviewed literature provided component-based approaches for estimating releases from well completions/recompletions. One component-based method is utilized in several studies including the 2008 CENRAP study "Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories" (Bar-Ilan, et al. 2008), "Development of Emissions Inventories for Natural Gas Exploration and Product Activities in the Haynesville Shale" (Grant, et al., 2009) and the "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin" (Bar-Ilan, et al., 2009a). These studies estimate the emissions per completion event based on the volume of vented gas per completion and the mass fraction of the given pollutant in the venting gas. This value is multiplied by the number completion events and takes into account destruction of a portion of the pollutant based on flaring or other “green” completion methods (methods by which emissions are minimized during well completion through capture and/or destruction of the vented gases). The “Emissions from Oil and Gas Production Facilities” (TCEQ, 2007) study uses U.S. Environmental Protection Agency’s (EPA’s) AP-42 emissions factors for CO and NO_x emissions and uses a displacement equation (mass balance approach) to estimate SO_2 and VOC emissions. Emissions are then calculated by multiplying this emissions factor by the number of completions, and the mass fraction of the given pollutant in the vented gas. The latter data may be collected via industry surveys.

3.1.3 Preferred emission estimation approach

As a preferred method to estimate emissions from well completions, ERG will use the methodology from the Central Regional Air Planning Association (CENRAP) study.

Emissions from well completions will be estimated on the basis of the volume of gas vented during completion and the average VOC content of that gas, obtained from a gas composition analyses. Emissions rates are evaluated at standard temperature and pressure (STP) in the CENRAP study. Data on the operating temperature and pressure will be collected via survey and emissions will be adjusted for the appropriate operating parameters.

The calculation methodology for completion emissions follows Equations 1 and 2:

$$E_{completion,i} = \left(\frac{P \times (V_{vented})}{(R / MW_{gas}) \times T \times 3.5 \times 10 - 5} \right) \times \frac{f_i}{907200} \qquad \text{Equation (1)}$$

where:

$E_{completion,i}$ is the emissions of pollutant *i* from a single completion event [ton/event]
P is atmospheric pressure [1 atm]
V_{vented} is the volume of vented gas per completion [MCF/event]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 K]
f_i is the mass fraction of pollutant *i* in the vented gas

The total emissions from all completions occurring in a county can be evaluated following Equation 2:

$$E_{completion,TOTAL} = E_{completion,i} \times S_{county} \times \left(1 - 0.98c_{flare} - c_{green}\right) \qquad \text{Equation (2)}$$

where:

$E_{completion,TOTAL}$ are the total emissions county-wide from completions [tons/year]
$E_{completion,i}$ are the completion emissions from a single completion event [tons/event]
c_{flare} is the fraction of completions in the basin controlled by flares

c_{green} is the fraction of completions in the basin controlled by green completion techniques
S_{county} is the county-wide new well and recompleted well count

Volume of vented gas per completion, V_{vented}:
The 2008 CENRAP study obtained basin-level vented gas volumes from survey data. ERG will attempt to obtain estimates for the volume of vented gas per completion by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the Texas Railroad Commission (TRC) District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average volume vented presented in the 2008 CENRAP study. The CENRAP data can also be used as a QA check to ensure that results from the survey are reasonable.

Mass fraction for a single pollutant, f_i:
The 2008 CENRAP study obtained basin-level mass fractions for various pollutants from survey data. Where survey data were not available for a specific basin, the average of all CENRAP basins was used. ERG will attempt to obtain estimates for the mass fraction of pollutants by conducting a survey of oil and gas. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average mass fractions of pollutants presented in the 2008 CENRAP study. The CENRAP data can also be used as a QA check to ensure that results from the survey are reasonable.

Number of completions controlled by flares, c_{flare} and the number of green completions, c_{green}:
The 2008 CENRAP study obtained basin-level estimates for the number of completions controlled by flares and the number of completions controlled by green completion techniques from survey data. ERG will attempt to obtain estimates for the number of completions controlled by flares or green completions either by conducting a survey of oil and gas producers, or from existing data from the TRC. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide.

County-level new/recompleted well count, S_{county}:
ERG will obtain county-level data for the number of new and recompleted wells from the TRC for each county included in this analysis.

3.1.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level data on the number of well completions, volume of vented gas per completion, oil and gas product composition, and number of completions controlled by flares or controlled by green completion techniques, and the number of active oil and gas wells are required. ERG will collect data on the number of oil and gas well completions per county using the most recently available database from the TRC. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active wells in the Texas counties covered in this emissions inventory development effort.

3.2 Well Blowdowns

Well blowdowns refer to the practice of venting gas from wells that have developed some kind of cap or obstruction before any additional intervention work can be done on the wells. Typically, well blowdowns are conducted on wells that have been shut in for a period of time and the operator desires to bring the well back into production. Well blowdowns are also sometimes conducted to remove fluid caps that have built up in producing gas wells. Because gas is directly vented from the blowdown event, blowdowns can be a source of VOC emissions. County-level emissions from this source will be estimated for the purpose of this inventory.

3.2.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from well blowdowns. The relevant sources reviewed are listed in Table 3.2.

Table 3.2 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Well Blowdown Emissions Estimates

Report Title	Geographic Coverage	Publication Date
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin (Bar-Ilan, et al., 2009a)	Piceance Basin, Colorado	January, 2009
Development of Emissions Inventories for Natural Gas Exploration and Product Activities in the Haynesville Shale (Grant, et al., 2009)	Haynesville Shale, Texas	August, 2009

3.2.2 Emission estimation approaches

The reviewed literature provided component-based approaches for estimating releases from well blowdowns. One component-based method is utilized in several studies including the 2008 CENRAP study "Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories" (Bar-Ilan, et al. 2008), "Development of Emissions Inventories for Natural Gas Exploration and Product Activities in the Haynesville Shale" (Grant, et al., 2009) and the "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin" (Bar-Ilan, et al., 2009a). Emissions from blowdowns are estimated on the basis of the volume of gas vented during a blowdown and the average pollutant content of that gas, obtained from gas composition analyses. This methodology is very similar to that of completion venting. Flaring and/or green practices may be used to control emissions from the blowdown process.

The previous ERG study, “Emissions from Oil and Gas Production Facilities” (TCEQ, 2007), did not estimate emissions from well blowdowns.

3.2.3 Preferred emission estimation approach

As a preferred method, ERG will use the methodology from the CENRAP study to generate estimated emissions from well blowdowns.

Emissions from well blowdowns will be estimated on the basis of the volume of gas vented during blowdown and the average VOC content of that gas, obtained from a gas composition analyses. Emissions rates are evaluated at STP in the CENRAP study. Data on the operating temperature and pressure will be collected via survey and emissions will be adjusted for the appropriate operating parameters.

The calculation methodology for blowdown emissions is identical to the method for completion emissions, and follows Equations 3 and 4:

$$E_{blowdown,i} = \left(\frac{P \times (V_{vented})}{(R / MW_{gas}) \times T \times 3.5 \times 10 - 5} \right) \times \frac{f_i}{907200} \qquad \text{Equation (3)}$$

where:

$E_{completion,i}$ is the emissions of pollutant i from a single blowdown event [ton/event]
P is atmospheric pressure [1 atm]
V_{vented} is the volume of vented gas per blowdown [MCF/event]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 K]
f_i is the mass fraction of pollutant i in the vented gas

The total emissions from all blowdowns occurring in a county can be evaluated following Equation 4:

$$E_{blowdown,TOTAL} = E_{blowdown,i} \times N_{blowdown} \times N_{wells} \times \left(1 - 0.98 c_{flare} - c_{green}\right) \qquad \text{Equation (4)}$$

where:

$E_{blowdown,TOTAL}$ are the total emissions county-wide from blowdowns [tons/year]
$E_{blowdown,i}$ are the blowdown emissions from a single blowdown event [tons/event]
$N_{blowdown}$ is the number of blowdowns per well in the county
N_{wells} is the total number of active wells in the county
c_{flare} is the fraction of blowdowns in the basin controlled by flares
c_{green} is the fraction of blowdowns in the basin controlled by green completion techniques

Volume of vented gas per blowdown, V_{vented}:

The 2008 CENRAP study obtained basin-level vented gas volumes from survey data. ERG will attempt to obtain estimates for the volume of vented gas per blowdown by conducting a survey of oil and gas producers. In the event that insufficient data is collected on a particular county, ERG will use the average of all other counties. If insufficient data is collected on all counties, ERG may default to the average volume vented presented in the 2008 CENRAP study. The CENRAP data can also be used as a Quality Assurance (QA) check to ensure that results from the survey are reasonable.

Mass fraction for a single pollutant, f_i:

The 2008 CENRAP study obtained basin-level mass fractions for various pollutants from survey data. Where survey data was not available for a specific basin, the average of all CENRAP basins was used. ERG will attempt to obtain estimates for the mass fraction of pollutants by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average mass fractions of pollutants presented in the 2008 CENRAP study. The CENRAP data can also be used as a QA check to ensure that results from the survey are reasonable.

County-level number of blowdowns per well, $N_{blowdown}$:

The 2008 CENRAP study obtained basin-level number of blowdowns from survey data. ERG will attempt to obtain estimates for the number of blowdowns per county by conducting a survey of oil and gas producers. In the event that insufficient data is collected on a particular county, ERG will use the average of all other counties. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average mass fractions of pollutants presented in the 2008 CENRAP study. The CENRAP data can also be used as a QA check to ensure that results from the survey are reasonable.

County-level well count, N_{wells}:

The 2008 CENRAP study obtained basin-level number of wells from survey data. ERG will attempt to obtain estimates for the number of wells per county by conducting a survey of oil and gas producers. In the event that insufficient data is collected on a particular county, ERG will use the average of all other counties. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average mass fractions of pollutants presented in the 2008 CENRAP study. The CENRAP data can also be used as a QA check to ensure that results from the survey are reasonable.

Number of blowdowns controlled by flares, c_{flare} and the number of green blowdowns, c_{green}:

The 2008 CENRAP study obtained basin-level estimates for the number of blowdowns controlled by flares and the number of blowdowns controlled by green techniques from survey data. ERG will attempt to obtain county-level estimates for the number of blowdowns controlled by flares or green blowdown methods either by conducting a survey of oil and gas producers, or from existing data from the TRC. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide.

3.2.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level data on the number of well blowdowns, volume of vented gas per blowdown, oil and gas product composition, and number of blowdowns controlled by flares or controlled by green techniques, and the number of active oil and gas wells are required. ERG will collect data on the number of oil and gas wells per county using the most recently available database from the TRC. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active wells in the Texas counties covered in this emissions inventory development effort.

3.3 Wellheads

The wellhead is the part of an oil or gas well that terminates at the surface and is the location where oil or gas products can be withdrawn. The primary function of the wellhead is to hold the casings and the production tubing of the well. On top of the wellhead sits the tubing hanger, from which the production tubing is run. The well christmas tree rests on top of the tubing hanger, as well as surface flow-control facilities used in the production phase of the well. The wellhead is a source of VOC emissions from various fugitive outlets including seals and joints. County-level emissions from this source will be estimated for the purpose of this inventory.

3.3.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from emissions generated at oil and gas wellheads. The relevant sources reviewed are listed in Table 3.3.

Table 3.3 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Wellhead Emissions Estimates

Report Title	Geographic Coverage	Publication Date
Oil and Gas Emission Inventories for the Western States (Russell, et al., 2005)	WRAP States	December, 2005
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007

3.3.2 Emission estimation approaches

The reviewed literature provided two similar approaches to estimate emissions from wellheads at oil and gas sites. The first of these approaches is presented in the study: “Oil and Gas Emission Inventories for the Western States” (Russell, et al., 2005), which uses oil and gas production data along with emission factors for various wellhead sources to determine wellhead emissions. These sources include: tanks, dehydrators, heaters, completions, and pneumatic devices.

Emissions from all of these sources are discussed elsewhere in this report. The "Emissions from Oil and Gas Production Facilities" (TCEQ, 2007) study uses AP-42 emission factors for oil and gas facilities to determine wellhead emissions from wellhead assemblies and rod pumps. Other reviewed sources did not provide wellhead emissions calculation methodologies.

3.3.3 Preferred emission estimation approach

As a preferred method to estimate emissions from wellheads, ERG will use the AP-42 emission factor to calculate emissions from oil and gas wellheads, based on the number of oil and gas wellheads in place. The AP-42 emission factor for VOC emissions from gas wellheads is based on gas production. Gas production data by county in Texas is also available from the TRC. However, additional emission methodologies may be developed if additional sources are located.

3.3.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level data on the number of oil wellheads and gas production are required. ERG will collect data on the number of oil wellheads and gas production wellhead sites per county using the most recently available database from the TRC.

3.4 Pneumatic Devices

Pneumatic devices are used for a variety of gas and oil well processes and are powered by high-pressure produced gas. These devices include transducers, liquid level controllers, pressure controllers and positioners. During the normal operation of these devices, they release or bleed natural gas to the atmosphere making them a source of VOC emissions. County-level emissions from these sources will be estimated for the purpose of this inventory.

3.4.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from emissions generated by pneumatic devices typically utilized at oil and natural gas production wells. The relevant sources reviewed are listed in Table 3.4.

Table 3.4 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Pneumatic Device Emissions Estimates

Report Title	Geographic Coverage	Publication Date
Oil and Gas Emission Inventories for the Western States (Russell, et al., 2005)	WRAP States	December, 2005
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007

Table 3.4 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Pneumatic Device Emissions Estimates (Cont.)

Report Title	Geographic Coverage	Publication Date
WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II (Bar-Ilan, et al., 2007)	WRAP States	September, 2007
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin (Bar-Ilan, et al., 2009a)	Piceance Basin, Colorado	January, 2009

3.4.2 Emission estimation approaches

The reviewed literature provided two similar approaches with different bases to estimate emissions from pneumatic devices at oil and gas sites. The first of these approaches is presented in the Western Regional Air Partnership (WRAP) Phase I (Russell, et al., 2005) and WRAP Phase II (Bar-Ilan, et al., 2007) reports which utilize separate emissions factors for oil wells and gas wells provided by the Wyoming Department of Environmental Quality (WYDEQ). The emissions factors for VOC and Hazardous Air Pollutants (HAPs) from pumps are given on a per well basis (tons/yr/well) and are calculated based on an average usage/bleed rate of 5 scf/hr, statewide average weighted gas compositions, continuous operation, and an assumption of two pumps per gas well and one pump per oil well. Area-wide emissions are then calculated based on the number of gas wells and oil wells currently active in a specific area. This approach was also adopted in the 2007 TCEQ report on emissions from oil and gas production facilities. However, the emissions factors were recalculated using weight percents provided in a 2004 report from the Gas Processors Association (GPA).

An alternative approach is presented in both the 2008 CENRAP study "Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories" (Bar-Ilan, et al. 2008) and "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin" (Bar-Ilan, et al., 2009a). The same calculation approach is used in this method; however, this method uses bleed rates obtained from the results of an extensive study performed by EPA as part of the Natural Gas Star program in 2004. This study provides bleed rate estimates for several different device types – liquid level controllers, positioners, pressure controllers, and transducers. This approach also conducted a survey to estimate the number of each device type present at typical gas and oil well sites. Given the additional level of detail presented with this approach, it will be the preferred approach for estimating emissions from pneumatic devices.

3.4.3 Preferred emission estimation approach

As a preferred method to estimate emissions from pneumatic devices, ERG will use the CENRAP methodology.

Emissions from a single well site are calculated using Equation 5:

$$E_{pneumatic,j} = \frac{f_j}{907200}\left(\sum_i V_i \times N_i \times t_{annual}\right) \times \frac{P}{\left(\frac{R}{MW_{gas}}\right) \times T \times 3.5 \times 10^{-5}} \qquad \text{Equation (5)}$$

where:

$E_{pneumatic,j}$ is the total emissions of pollutant j from all pneumatic devices for a typical well [ton/year/well]
V_i is the volumetric bleed rate from device i [scf/hr/device]
N_i is the total number of device i owned by the participating companies
t_{annual} is the number of hours per year that devices are operating
P is the atmospheric pressure [1 atm]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]
T is the atmospheric temperature [298 K]
f_j is the mass fraction of pollutant j in the vented gas

County-wide emissions are calculated using Equation 6:

$$E_{pneumatic,TOTAL} = E_{pneumatic,j} \times N_{well} \qquad \text{Equation (6)}$$

where:

$E_{pneumatic,TOTAL}$ is the total pneumatic device emissions in the county [ton/yr]
$E_{pneumatic,j}$ is the pneumatic device emissions for a single well of pollutant j [ton/yr]
N_{well} is the total number of active wells in the county for a given year

Emissions rates are evaluated at STP in the CENRAP study. Data on the operating temperature and pressure will be collected via survey and emissions will be adjusted for the appropriate operating parameters.

Volumetric bleed rate from device i, V_i:
The 2008 CENRAP study uses bleed rates for various devices presented in a 2004 EPA Natural Gas Star program study. ERG will also use the bleed rates from the EPA Natural Gas Star program study when calculating emissions from pneumatic devices at oil and gas production sites.

Total number of devices, N_i:
The 2008 CENRAP study obtained basin-level total number of devices per well from survey data. Where survey data was not available for a specific basin, the average of all CENRAP

basins was used. ERG will attempt to obtain estimates for the number of devices per well by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average of number of devices for each type presented in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Number of hours per year that devices are operating, t_{annual}:
The 2008 CENRAP study assumed basin-level annual hours of device operation to be 8760 hr/yr (non-stop operation). ERG will attempt to obtain estimates for the annual hours of device operation by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to a value of 8760 hr/yr assumed in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Molecular weight of gas, MW_{gas}:
The 2008 CENRAP study obtained basin-level molecular weights of gas bleeding from survey data. ERG will attempt to obtain data on the molecular weights by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average of the molecular weights in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Mass fraction of pollutant j in the vented gas, f_j:
The 2008 CENRAP study obtained basin-level mass fractions from survey data. ERG will attempt to obtain estimates for the mass fractions of pollutants by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the compositions presented in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

3.4.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level data on the number of devices per well, annual hours of device operation, oil and gas product composition and molecular weight, and number of active oil and gas wells are required. ERG will collect data on the number of oil and gas wells per county using the most recently available database from the TRC. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active wells in the Texas counties covered in this emissions inventory development effort.

3.5 Fugitive Emissions (Equipment Leaks)

All oil and gas producing sites have a system of pumps and piping to transport oil and gas from the wellhead to the processing area. These pumps and piping networks are constructed with many individual components including flanges, valves, seals, and connectors. As a result of high operating pressures, varying fitting tightness, and age and condition, each of these components has the potential to release fugitive emissions while oil and gas product flows through them. County-level emissions from these sources will be estimated for the purpose of this inventory.

3.5.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from fugitive emissions generated by non-point source equipment and components typically utilized at oil and natural gas production wells. The relevant sources reviewed are listed in Table 3.5.

Table 3.5 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Fugitive Emissions Estimates

Report Title	Geographic Coverage	Publication Date
Ozone Precursors Emissions Inventory for San Juan and Rio Arriba Counties, New Mexico (Pollack, et al., 2006)	San Juan and Rio Arriba Counties, New Mexico	August, 2006
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin (Bar-Ilan, et al., 2009a)	Piceance Basin, Colorado	January, 2009

3.5.2 Emission estimation approaches

The reviewed literature sources all provided a similar approach for estimating fugitive emissions from equipment leaks. This method estimates emissions using component-based emissions factors. The component-based method uses EPA's AP-42 emissions factors for each component type based on the type of service to which the equipment applies – gas, light liquid, heavy liquid, or water. Emissions are then calculated by multiplying this emissions factor by the number of components per well, the annual number of hours the well is in operation, and the mass fraction of the given pollutant in the vented gas. The latter data were collected via industry surveys. These well-based emissions are then multiplied by the number of wells for a given area. The 2007 TCEQ study uses emissions factors developed by the American Petroleum Institute (API), and the number of components per well was obtained from a study conducted by the Canadian Association of Petroleum Producers (CAPP).

The component-based method applies to both oil and gas producing wells. If sufficient data on the number of components at each well site can be obtained, performing a component-based analysis will allow for the most comprehensive estimates for fugitive releases.

3.5.3 Preferred emission estimation approach

As a preferred method to estimate fugitive emissions from equipment leaks, ERG will use the CENRAP methodology.

Fugitive emissions from a single well site may be calculated using Equation 7:

$$E_{fugitive,j} = \sum_{i} EF_i \times N_i \times t_{annual} \times Y_j \times 0.0011 \qquad \text{Equation (7)}$$

where:

$E_{fugitive,j}$ is the fugitive emissions for a single typical well for pollutant j [ton/yr/well]
EF_i is the emission factor of TOC for a single component i [kg/hr/component]
N_i is the total number of components of type i
t_{annual} is the annual number of hours the well is in operation [hr/yr]
Y_j is the mass fraction of pollutant j to TOC in the vented gas

County-wide fugitive emissions are calculated using Equation 8:

$$E_{fugitive,TOTAL} = E_{fugitive,j} \times N_{well} \qquad \text{Equation (8)}$$

where:

$E_{fugitive,TOTAL}$ is the total fugitive emission in the county [ton/yr]
$E_{fugitive,j}$ is the fugitive emissions for a single well of pollutant j [ton/yr]
N_{well} is the total number of active wells in the county for a given year

Emissions rates are evaluated at STP in the CENRAP study. Data on the operating temperature and pressure will be collected via survey and emissions will be adjusted for the appropriate operating parameters.

Emission factor of TOC for a single component, EF_i:
ERG will use EPA's AP-42 emissions factors when calculating fugitive emissions from equipment leaks at oil and gas production sites.

Total number of components, N_i:
The 2008 CENRAP study obtained basin-level total number of components per well from survey data. Where survey data was not available for a specific basin, the average of all CENRAP basins was used. ERG will attempt to obtain estimates for the number of components per well by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-

wide. If insufficient data is collected on all counties, ERG may default to the average number of components for each service type presented in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Annual number of hours the well is in operation, t_{annual}:
The 2008 CENRAP study assumed basin-level annual hours of well operation to be 8760 hr/yr (non-stop operation). ERG will attempt to obtain estimates for the annual hours of well operation by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to a value of 8760 hr/yr assumed in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Mass fraction of pollutant j to TOC in the vented gas, Y_j:
The 2008 CENRAP study obtained basin-level mass fractions from survey data. ERG will attempt to obtain estimates for the mass fractions of pollutants by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the compositions presented in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

3.5.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level data on the number of components per well, annual hours of well operation, oil and gas product composition, and number of active oil and gas wells are required. ERG will collect data on the number of oil and gas wells per county using the most recently available database from the TRC. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active wells in the Texas counties covered in this emissions inventory development effort.

3.6 Artificial Lift (Pumpjack) Engines

A pumpjack is used to mechanically lift liquid out of the well if there is not enough bottom hole pressure for the liquid to flow all the way to the surface. The pumpjack can be driven by an electric motor; however, in isolated locations without access to electricity, combustion engines are used. The most common "off-grid" pumpjack engines run on casing gas produced from the well, but pumpjacks have been run on many types of fuel, such as propane (LPG) and diesel. Generally, pumpjacks have smaller engines than wellhead compressor engines, but they operate continuously (8760 hours per year) with minimum down-time. For this project, criteria pollutant emissions from pumpjack engines will be estimated.

3.6.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from artificial lift pumpjack engines. The relevant sources reviewed are listed in Table 3.6.

Table 3.6 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Artificial Lift (Pumpjack) Engines

Report Title	Geographic Coverage	Publication Date
Natural Gas Compressor Engine Survey and Engine NOx Emissions at Gas Production Facilities (HARC, 2005)	Eastern Portion of Texas	August, 2005
Ozone Precursors Emission Inventory for San Juan and Rio Arriba Counties, New Mexico (Pollack, et al., 2006)	San Juan and Rio Arriba Counties, New Mexico	August, 2006
Natural Gas Compressor Engine Survey for Gas Production and Processing Facilities (HARC, 2006)	Eastern Portion of Texas	October, 2006
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008

3.6.2 Emission estimation approaches

Of the studies reviewed, there was basically only one methodology used in determining emissions from pumpjack engines. The 2008 study conducted by ENIRON entitled: "Recommendations for Improvements to the CENRAP States' Oil and Gas Emission Inventories" (Bar-Ilan, et al., 2008), applies pollutant specific emission factors (g/hp-hr) to various data gathered from an inventory of artificial lift engines (based off of surveyed companies). The data consisted of engine specific information including horsepower, load factors, and actual hours operated. The emissions were scaled up to the basin level on the basis of well counts and then scaled to county-level using the fraction of total oil production from oil wells located in each county. All engine emissions factors (except those for SO_2) were obtained from the EPA's NONROAD model (EPA, 2005), which contains default emissions factors for an artificial lift natural gas fired engine. A similar methodology was used to calculate emissions from artificial pumpjack engines in the 2006 study entitled: "Ozone Precursors Emission Inventory for San Juan and Rio Arriba Counties, New Mexico" (Pollack, et al., 2006). However, the emission factors used in the 2006 New Mexico study were based on survey data of specific engine types/categories and their manufacturers' emission rates instead of the EPA's NONROAD model. The specific methodology from these two studies is discussed in Section 3.6.3.

As an alternative to the methodology used in the CENRAP 2008 and the 2006 New Mexico studies, ERG explored the idea of applying the methodology we have proposed for estimating emissions from compressor engines (see Section 3.11) to determine emissions from pumpjack engines. We believe this approach would be optimal when calculating pumpjack emissions at the county level because it would not require knowing the specific count of pumpjack engines, nor their individual sizes. However, the approach would require ERG to develop power-to-pump requirements (Hp-hr/bbl) which are certain to vary with the depth of the oil in each well and may also depend on other factors such as plunger/equipment variations. ERG will attempt to obtain the required data to implement this methodology (pumpjack engine size, hours of operation, engine loads, well depth, and production data for each well) through the industry survey. Depending upon the response rate to the survey, ERG may be able to proceed with this approach and develop power-to-pump requirements in terms of Hp-hr/bbl based on engine size, hours of operation, and oil production data. At this point, we consider this to be an alternative approach.

3.6.3 Preferred emission estimation approach

ERG will use the methodology from the 2008 CENRAP study to generate estimated emissions from pumpjack engines. The calculation methodology for this particular approach is shown in Equations 9 and 10:

$$E_{engine} = \frac{EF_i \times HP \times LF \times t_{annual}}{907{,}185} \qquad \text{Equation (9)}$$

where:

E_{engine} are emissions from a pumpjack engine [ton/year/engine]
EF_i is the emissions factor of pollutant i [g/hp-hr]
HP is the horsepower of the engine [hp]
LF is the load factor of the engine
t_{annual} is the annual number of hours the engine is used [hr/yr]

County-wide pumpjack engine emissions would then be calculated using Equation (10):

$$E_{engine,TOTAL} = E_{engine} \times W_{TOTAL} \times f_{pumpjack} \times (1 - e_{pumpjack}) \qquad \text{Equation (10)}$$

where:

$E_{engine,TOTAL}$ is the total emissions from pumpjack engines in the county [ton/yr]
E_{engine} is the total emissions from a pumpjack engine [ton/yr]
W_{TOTAL} is the total number of wells in the county
$f_{pumpjack}$ is the fraction of oil wells with pumpjack engines
$e_{pumpjack}$ is the fraction of pumpjack engines that are electrified

3.6.4 Data Needs

ERG will implement the approach used in the 2008 CENRAP study and 2006 New Mexico study to estimate emissions from pumpjack engines. In order to perform the emission calculations, information on engine ratings, load factors, annual hours of engine operation and county-level data of the number of oil wells with and without pumpjack engines is required. ERG will collect data on the number of oil wells per county using the most recently available database from the TRC. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active oil wells in the Texas counties covered in this emissions inventory development effort.

If the industry response is sufficient, ERG may attempt to develop power-to-pump requirements (Hp-hr/bbl) for pumpjack engines to implement the alternative approach.

3.7 Heaters and Boilers

The purpose of heaters and boilers at oil and gas production facilities is to provide thermal energy input to certain operations within the production process. They can be used as separator heaters (heater treaters) to provide heat input to separation units, as tank heaters to maintain storage tank temperatures, or as inline heaters to maintain temperature within pipes and connections. Heaters and boilers may also be used in dehydrators; however, these sources will be covered under the dehydrator source methodology of this report. Heaters and boilers are typically natural gas-fired external combustors. They are primarily considered a source of NO_x, as well as a minor source of CO, VOC and PM emissions. SO_2 emissions may also occur if the gas used to fire the heaters contains Hydrogen Sulfide (H_2S) which will be subsequently converted to SO_2 during combustion. County-level emissions from heater sources will be estimated for the purpose of this inventory.

3.7.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from emissions generated by heaters and boilers typically utilized at oil and natural gas production wells. The relevant sources reviewed are listed in Table 3.7.

Table 3.7 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Heater and Boiler Emissions Estimates

Report Title	Geographic Coverage	Publication Date
Oil and Gas Emission Inventories for the Western States (Russell, et al., 2005)	WRAP States	December, 2005
Ozone Precursors Emission Inventory for San Juan and Rio Arriba Counties, New Mexico (Pollack, et al., 2006)	San Juan and Rio Arriba Counties, New Mexico	August, 2006
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007

Table 3.7 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Heater and Boiler Emissions Estimates (Cont.)

Report Title	Geographic Coverage	Publication Date
WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II (Bar-Ilan, et al., 2007)	WRAP States	September, 2007
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin (Bar-Ilan, et al., 2009a)	Piceance Basin, Colorado	January, 2009

3.7.2 Emission estimation approaches

The reviewed literature provided two different approaches to estimating emissions from heaters and boilers at oil and gas sites. The first of these approaches is presented in the WRAP Phase I report "Oil and Gas Emission Inventories for the Western States" (Russell, et al., 2005) and WRAP Phase II report "WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II" (Bar-Ilan, et al., 2007). This approach will subsequently be referred to as Method 1. Method 1 utilizes separate emissions factors for oil wells and gas wells provided by the WYDEQ. The emissions factors for gas wells are given on a per well basis (lbs/yr per well) and oil well emissions factors are given on a per barrel produced basis (lbs/barrel). Area-wide emissions are then calculated based on the number of gas wells and barrels of oil produced in a specific area. Method 1 was also adopted in the 2007 TCEQ report on emissions from oil and gas production facilities.

An alternative approach to estimate emissions from heaters and boilers was presented in the 2008 CENRAP report "Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories" (Bar-Ilan, et al. 2008) and the Piceance Basin study "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin" (Bar-Ilan, et al., 2009a) from the Independent Petroleum Association of Mountain States (IPMAS)/WRAP Phase III reports. This approach will subsequently be referred to as Method 2. For Method 2, emissions of a particular pollutant from a single heater are based on the emissions factor of the heater, the annual flow rate of gas and the annual operating time of the heater. The gas flow is derived from the rating of the heater and the local natural gas heating value. All emissions factors used were based on EPA's AP-42 emissions factors for natural gas-fired heaters provided under the external combustion sources category. An additional heater cycling fraction factor was also incorporated which takes into account the fraction of operating hours that the heater is actually firing. The 2008 CENRAP report also provides a separate methodology for estimating SO_2 emissions by estimating the mass of gas combusted in the heater using the ideal gas law and then utilizing the mass fraction of H_2S in the gas assuming 100 percent conversion to SO_2. Basin-wide emissions were then estimated by determining the typical number of heaters per well and scaling up by well count. These estimates were then expanded to the county-level by allocating the total basin-wide heater emissions into each county according to the fraction of basin total wells that are located in each county.

Between the two methodologies, Method 2 provides a fundamental, bottom-up approach which allows for emissions to be estimated based on site-specific parameters and results in a more accurate and dynamic emissions inventory for heaters and boilers. Method 1 uses emissions factors which are previously calculated based on industry-wide averages for heater ratings and gas heating values specific to Wyoming, resulting in a lack of flexibility and detail as compared to Method 2. Additionally, Method 2 incorporates a scaling factor based on the number of heaters per well to supplement the scaling factor for the total number of wells. This level of detail is advantageous and allows for an additional layer of data collection when calculating emissions on the county-level. This is not captured in Method 1 which only accounts for the total number of wells.

There are some short-comings with Method 2 that will need to be addressed in the development of this current emissions inventory. Due to lack of detail in the utilized databases, a breakdown of emissions by well type (i.e. oil or gas) was not available. Additionally, county-level emissions were derived from the allocation of basin-wide emissions based on the fraction of wells located in each county. The development of the updated TCEQ emissions inventory will attempt to obtain county-level data by well type in all aspects of the analysis to obtain a more accurate model of emissions from county to county.

3.7.3 Preferred emission estimation approach

As a preferred method to estimate emissions from heaters and boilers, ERG will use the CENRAP methodology.

Emissions from a single heater may be calculated using Equation 11 (excluding SO_2 emissions):

$$E_{heater} = \frac{EF_{heater} \times Q_{heater} \times t_{annual} \times hc}{\left(HV_{local} \times 10^6 \times 2000\right)} \qquad \text{Equation (11)}$$

where:

E_{heater} is the emissions from a given heater [ton/yr]
EF_{heater} is the emission factor for a heater for a given pollutant [lb/MMSCF]
Q_{heater} is the heater MMBTU/hr rating [$\text{MMBTU}_{\text{rated}}$/hr]
HV_{local} is the local natural gas heating value [$\text{MMBTU}_{\text{local}}$/scf]
t_{annual} is the annual hours of operation [hr/yr]
hc is the heater cycling fraction to account for the fraction of operating hours that the heater is firing.

SO_2 emissions from a single heater may be calculated using Equation 12:

$$E_{heater,SO_2} = \frac{2 \times f_{H_2S}}{907200} \times \left(\frac{Q_{heater} \times t_{annual} \times hc}{HV_{local}} \times \frac{P}{\left(\frac{R}{MW_{gas}}\right) \times T \times 0.035} \right) \qquad \text{Equation (12)}$$

where:

$E_{heater,SO2}$ is the SO_2 emissions from a given heater [ton-SO_2/yr]
f_{H2S} is the mass fraction of H_2S in the gas
Q_{heater} is the heater MMBTU/hr rating [$\text{MMBTU}_{\text{rated}}$/hr]
t_{annual} is the annual hours of operation [hr/yr]
hc is the heater cycling fraction to account for the fraction of operating hours that the heater is firing.
HV_{local} is the local natural gas heating value [$\text{MMBTU}_{\text{local}}$/scf]
P is atmospheric pressure [1 atm]
R is the universal gas constant [0.082 L-atm/mol-K]
MW_{gas} is the molecular weight of the gas [g/mol]

The total emissions generated by heaters and boilers from specific county are calculated using Equation 13:

$$E_{heater,TOTAL} = \left(E_{heater} + E_{heater,SO_2}\right) \times N_{heater} \times \frac{W_{TOTAL}}{2000} \qquad \text{Equation (13)}$$

where:

$E_{heater,TOTAL}$ is the total heater emissions in the county [ton/yr]
E_{heater} is the total emissions from a single heater [ton/yr]
$E_{heater,SO2}$ is the total SO_2 emissions from a single heater [ton-SO_2/yr]
W_{TOTAL} is the total number of wells in the county
N_{heater} is the typical number of heaters per well in the county

Emission factor for a heater for a given pollutant, E_{heater}:
ERG will use EPA's AP-42 emissions factors when calculating emissions from heaters and boilers at oil and gas production sites.

Heater MMBTU/hr rating, Q_{heater}:
The 2008 CENRAP study obtained basin-level heater firing rates from survey data. Where survey data was not available for a specific basin, the average of all CENRAP basins was used. ERG will attempt to obtain heater firing rates by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average of the heater firing rate values presented in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Local natural gas heating value, HV_{local}:
The 2008 CENRAP study attempted to collect basin-level local heating values from survey data. However, the responses for the request of the value were insufficient; therefore, the average natural gas heating value from the IPAMS/WRAP Phase III analysis was used. ERG will attempt to obtain local heating values by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the local natural gas heating value presented in the 2008 CENRAP study originally taken from the IPAMS/WRAP Phase III study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Annual hours of operation, t_{annual}:
The 2008 CENRAP study obtained basin-level annual hours of operation for heaters from survey data. ERG will attempt to obtain data on the annual hours of operation for heaters and boilers by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average of the annual operation hours presented in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Heater cycling fraction, hc:
The 2008 CENRAP study obtained basin-level heater cycling fractions from survey data. A heater cycling fraction of 1 was obtained for all responding basins. ERG will attempt to obtain data on the heater cycling fraction by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to a value of 1 as used in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Mass fraction of H_2S, f_{H2S}:
The 2008 CENRAP study obtained basin-level mass fractions of H_2S in the gas used to fire the heaters and boilers from survey data. ERG will attempt to obtain data on the mass fraction of H_2S by conducting a survey of oil and gas producers, or from the TRC. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average of the H_2S mass fractions in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Molecular weight of gas, MW_{gas}:
The 2008 CENRAP study obtained basin-level molecular weights of gas used to fire the heaters and boilers from survey data. ERG will attempt to obtain data on the molecular weights by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average of the molecular weights in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

Typical number of heater per well, N_{heater}:
The 2008 CENRAP study obtained basin-level typical number of heaters per well from survey data. ERG will attempt to obtain data on the number of heaters per well by conducting a survey of oil and gas producers. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide. If insufficient data is collected on all counties, ERG may default to the average of the number of heaters per well in the 2008 CENRAP study. The CENRAP data can also be used as a quality assurance check to ensure that results from the survey are reasonable.

3.7.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level data on the number of heaters and boilers per well, annual hours of heater operation, heater ratings, local natural gas heating values, heater cycling fractions, gas molecular weight and H_2S content, and number of active oil and gas wells are required. ERG will collect data on the number of oil and gas wells per county using the most recently available database from the TRC. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active wells in the Texas counties covered in this emissions inventory development effort.

3.8 Dehydrators

Oil and natural gas, when first pumped from the ground, may contain a mixture of liquid and gaseous organic compounds, nitrogen, carbon dioxide, water, sand, and other impurities. The extracted product is passed through a three-phase separator. The separator allows the water, oil and gas to separate. The gaseous component is then piped to a dehydrator to remove any remaining moisture, improving its quality for sale, and to help prevent corrosion in downstream pipelines.

The most common and economical process for dehydrating natural gas is to contact the gas with a hygroscopic liquid such as one of the glycols. Glycol dehydration is an absorption process, where the water vapor in the gas stream becomes dissolved in a relatively pure stream of glycol liquid solvent, removing the water from the natural gas. This process is completed in an absorption column. After the water is removed from the gas stream, the gas is pumped to a gas transmission pipeline. During the absorption process, the glycol also absorbs some methane and VOC.

After leaving the absorber, the water-rich glycol is de-pressurized. This step is necessary as the absorber is typically operated at high pressure. The pressure must be reduced before the regeneration step. This step may occur in a flash vessel, if the dehydration system is equipped with one, or it may occur in the glycol regenerator vessel. If the water-rich glycol is first fed to a flash vessel, the hydrocarbon vapors are vented and any liquid hydrocarbons are skimmed from the glycol. The de-pressurization step is the primary source of VOC emissions from dehydrator systems.

The glycol is regenerated by boiling the water out of the glycol. The water-rich glycol is pumped into a vented boiler vessel called a glycol regenerator boiler. Heat is added until the temperature of the mixture is greater than 212 degrees (the boiling point of water), but less than 400 degrees (the boiling point of glycol). The regeneration step allows the glycol to be purified and recovered for reuse with minimal loss of glycol. Any VOCs remaining in the glycol are volatized and vented to the atmosphere. The glycol regeneration step involves burning a fuel in a boiler to heat the glycol-water mixture. The combustion results in emissions of NO_X and CO, and small amounts of PM_{10}, SO_2, VOC, and HAPs.

In summary, the two discreet units in a dehydrator system that generate pollutant emissions are the flash vessel (if present) and the glycol regenerator boiler. The flash vessel and glycol regenerator normally vent methane, VOC, and HAP during normal, uncontrolled operation, while the glycol regenerator boiler also has combustion emissions.

3.8.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from dehydrators. The relevant sources reviewed are listed in Table 3.8.

Table 3.8 Existing Oil and Gas Exploration Emissions Studies

Report Title	Geographic Coverage	Publication Date
Oil and Gas Emission Inventories for the Western States (Russell, et al., 2005)	WRAP States	December 2005
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II (Bar-Ilan, et al., 2007)	WRAP States	September, 2007
Development of Baseline 2006 Emissions from Oil and Gas Activity in the South San Juan Basin (Bar-Ilan, et al., 2009b)	New Mexico	November, 2009
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
Development of Emissions Inventories for Natural Gas Exploration and Production Activity in the Haynesville Shale (Grant, et al., 2009)	Haynesville Shale, Texas & Louisiana	August 2009

3.8.2 Emission Estimation Approaches

The reviewed literature provided both component-based and production-based approaches for estimating emissions from dehydrator flash vessels, glycol regenerator vents, and glycol regenerator boilers.

The 2005 WRAP Phase I study "Oil and Gas Emission Inventories for the Western States" (Russell, et al., 2005), the 2007 WRAP Phase II study "WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II" (Bar-Ilan, et al., 2007), and the 2007 TCEQ study "Emissions from Oil and Gas Production Facilities" estimated uncontrolled VOC emissions from dehydrator flash vessels and glycol regenerator vents using a gas production-based emission factor provided by the WYDEQ. The emission factor was multiplied by well-specific gas production figures obtained from the State oil and gas commissions. The Wyoming emission factor was derived by calculating a production-weighted average composition of wet gas for each formation across the state. The weighted average was then used with GlyCalc modeling software to calculate emission factors based on one million standard cubic foot of gas per day (MSCFD). This methodology is not preferred for the 2008 inventory as the emission factor is based on gas composition data from Wyoming.

The 2009 WRAP Phase III study "Development of Baseline 2006 Emissions from Oil and Gas Activity in the South San Juan Basin" (Bar-Ilan, et al., 2009b) utilized a similar approach to estimating emissions from dehydrator flash vessels and glycol regenerator vents as was done in the WRAP Phase I study. Emissions from glycol regenerator boilers were calculated using AP-42 emission factors and the limited data available for field dehydrators to produce an emission factor on a per-unit-of-gas-throughput basis. This emission factor was applied to basin-wide gas production rates to determine basin-wide emissions from the regenerator boilers.

The 2008 CENRAP study "Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories" (Bar-Ilan, et al., 2008) utilized the same approach to estimating emissions as was done in the WRAP Phase III study, except for the Texas basins. For Texas basins, the VOC emissions from dehydrator flash vessels were estimated with GlyCalc software using data on the composition of wellhead gas for each of the basins. This gas composition data were obtained from Northeast Texas Air Care (NETAC) and TCEQ and was based on sampling. This emission factor was applied to all gas production in each basin to derive basin-wide emissions estimates for dehydrator flash vessels and glycol regenerator vents. Emissions from glycol regenerator boilers were calculated using AP-42 emission factors to produce an emission factor on a per-unit of gas throughput basis. This emission factor was applied to all gas production in each basin to derive basin-wide emissions estimates for glycol regenerator boilers. This methodology was also used in the 2009 study "Development of Emissions Inventories for Natural Gas Exploration and Production Activity in the Haynesville Shale" (Grant, et al., 2009) for the East Texas Basin.

The reviewed literature also addressed the effect of dehydrator system control technologies on emissions. The 2007 WRAP Phase II study "WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II" (Bar-Ilan, et al. 2007) evaluated three strategies or technologies for controlling VOC and HAP emissions from dehydrator systems. These are: optimize glycol circulation rate, install electric pumps, and install flash tank separators.

- **Optimizing Glycol Recirculation Rate:** The study determined that VOC emissions could be reduced by 33 to 67 percent by optimizing the glycol circulation rate. Glycol recirculation rate is set for the optimal rate based on the initial rate of gas production at a well. However, the rate is typically not adjusted as the gas production rate declines. As production rates decrease over time, glycol units designed for the original production rates tend to over circulate causing emission increases without significant reduction in gas moisture content.

- **Using Electric Pumps:** The study determined that VOC emissions could be reduced by 67 percent by using electric pumps to move the glycol fluids. Typically, fluids are moved through the glycol dehydration and regeneration system by using the pressurized gas produced at the wellhead. VOC emissions occur when the gas is vented during the regenerator step.
- **Installing a Flash Vessel Separator:** The study determined that VOC emissions could be reduced by 10-40 percent by installing a flash vessel separator on dehydrator systems that do not already incorporate one.

The 2007 WRAP Phase II study "WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II" (Bar-Ilan, et al. 2007) estimated that VOC and HAP emissions could be reduced by 98% through the use of VRUs. The US EPA, in AP-42, Chapter 13.5 (Industrial Flares), estimates that control of waste VOC via flaring would control VOC by a minimum of 98%. These technologies are also applicable for vents in dehydrator systems. VRUs also 'increase' oil and gas production by recovering hydrocarbons that would be lost and redirecting them for pipeline sale or onsite fuel supply.

3.8.3 Preferred Emission Estimation Approach

Dehydrator System Flash Vessels and Glycol Regenerator Vents: As a preferred method, ERG will use the basic methodology from the CENRAP study to generate estimated emissions from dehydrators. The calculation of emission factors will be based on gas composition and production data obtained from the survey or other available data, and the annual natural gas production by county will be obtained for the year 2008 from the TRC. Survey data will be used to estimate the percentage of dehydration systems using four control technologies (optimize flow rate, flash tanks, VRUs, and flares). GlyCalc will be used to develop emission factors for VOC, benzene, toluene, ethylbenzene, and xylene (BTEX). Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide.

Glycol Regenerator Boilers: Emission factors for glycol regenerator boilers will be based on survey data for the amount of fuel needed to regenerate the glycol given the glycol flow rates and average moisture content of the gas produced. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide.

The equations and methodology for estimating dehydrator-related emissions are discussed below. These equations assume that all gas requires dehydration, either in the field or at a central processing facility, that all dehydrators circulate glycol at the optimum rate, and that the standard dehydrator system does not incorporate a flash vessel.

The calculation methodology for dehydrator flash vessel and glycol regenerator vent emissions at the county level follows Equation 14:

$$E_{dehydrator,\ i,\ county\ j} = EF_{dehydrator,\ i,\ county\ j} \text{ x } P_{gas,\ county\ j} \text{ x } (1 + 0.5\ C_{flowrate} - 0.25\ C_{flashvessel} - 0.98\ C_{vru} - 0.98\ C_{flare}) \qquad \text{Equation (14)}$$

where:

$E_{dehydrator,\ i,\ county\ j}$ is the emissions of pollutant i from dehydrators in county j [tons/year]
$EF_{dehydrator,\ i,\ county\ j}$ is the emission factor for pollutant i from dehydrators in county j [tons/MSCF]
$P_{gas,\ county\ j}$ is the production of gas in county j [MSCF/year]
$C_{flowrate}$ is the fraction of gas production in county j without optimized dehydrator flow rate
$C_{flashvessel}$ is the fraction of gas production in county j with dehydrators equipped with flash tanks
C_{vru} is the fraction of gas production in county j controlled by VRUs
C_{flare} is the fraction of gas production in county j controlled by flares

A glycol regenerator boiler is essentially a heater and has similar emissions characteristics to typical combustion units. On-site gas is typically used as the fuel. Glycol regenerator boiler emission factors are developed using the process simulation software GlyCalc and AP-42 emission factors for heaters. The emission factor is developed in terms of the amount of heat needed to process one MSCF of produced gas, and is adjusted for the heat content of the on-site gas, as needed. The calculation methodology for glycol regenerator boilers at the county level follows Equation 15:

$$E_{regenerator\ boiler,\ i,\ county\ j} = EF_{regenerator\ boiler,\ i} \text{ x } P_{gas,\ county\ j} \qquad \text{Equation (15)}$$

where:

$E_{regenerator\ boiler,\ i,\ county\ j}$ is the emissions of pollutant i from glycol regenerator boilers in county j [tons/year]
$EF_{regenerator\ boiler,\ i}$ is the emission factor for pollutant i from a glycol regenerator boiler per unit production [tons/MSCF]
$P_{gas,\ county\ j}$ is the gas production [MSCF/year]

3.8.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level data on gas composition (VOC content and HAP speciation), typical configurations of dehydration system equipment (including glycol flow rates per MSCF of gas produced), and the GlyCalc software are required. ERG will collect data on the natural gas production per county using the most recently available database from the TRC, and will purchase the GlyCalc software directly from the vendor. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active wells in the Texas counties covered in this emissions inventory development effort.

3.9 Storage Tanks

Storage tanks are used in a variety of applications in the oil and gas industry. An oil and gas well may produce oil, natural gas, or a mixture of the two. When oil and gas are brought to the surface, the liquids produced may contain a mixture of liquid and gaseous organic compounds, nitrogen, carbon dioxide, water, sand, and other impurities. The mixture is typically passed through a three-phase separator, which allows the water, oil and gas to separate. The liquid oil and water components are then piped to storage tanks. If the well produces gas, it is possible that liquids may condense out of the gas as the pressure is decreased. The hydrocarbon liquid produced at gas wells is known as condensate. Oil and condensate are piped to storage tanks until they can be transported offsite. Tanks are typically vented to the atmosphere.

Oil and condensate storage tank emissions at wellhead and gathering sites are composed of flashing losses, working losses, and breathing losses. Flashing losses occur when a produced liquid (crude oil or condensate) with entrained gases experiences a pressure drop, as during the transfer of liquid hydrocarbons from a wellhead or separator to a storage tank. As the pressure on the liquid drops, some of the lighter compounds dissolved in the liquid are released or "flashed". Some compounds that are liquids at the initial pressure and temperature, change phase from a liquid to a gas and are also released or "flashed" from the liquid in the storage tank. Working losses occur when vapors are displaced from a tank during the filling and unloading cycles, and when the fluid is agitated during filling of the tank. Breathing losses (also called standing losses) occur due to the normal evaporation of liquid in a tank. Breathing losses are vapors that are produced in response to the daily temperature change.

3.9.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from oil and condensate storage tanks. The relevant sources reviewed are listed in Table 3.9.

Table 3.9 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Storage Tanks

Report Title	Geographic Coverage	Publication Date
Calculation of Flashing Losses/VOC Emissions from Hydrocarbon Storage Tanks (ODEQ, 2004)	All Regions	July, 2004
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II (Bar-Ilan, et al., 2007)	WRAP States	September, 2007
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Uinta Basin (Friesen, et al., 2009)	Uinta Basin, Utah	March , 2009

Table 3.9 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Storage Tanks (Cont.)

Report Title	Geographic Coverage	Publication Date
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin (Bar-Ilan, et al., 2009a)	Piceance Basin, Colorado	January, 2009
Development of Baseline 2006 Emissions from Oil and Gas Activity in the South San Juan Basin (Bar-Ilan, et al., 2009b)	San Juan Basin, New Mexico	November, 2009
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
Technical Supplement 6: Above Ground Liquid Storage Tanks (TCEQ, 2009a)	Texas	January 2009
Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation (TCEQ, 2009b)	Texas	July, 2009
Flash Emissions Model Evaluation Quantifying Volatile Organic Compound Emissions from Upstream Oil and Gas Storage Tanks (TCEQ, 2009d)	Texas	October 2009
VOC Emissions From Oil And Condensate Storage Tanks (TERC, 2009)	East Texas	April, 2009
Calculating Volatile Organic Compounds (VOC) Flash Emissions from Crude Oil and Condensate Tanks at Oil and Gas Production Sites (APDG 5942) (TCEQ, 2009c)	Texas	September, 2009

3.9.2 Emission Estimation Approaches

The reviewed literature provided both component-based and production-based approaches for estimating emissions from oil and condensate storage tanks. The three 2009 WRAP Phase III studies "Development of Baseline 2006 Emissions from Oil and Gas Activity in the San Juan Basin" (Bar-Ilan, et al., 2009b), "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin" (Bar Ilan, et al., 2009a), and "Development of Baseline 2006 Emissions from Oil and Gas Activity in the Uinta Basin" (Friesen, et al., 2009) either used storage tank emission factors supplied by producers or calculated emission factors for storage tanks based on data provided by the producers. These emission factors were then used to directly calculate emissions based on production at each well site (Piceance Basin), or to derive weighted average emission factors for the basin that were then multiplied by basin-wide production to derive emission estimates (San Juan Basin, Uinta Basin).

The 2009 TERC study “VOC Emissions From Oil And Condensate Storage Tanks” (TERC, 2009) used data from the measured emissions from oil and condensate tank batteries to develop emission factors for the other oil and condensate storage tanks in the East Texas region.

The 2009 TCEQ study “Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation” (TCEQ, 2009b) compared data from directly measured emissions from 36 oil and condensate storage tank batteries to the emissions estimates generated using the HYSYS process simulator, the E&P Tank model, the Gas-to-Oil Ratio (GOR), the Vasquez-Beggs correlation, the GRI-HAPCalc program, the Valko-McCain correlation, the EC/R equation, and TANKS 4.09d.

The 2008 CENRAP study “Recommendations for Improvements to the CENRAP States’ Oil and Gas Emissions Inventories” (Bar-Ilan, et al., 2008) estimated emission factors for oil and condensate storage tanks using GRI-GLYCalc or HYSYS software, and these emission factors were multiplied by production figures for oil and condensate to develop emissions estimates. The 2009 TCEQ study “Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation” (TCEQ, 2009b), the 2009 TCEQ guidance “Technical Supplement 6: Above Ground Liquid Storage Tanks” (TCEQ, 2009a), and the 2009 TCEQ guide “Calculating Volatile Organic Compounds (VOC) Flash Emissions from Crude Oil and Condensate Tanks at Oil and Gas Production Sites (APDG 5942)” (TCEQ, 2009c) recommend calculating working and breathing losses with EPA TANKS and calculating flashing losses from black oil systems and gas condensate systems using, in order of preference, direct measurement, process simulator models (HYSIM, HYSIS, WINSIM, or PROSIM), the E&P TANK program, GRI-HAPCalc, or the GOR method.

The 2007 TCEQ study used an emission factor developed for gas production in Wyoming, which was applied to oil and condensate production data for Texas.

The reviewed literature also addressed the effect of storage tank control technologies on emissions. The 2007 WRAP Phase II study “WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II” (Bar-Ilan, et al. 2007) estimated that VOC and HAP emissions could be reduced by 98% through the use of VRUs. VRUs also ‘increase’ oil and gas production by recovering hydrocarbons that would be lost and redirecting them for pipeline sale or onsite fuel supply. The US EPA, in AP-42, Chapter 13.5 (Industrial Flares), estimates that control of waste VOC via flaring would control VOC by a minimum of 98%.

3.9.3 Preferred Emission Estimation Approach

ERG proposes a two tiered approach to developing regional emission estimates. ERG will use the methodology and emission factor data developed in the 2009 TERC to develop emission estimates for oil and condensate storage tanks in the East Texas Shale region. ERG will use this same methodology in other regions of Texas for which adequate existing direct measurement data are available. For other regions of Texas, ERG will use the methodology recommended in the 2009 TCEQ study, the 2009 TCEQ guidance, and the 2009 TCEQ APDG 5942. Specifically, we anticipate that working and breathing losses will be calculated with EPA TANKS, and flashing losses will be calculated using process simulator models, the E&P TANK program, GRI-HAPCalc, or the GOR method, using the average VOC content of wellhead gas, obtained from a gas composition analyses, the API gravity of oil, and the gas-oil ratio, as data is available.

Emission factors developed using these approaches will be assigned to the counties within their respective regions and will be multiplied by county-specific production data obtained from the TRC to derive county-specific emission estimates. Data on operating temperature and pressure will be collected via survey and emissions will be adjusted for the appropriate operating parameters.
The calculation methodology for oil storage tank emissions at the county level follows Equation 16:

$$E_{oil\ tank,\ i,\ county\ j} = EF_{oil,\ i,\ county\ j} \text{ x } P_{oil,\ county\ j} \text{ x } (1 - 0.98\ C_{vru} - 0.95\ C_{flare}) \qquad \text{Equation (16)}$$

where:

$E_{oil\ tank,\ i,\ county\ j}$ is the emissions of pollutant i from oil storage tanks in county j [tons/year]
$EF_{oil,\ i,\ county\ j}$ is the emission factor for pollutant i from oil storage tanks in county j [tons/MSCF]
$P_{oil,\ county\ j}$ is the production of oil in county j [MSCF/year]
C_{vru} is the fraction of oil production in county j controlled by VRUs
C_{flare} is the fraction of oil production in county j controlled by flares

The calculation methodology for condensate storage tank emissions at the county level follows Equation 17:

$$E_{condensate\ tank,\ i,\ county\ j} = EF_{condensate,\ i,\ county\ j} \text{ x } P_{condensate,\ county\ j} \text{ x } (1 - 0.98\ C_{vru} - 0.95\ C_{flare}) \qquad \text{Equation (17)}$$

where:

$E_{condensate\ tank,\ i,\ county\ j}$ is the emissions of pollutant i from oil storage tanks in county j [tons/year]
$EF_{condensate,\ i,\ county\ j}$ is the emission factor for pollutant i from oil storage tanks in county j [tons/MSCF]
$P_{condensate,\ county\ j}$ is the production of oil in county j [MSCF/year]
C_{vru} is the fraction of condensate production in county j controlled by VRUs
C_{flare} is the fraction of condensate production in county j controlled by flares

Emission factors, $EF_{oil,\ i,\ county\ j}$, $EF_{condensate,\ i,\ county\ j}$:
The 2009 TERC study developed emission factors for oil and condensate storage tanks in the East Texas region. ERG will use these emission factors in developing emissions estimates for the counties covered by these studies. For the remainder of Texas, ERG will attempt to obtain county-level data on the properties of oil and condensate produced to develop emission factors for oil and condensate storage tanks using process simulation models or other emissions estimation models as outlined above. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide.

Production of oil and condensate $P_{oil, county j}$, $P_{condensate, county j}$
ERG will obtain county level data on the production of oil and condensate from the TRC.

Fraction of storage tanks controlled by flares, C_{flare} and the fraction of storage tanks controlled by VRUs, C_{vru}:
ERG will attempt to obtain estimates for the number of storage tanks controlled by flares or VRUs either by conducting a survey of oil and gas producers, or from existing data from the TRC. Depending on the amount of data collected, averages may be determined at the county level, the TRC District level, the basin level, or state-wide.

3.9.4 Data Needs

In order to implement the preferred emission estimation approach, county-level data on monthly oil and condensate production data, monthly average temperature data, the frequency of oil and condensate tank unloading operations, and oil and gas composition/speciation profiles are needed. ERG will collect survey data on the number, size, configuration and usage of tanks at oil wells and gas wells, along with production data matched to those sites, so that averages for tank volume relative to production rate can be determined. ERG will collect data on oil and condensate production data using the most recently available database from the TRC. ERG will attempt to collect all other data items by conducting a survey of oil and gas producers owning active wells in the Texas counties covered in this emissions inventory development effort.

3.10 Oil and Condensate Loading Racks

Oil and condensate stored in field storage tanks is transferred to trucks and railcars and shipped to refineries for further processing. Fugitive VOC emissions are released from these loading processes as the vapors in the receiving vessel are displaced by the liquids from the storage tanks. These vapors are normally vented to the atmosphere.

3.10.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from oil and condensate loading racks. The relevant sources reviewed are listed in Table 3.10.

Table 3.10 Oil and Gas Exploration Emissions Studies

Report Title	Geographic Coverage	Publication Date
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II (Bar-Ilan, et al. 2007)	Western States	September, 2007
Development of Baseline 2006 Emissions from Oil and Gas Activity in the South San Juan Basin (Bar-Ilan, et al., 2009b)	New Mexico	November, 2009

3.10.2 Emission Estimation Approaches

The August 2007 TCEQ report "Emissions from Oil and Gas Production Facilities" (TCEQ, 2007) and the November 2009 report "Development of Baseline 2006 Emissions from Oil and Gas Activity in the South San Juan Basin" (Bar-Ilan, et al., 2009b) included a production-based emissions methodology for oil and condensate loading. Both of these studies estimated uncontrolled VOC emissions from oil and condensate loading using the AP-42 loading equation.

In the 2007 TCEQ study, the true vapor pressure of oil and condensate was determined by using average temperature data for each county in Texas and temperature-dependent vapor pressures of crude oil from AP-42. Temperature data from 87 weather stations throughout Texas were obtained and isotherms were developed to estimate average annual temperatures for each county in Texas. These temperatures determined both the true vapor pressure using AP-42 data and the average temperature of the bulk liquid (T). The molecular weight of tank vapors was assumed constant and equal to AP-42 data for crude oil (50 lb/lb-mole) and gasoline (RVP 7) (68 lb/lb-mole) at 60 degrees F for oil and condensate, respectively. The gasoline value was used for condensate since no specific number for condensate was available. The type of loading operation was assumed to be submerged loading with a dedicated vapor balance.

The AP-42 equation to calculate temperature-dependent emission factors for loadout losses generates an emission factor based on the amount of liquid loaded. The calculated emission factors were applied to the amount of oil and condensate produced in each county, which was obtained from data provided by the TRC.

The reviewed literature also addressed the effect of storage tank control technologies on emissions. These technologies could be adapted to control emissions from storage tank unloading. The 2007 WRAP Phase II study "WRAP Area Source Emissions Inventory Projections and Control Strategy Evaluation Phase II" (Bar-Ilan, et al. 2007) estimated that VOC and HAP emissions could be reduced by 98% through the use of VRUs. The US EPA, in AP-42, Chapter 13.5 (Industrial Flares), estimates that control of waste VOC via flaring would control VOC by a minimum of 98%.

3.10.3 Preferred Emission Estimation Approach

ERG will use the methodology in the 2007 TCEQ study and the 2009 WRAP Phase III study. AP-42 emission factors for loading losses will be calculated at the county level. These emission factors will be multiplied by county-specific production data obtained from the TRC to derive county-specific emission estimates. This methodology requires oil and condensate production data, data on the composition and RVP of the oil and condensate produced, and monthly temperature data for the counties in which the oil and condensate are produced. Survey data will be gathered on the number of sites in the county that use VRUs or flares to control loading emissions. These data will be used to account for emissions controlled by VRUs or flares.

The AP-42 equation to calculate loading emission factors is shown in Equation 18:

$$LL_{oil,\ condensate,\ county\ j} = 12.46 \text{ x } S \text{ x } P \text{ x } M / T_{county\ j} \qquad \text{Equation (18)}$$

Where:

$LL_{oil,\ condensate,\ county\ j}$ is the loading loss [lb/1,000 gal of liquid loaded] for county j
S is Saturation factor (based on type of loading operation)
P is True vapor pressure of liquid loaded [psia]
M is Molecular weight of tank vapors [lb/lb-mole]
$T_{county\ j}$ is Temperature of bulk liquid loaded [^{o}R] for county j

The AP-42 equation to calculate temperature-dependent emission factors for loadout losses generates an emission factor based on the amount of liquid loaded. Truck or railcar loading emissions will then be calculated by multiplying the emission factor by county-level production figures for oil and condensate production, as shown in Equation 19:

$$E_{loading,\ county\ j} = LL_{oil,\ condensate,\ county\ j} \text{ x } P_{oil,\ condensate,\ county\ j} \text{ x 42 gal/bbl x 1 ton/2,000 lbs x } (1 - 0.98\ C_{vru} - 0.98\ C_{flare}) \quad \text{Equation (19)}$$

Where:

$E_{loading,\ county\ j}$ is the emissions from oil or condensate truck loading for county j [ton/year]
$LL_{oil,\ condensate,\ county\ j}$ is the emission factor for oil or condensate loading loss for county j [lb/1,000gal]
$P_{oil,\ condensate,\ county}j$ is oil or condensate production for county j [bbl/year]
C_{vru} is the fraction of loading in county j controlled by VRUs
C_{flare} is the fraction of loading in county j controlled by flares

3.10.4 Data Needs

In order to implement the preferred emissions estimation approach, county-level oil and condensate production data on a monthly basis, loading type, vapor pressure data for oil and condensate, molecular weight of tank vapors, and monthly average temperature data for each county is needed. ERG will collect county-level oil and condensate production data using the most recently available database from the TRC. ERG will attempt to obtain the other data needed to apply this methodology through the survey. If survey data is unavailable, default data may be used as described above for the 2007 TCEQ study. The 2007 TCEQ data can also be used as a QA check on the reasonableness of the survey results.

3.11 Compressor Engines

Spark-ignited internal combustion engines are normally used to drive gas field compressors. The compressors are used to boost the pressure of well-head natural gas so that it can be injected into higher pressure gathering lines. These compressor engines burn well-head natural gas and can represent a significant NO_x area emissions source category as they generally operate 8,760 hours per year with minimum down-time. For this project, in addition to criteria pollutant emissions, formaldehyde emissions from compressor engines will be estimated. Formaldehyde is formed as a by-product of the combustion process.

3.11.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from compressor engines. The relevant sources reviewed are listed in Table 3.11.

Table 3.11 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Compressor Engines

Report Title	Geographic Coverage	Publication Date
Tyler/Longview/Marshall Flexible Attainment Region Emission Inventory of Ozone Precursors VOC, NOx and CO (Pollution Solutions, 2005)	Tyler, Longview, Marshall area, Texas	February, 2005
Natural Gas Compressor Engine Survey and Engine NOx Emissions at Gas Production Facilities (HARC, 2005)	Eastern Portion of Texas	August, 2005
Ozone Precursors Emission Inventory for San Juan and Rio Arriba Counties, New Mexico (Pollack, et al., 2006)	San Juan and Rio Arriba Counties, New Mexico	August, 2006
Natural Gas Compressor Engine Survey for Gas Production and Processing Facilities (Burklin and Heaney, 2006)	Eastern Portion of Texas	October, 2006
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
Special Study Relating to Oil and Gas Production: 2005 and 2007 Emissions from Compressor Engines with Consideration for Load Factor (Pollution Solutions, 2008)	Tyler, Longview, Marshall area, Texas	August, 2008
Recommendations for Improvements to the CENRAP States' Oil and Gas Emissions Inventories (Bar-Ilan, et al., 2008)	CENRAP States	November, 2008
2008 Southeast Texas Compressor Engines and Dehydrators Survey (TCEQ, 2009e)	Southeast Texas	Presentation May, 2009
Development of Emissions Inventories for Natural Gas Exploration and Production Activity in the Haynesville Shale (Grant, et al., 2009)	Northeast Texas and Northwest Louisiana	August, 2009

3.11.2 Emission estimation approaches

Of the studies reviewed, the majority take a similar approach in determining emissions from compressor engines at oil and gas production facilities. These studies typically apply a county specific emission factor (developed through various survey data) to natural gas production by county. The specific methodology is discussed in Section 3.11.3.

It should be noted that the CENRAP 2008 report varies from this approach in that it recommends using well count as a surrogate for scaling wellhead compressor emissions to the basin level. The report states that gas production estimates may underestimate the number of wellhead compressors in use. County-level emissions estimates were then derived by allocating basin total wellhead compressor engine emissions to the county level by the fraction of total basin wells in each county.

3.11.3 Preferred emission estimation approach

As a preferred method to estimate emissions from natural gas compressor engines, ERG will use annual natural gas production by county along with survey-generated county-level emission factors to determine emissions from compressor engines at oil and gas production facilities. The annual natural gas production by county will be obtained for the year 2008 from the TRC.

County-level emission factors will be calculated using the methodology from the study "Natural Gas Compressor Engine Survey and Engine NO_X Emissions at Gas Production Facilities" conducted by ERG for the Houston Advanced Research Council (HARC) to generate emission factors from compressor engines at oil and gas production facilities (HARC, 2005). The HARC 2005 report was updated in 2006 to include more engine size categories and to add the year 2000 to the previous inventory; however, these updates did not change the calculation methodology used in the original 2005 report.

County-level emission factors will be calculated Equation (19) as provided in the HARC study reports:

$$EF_{ijk} = F_{1i} \text{ x } F_{2j} \text{ x } C_i \text{ x } H_j \text{ x } EF_{jk} \text{ x } 1/2000 \qquad \text{Equation (19)}$$

Where:

EF_{ijk} is the emission factor for county i, for engine type j, and pollutant k [tons/MSCF]
F_{1i} is the fraction of wells requiring compression in county i
F_{2j} is the fraction of compression load represented by engines of type j
C_i is the compression requirements for county i [hp-hr/MSCF]
H_j is the brake specific fuel consumption for engine type j [MMBtu/hp-hr]
EF_{jk} is the emission factor for engine type j, and pollutant k [lb/MMBtu]

The data needed to implement this approach is discussed below.

Fraction of wells requiring compression in county i, F_{1i}:
The HARC studies (HARC, 2005 and 2006) assumed the fraction of wells requiring compression is equal to the fraction of wells greater than one year old. As 2008 is the base year for this study and was an unusually active year in Texas for well drilling, ERG will attempt to verify this assumption by contacting experts in the field by phone as well as through a survey questionnaire. Although the fraction of wells greater than one year old was relatively constant in the three districts examined by the HARC studies, ERG will re-calculate an average fraction across the entire state using data from all twelve TRC districts for 2008. The number of wells completed each year and the total number of operating wells by district are available from the TRC.

Fraction of compression load represented by engines of type j, F_{2j}:
While the initial report (HARC, 2005) focused on engines less than 500 horsepower (hp), the follow-up report (HARC, 2006) included engines greater than 500 hp and also provided a more detailed breakdown of engines less than 500 hp. ERG will attempt to update the distribution of engine types through a new survey questionnaire. In addition, ERG will combine engine data from the two 2007 TCEQ engine surveys conducted on the counties located in the Dallas -Forth Worth (D-FW) metropolitan area and Southeast Texas. These TCEQ surveys were completed as efforts to amend the state clean air plan for ozone. Engine operators reported engine counts, engine sizes, NO_X emissions, and other data to TCEQ. If insufficient data are available through the D-FW and Southeast Texas surveys, ERG may default to the distribution of engine types presented in the follow-up HARC report and TCEQ surveys to estimate the fractions of various engine types in attainment and nonattainment areas of Texas.

Compression Requirements for county i, C_i:
A compressor's operating behavior is generally dependent on the relationship between pressure ratio and volume or mass flow rate. In particular, the operating behavior for a compressor engine located at an oil and gas well is based on the compressor suction and discharge pressures required to convey the natural gas from the well head to the gathering lines. These pressures, or the compression ratio, along with the natural gas flow-rate through the compressor, define the engine load in terms of the amount of mechanical work that is required to compress the natural gas produced by the well. This mechanical work (hp-hr) is directly proportional to the volume of fuel (MSCF) that must be burned by the compressor engine and the relationship is termed a *compression requirement* (hp-hr/MSCF). Special compressor calculators can be used to convert inlet and outlet pressures into *compression requirements* which can then be used to determine emissions created by compressor engines. Because of this direct relationship of mechanical work to volume of fuel burned, one would expect a 100 Hp engine to burn almost an equal amount of fuel as two (2) 50 Hp engines when compressing the same volume of natural gas produced by the same well. Therefore, it is not necessary to know the specific numbers of engines, or their individual sizes when calculating emissions from compressors at the county level.

In spite of this observable fact, all natural gas compressors have a maximum rating and most of them deliver less natural gas than their maximum rating. In a 2002 emissions inventory (Pollution Solutions, 2005) entitled "Tyler/Longview/Marshall Flexible Attainment Region Emission Inventory", the author developed a *compression requirement* (hp-day/MSCF) through survey data assuming the compressor engines were operating under full load or maximum installed horsepower. This assumption caused an overestimation of the amount of fuel that was consumed by the compressor engines and consequently overestimated the amount of emissions from these engines. A more recent study by Pollution Solutions (2008) entitled "2005 and 2007 Compressor Engine Emissions and Load Factors Report" determined average load factors for three engine categories, all of which were less than 100%. For engines less than 240 hp, the load factor was 70%. For engines between 240-500 hp, the load factor was 69%. For engines greater than 500 hp, the load factor was 58%. These engine load factors were applied to the previous study (Pollution Solutions, 2005) in order to determine more accurate emissions estimates for compressor engines located in Panola County as well as the five NETAC counties.

The 2005 HARC report developed compression requirements ranging between 3.1 and 3.5 Hp-hr/MSCF for three distinct districts in eastern Texas, including one attainment area and two nonattainment areas (Houston and Dallas) by obtaining typical well pressures and gathering line pressures through a field study. The engines in this particular field survey were operated at loads ranging from about 10% to 70% of full load, and averaged 40% load. Additionally, compression requirements that can be deduced from the 2008 Pollution Solutions study are relatively in-line with the compression requirements used in the 2005 HARC report. More specifically, the 191 Hp-day/MSCF compression requirement used in the 2005 Pollutions Solutions study, when adjusted for the load factors from the 2008 Pollutions Solutions study, yield *compression requirements* between 4.5 to 5.5 Hp-hr/MSCF. Additionally, TCEQ determined through a 2007 TCEQ engine survey (conducted on the counties located in the D-FW metropolitan area) a *compression requirement* of 226 Hp-day/MMcf for area source compressor engines outside the D-FW metropolitan area. This value equates to approximately 5.4 Hp-hr/MSCF which is also in agreement with previous studies mentioned.

ERG will attempt to develop 2008 compression requirements through a new survey questionnaire that would aim to collect typical well pressures and gathering line pressures, as well as engine load factors. As mentioned previously, the compression requirements developed for the 2005 HARC study, the 2008 Pollution Solutions study, and the 2007 TCEQ engine D-FW metropolitan survey were all relatively consistent. ERG may default to and apply an average of these factors to the entire state in both attainment and nonattainment areas if insufficient data is obtained through the survey effort.

Brake specific fuel consumption for engine type j, H_j:
The HARC studies (HARC, 2005 and 2006) determined brake specific fuel consumption for the most common engine model of each engine category using engine model distributions provided by engine leasing companies. ERG will develop updated representative engine models using data gathered through a survey questionnaire. In addition, ERG will use the engine data from the two 2007 TCEQ engine surveys conducted on the counties located in the D-FW metropolitan area and Southeast Texas, and may use the 2005 and 2006 HARC data as well.

Emission factor for engine type j, and pollutant k, EF_{jk}:
As noted in the 2008 CENRAP study, there are two distinct types of compressor engines used to boost the pressure of well-head natural gas: “rich-burn” engines that are characterized by NO_x emissions factors in the range of approximately 10 – 20 g/bhp-hr; and “lean-burn” engines that are characterized by NO_x emissions factors in the range of approximately 1.0 – 5.0 g/bhp-hr. The

exact NO_x emissions factors depend on the horsepower, make and model, and model year of the engine, and whether the engine has been converted from a rich-burn to a lean-burn engine.

Many of the compressor engine emission factors used in the 2008 CENRAP study came from a 2006 study entitled: "Ozone Precursors Emission Inventory for San Juan and Rio Arriba Counties, New Mexico" (Pollack, et al., 2006). This particular study contained an extensive database of emissions factors for a range of well-head compressor engine makes and models. From this database, average rich-burn and lean-burn engine emissions factors for NO_x, VOC, CO, and SO_2 were derived. PM_{10}, CO_2, and CH_4 emission factors were obtained from AP-42. It should be noted that all pollutant and engine-specific emission factors used in the 2005/2006 HARC studies were taken from AP-42.

For this study, ERG will attempt to develop improved emission factors (especially for NO_x and formaldehyde emissions) using data gathered through a survey questionnaire in order to estimate pollutant emissions from each engine type based on the county-by-county breakdown of engine use described above. In addition to new survey data, ERG will use the engine data from the two 2007 TCEQ engine surveys conducted on the counties located in the D-FW metropolitan area and Southeast Texas; as well as the data from the 2006 New Mexico study. If insufficient data is collected through the survey effort, ERG may default to and apply the average rich-burn and lean-burn engine emissions factors used in the 2006 New Mexico study, or AP-42 emission factors.

ERG has not found any studies using a different formaldehyde emission factor than provided in EPA's AP-42 document (July 2000) entitled "Natural Gas-fired Reciprocating Engines". AP-42 presents Formaldehyde emission factors for 2-stroke lean burn engines, 4-stroke lean burn engines, and 4-stroke rich burn engines. All the AP-42 formaldehyde emission factors have an "A" rating.

3.11.4 Data Needs

In order to implement the preferred emission estimation approach, the gas production in each county is needed. ERG will collect data on throughput per county using the most recently available database from the TRC. This activity data when applied to the different factors mentioned in Section 3.11.3 above, will allow ERG to estimate county-level emissions from compressor engines.

3.12 Turbines

Turbines are used in the oil and gas industry to compress gas or to generate electricity. In the gas industry they tend to be used in processing and transmission rather than gathering applications (CAPP, 2004). Compressors driven by turbines may be found at midstream oil and gas facilities such as large pipeline compressor stations, gas storage facilities, or gas processing plants. Turbines may also be utilized in some smaller upstream applications to assist in the transfer of gas produced in the field from multiple or individual well sites or gas gathering plants to midstream facilities. However, some of these applications (at the well or gas gathering plant level) are usually handled by reciprocating internal combustion engines, which are covered in

Section 3.11 of this memo. Most midstream facilities utilizing natural gas-fired turbines are assumed to be permitted and included in the inventory as major point sources. Turbines used in the oil and gas industry burn natural gas and can represent a significant source of NO_x emissions, in addition to other combustion-related pollutants.

In remote locations such as offshore platforms or oil and gas fields where electricity off the grid is not readily available, gas turbines may be used in a combined heat and power (CHP) application to drive generators for electricity and to provide heat in buildings and crew quarters.

3.12.1 Literature Review

ERG conducted a literature review to obtain information on established methodologies to estimate the atmospheric release of pollutants from turbines. The relevant sources reviewed are listed in Table 3.12.

Table 3.12 Existing Oil and Gas Exploration Emissions Studies Containing Methodologies for Turbines

Report Title	Geographic Coverage	Publication Date
Emissions from Oil and Gas Production Facilities (TCEQ, 2007)	Texas	August, 2007
Development of Baseline 2006 Emissions from Oil and Gas Activity in the Uinta Basin (Friesen, et al., 2009)	Uinta Basin, Utah	March , 2009

3.12.2 Emission estimation approaches

The reviewed literature did not provide any sources that explicitly included gas-fired turbines as an area source emissions source.

The study "Development of baseline 2006 Emissions From Oil and Gas Activity in the Unita Basin" (Friesen, et al., 2009) included one compressor station that was defined as a turbine as part of the point source inventory. The data for this point source was provided directly by the State of Utah.

The study "Emissions from Oil and Gas Production Facilities" (TCEQ, 2007) included emission from turbines located at offshore platforms as obtained from the Minerals Management Service (MMS). The study did not estimate emissions from onshore turbines.

3.12.3 Preferred emission estimation approach

At this point, it is unknown whether turbines will be found at locations other than point sources already included in the State of Texas Air Reporting System (STARS) emissions inventory. There are no existing studies that present approaches for estimating area sources emissions from turbines used in oil and gas upstream production sources, but there are AP-42 emission factors that could be used if it is discovered that there are turbines not counted in the point source inventory.

3.12.4 Data Needs

As part of the survey efforts, ERG will include questions pertaining to turbine usage in gas field applications at the well level and at gas gathering and processing stations. As any smaller turbines (those not already included in the point source inventory) would be used for the same purposes as compressor engines, the target recipients of the survey would be identical. Based on the findings of the HARC "Natural Gas Compressor Engine Survey for Gas Production and Processing Facilities" study (HARC, 2006), there are very few engines used in gas field compressor applications approaching the size of the smallest turbines (approximately 1,500 hp).

ERG will coordinate inclusion of turbines in this area source inventory with TCEQ if it is determined that there are turbines unaccounted for in the point source inventory.

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APPENDIX A

LIST OF ACRONYMS/ABBREVIATIONS

API	American Petroleum Institute
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CAPP	Canadian Association of Petroleum Producers
CenRAP	Central States Regional Air Partnership
CO	Carbon Monoxide
DOE	U.S. Department of Energy
ERG	Eastern Research Group, Inc.
GOR	Gas-to-Oil Ratio
GPA	Gas Processors Association
GRI	Gas Research Institute
HAP	Hazardous Air Pollutant
HARC	Houston Advanced Research Center
hp	Horsepower
H_2S	Hydrogen Sulfide
IPMAS	Independent Petroleum Association of Mountain States
LPG	Liquefied Petroleum Gas
MMS	Minerals Management Service
MMSCF	Million Standard Cubic Feet
MMSCFD	Million Standard Cubic Feet Per Day
MSCF	Thousand Standard Cubic Feet
MW	Molecular Weight
NETAC	Northeast Texas Air Care
NIF	National Emissions Inventory Input Format
NOx	Nitrogen Oxides
PM_{10}	Particulate Matter that has particle diameter less than 10 micrometers
$PM_{2.5}$	Particulate Matter that has particle diameter less than 2.5 micrometers
QA	Quality Assurance
SCC	Source Classification Code
SCF	Standard Cubic Feet
SO_2	Sulfur Dioxide
STARS	State of Texas Air Reporting System
STP	Standard Temperature and Pressure
TCEQ	Texas Commission on Environmental Quality
TexAER	Texas Air Emissions Repository
TRC	Texas Railroad Commission
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VRU	Vapor Recovery Unit
WRAP	Western Regional Air Partnership
WYDEQ	Wyoming Department of Environmental Quality

Appendix B – Task 3 Memorandum

TECHNICAL MEMORANDUM

Date: July 9, 2010

To: Martha Maldonado
Project Representative
Texas Commission on Environmental Quality (TCEQ)

From: Mike Pring, Eastern Research Group, Inc. (ERG)
Daryl Hudson (ERG)
Jason Renzaglia (ERG)
Brandon Smith (ERG)
Stephen Treimel (ERG)

Re: Oil and Gas Sources Inventory – Final Technical Memorandum for Task 3
TCEQ Contract No. 582-7-84003, Work Order No. 582-7-84003-FY10-26

1.0 Introduction

The purpose of this Work Order is to develop a 2008 base year air emissions inventory from upstream onshore oil and gas production sites for select counties in Texas. The inventory will address area source criteria pollutant emissions of volatile organic compounds (VOC), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and sulfur dioxide (SO_2); and certain toxic pollutant emissions such as formaldehyde from compressor engines, and benzene, toluene, ethylbenzene, and xylene from dehydrators. In addition to compiling the emissions inventory, other goals of this Work Order are to identify the emission source types operating at oil and gas production sites, identify the best emissions determination methodology for each emission source type, develop a methodology for estimating emissions from oil and gas production sites based on the oil and gas produced at the county level, and identify the producers of oil and gas for each county.

This Work Order builds on two previous studies ERG conducted for TCEQ to estimate emissions from oil and gas exploration and production activities. The first, implemented in 2007, focused on compiling a state-wide emissions inventory (including both onshore and offshore sources) for oil and gas exploration and production for a 2005 base year (ERG, 2007). The second study, conducted in 2009 for a 2008 base year, focused only on emissions from onshore oil and gas well drilling rig engines (ERG, 2009). Both of these studies included emission estimates for every county in Texas. In contrast, this current study will only address onshore area sources (those not included in the Texas point source inventory), and does not address drilling rig engines. TCEQ is also currently developing an emissions inventory for offshore oil and gas platforms under TCEQ Work Order No. 582-07-84003-FY10-25.

The onshore area source project is divided into four primary technical work tasks:

- Identification and review of existing studies pertaining to estimating emissions from oil and gas production sites and recommendation of an emission estimation approach for each identified source type;
- Identification of oil and gas well operators and preparation of draft survey materials, including obtaining data from existing studies and databases;
- Development of a methodology to estimate county-level emissions from each identified source type; and
- Development of a 2008 base year emissions inventory, including collection of activity and emissions data (as available), the preparation of emissions inventory calculation spreadsheets (including activity data and emission factors) and documentation of data, procedures, and results in a final project report. The final emissions inventory will be compiled into National Emissions Inventory Input Format (NIF) 3.0 text files for import into Texas Air Emissions Repository (TexAER).

The purpose of this memo is to document the methodology ERG will use to identify the owners and/or operators of oil and gas production sites, and to provide TCEQ with draft survey materials. Additionally, the methodology used to develop the draft survey materials are provided. In the project Work Plan, this work is referred to as Task 3.

This discussion begins by presenting the references and datasets that were used to identify oil and gas production sites owners and operators in Section 2.0. Section 3.0 presents example draft survey forms, the process used to develop these, with the forms and instructions for each source type provided in Attachment B.

County-level, area source emission estimates will be developed based on county-level oil and gas production data (total oil and gas produced in each county in 2008).

2.0 Identification of Oil and Gas Owners and Operators

This task targets identification of Oil and Gas Area Source operators who were active in Texas in 2008. A list of candidate owners and operators were obtained from multiple sources as follows:

- Texas Railroad Commission (RRC) and RigData® - ERG obtained data from the RRC for all oil and gas wells drilled in Texas in 2008. This database contains over 18,500 records for wells where drilling occurred in 2008. In addition, ERG obtained the RigData® database (a commercial database) in 2009 as part of the "Drilling Rig Emission Inventory for the State of Texas" project conducted for TCEQ. In addition to drilling contractor data, this database also contains owner and operator contact information (Company Name, Company Contact Name, and Company Contact Mailing Address) for over 24,000 wells. The combined data for these 2 datasets is included in Attachment A as "Drilling Data 2008 Contact Directory.xls".
- TCEQ Permit Data – TCEQ provided contact information for approximately 9,000 regulated entities registered with TCEQ pursuant to Standard Permit pursuant to 116.620 (Installation and/or Modification of Oil and Gas Facilities). This database contains

owner and operator contact information (Company Name, Company Contact Name, Company Contact Mailing Address, Company Contact Title, and Company Contact E-mail address for some sources). It is assumed that many of these sources are not currently required to report their air emissions to TCEQ under TAC 101.10(a)(1-3). This data is included in Attachment A as “Standard Permit 116.620 Contact Directory.xls”.

- Texas Railroad Commission (RRC) Oil & Gas Directory - Operator Contact Information – This data was obtained directly from the RRC and includes a listing of entities registered with the Commission's Oil and Gas Division by name, including address and telephone number. The listing includes all operators with Active status on Commission organization records, as well as those with "Delinquent" status (indicating that they still have activity, but have not updated their organizational registration). The listing does not include those with "Inactive" status (indicating no activity and no current registration). This data was obtained from (http://www.rrc.state.tx.us/data/operators/ogdirectory/index.php) on April 28, 2010 and is included in Attachment A as “TRC Oil and Gas Contact Directory.xls”.

These databases were imported into MS Access for easy querying for duplicates and to QA addresses and contact information. The final datasets of contact information are included in Attachment A.

3.0 Survey Forms

As TCEQ may wish to conduct a state-wide survey of oil and gas owners and operators in the future in order to refine the emissions inventory, survey forms were prepared for Artificial Lift Engines, Compressor Engines, Dehydrators, Equipment Leaks, Heaters, Loading Racks, Pneumatic Devices, Storage Tanks, Well Blowdowns, and Well Completions. These forms were structured such that the information needed to develop more highly-refined emissions estimates for each source category (at a county-level, using area source approaches) would be obtained. While obtaining the needed data, other goals in the development of these forms was to make them as straightforward as possible, to make them universally accessible (through the use of widely used software found in MS-Office), and to make them consistent with the format and nomenclature used in TCEQ’s current Barnett Shale study. TCEQ comments on the draft survey materials have been incorporated into the final survey materials provided herein.

Attachment B presents final survey forms for Artificial Lift Engines, Compressor Engines, Dehydrators, Equipment Leaks, Heaters, Loading Racks, Pneumatic Devices, Storage Tanks, Well Blowdowns, and Well Completions.

ATTACHMENT A

(See files “Standard Permit 116.620 Contact Directory.xls”, “TRC Oil and Gas Contact Directory.xls”, and “Drilling Data 2008 Contact Directory.xls”)

ATTACHMENT B

Draft Survey Packages

(See files “Artificial Lift Engine Survey.xls”, “Compressor Engine Survey.xls”, “Dehydrator Survey.xls”, “Equipment Leaks Survey.xls”, “Heater Survey.xls”, “Loading Rack Survey.xls”, “Pneumatic Device Survey.xls”, “Storage Tank Survey.xls”, “Well Blowdown Survey.xls”, and “Well Completion Survey.xls”)

Appendix C - VOC and PM HAP Speciation Data

Appendix C. HAP Factors

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Pump Jack	Natural Gas	VOC	0.11259434	lb/MMBtu		
Pump Jack	Natural Gas	Acetaldehyde	2.79E-03	lb/MMBtu	2.48E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Acrolein	2.63E-03	lb/MMBtu	2.34E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Benzene	1.58E-03	lb/MMBtu	1.40E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	1,3-Butadiene	6.63E-04	lb/MMBtu	5.89E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Carbon Tetrachloride*	1.77E-05	lb/MMBtu	1.57E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Chlorobenzene*	1.29E-05	lb/MMBtu	1.15E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Chloroform*	1.37E-05	lb/MMBtu	1.22E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Dichlorobenzene	1.20E-03	lb/MMBtu	1.07E+00	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	1,3-Dichloropropene*	1.27E-05	lb/MMBtu	1.13E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	7,12-Dimethylbenz(a)anthracene*	1.60E-05	lb/MMBtu	1.42E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Ethylbenzene*	2.48E-05	lb/MMBtu	2.20E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Ethylene Dibromide*	2.13E-05	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Formaldehyde	2.05E-02	lb/MMBtu	1.82E+01	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Methanol	3.06E-03	lb/MMBtu	2.72E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Methylene Chloride	4.12E-05	lb/MMBtu	3.66E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	2-Methylnaphthalene	2.40E-05	lb/MMBtu	2.13E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	3-Methylchloranthrene*	1.80E-06	lb/MMBtu	1.60E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Naphthalene*	9.71E-05	lb/MMBtu	8.62E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Propylene	0.016842105	lb/MMBtu	1.50E+01	Air Resources Board. California Environmental Protection Agency. http://www.arb.ca.gov/app/emsinv/catef_form.html
Pump Jack	Natural Gas	Styrene*	1.19E-05	lb/MMBtu	1.06E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	1,1,2,2-Tetrachloroethane	2.53E-05	lb/MMBtu	2.25E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Toluene	5.58E-04	lb/MMBtu	4.96E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	1,1,2-Trichloroethane*	1.53E-05	lb/MMBtu	1.36E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Vinyl Chloride*	7.18E-06	lb/MMBtu	6.38E-03	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	Xylenes (isomers and mixture)	1.95E-04	lb/MMBtu	1.73E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Pump Jack	Natural Gas	o-Xylenes			0.01	EPA Speciate 4.2 Database
Pump Jack	Natural Gas	m-Xylenes			0.01	EPA Speciate 4.2 Database

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Pump Jack	Natural Gas	PM	7.70E-04	lb/MMBtu		
Pump Jack	Natural Gas	Acenaphthene*	1.80E-06	lb/MMBtu	2.34E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Acenaphthylene*	1.80E-06	lb/MMBtu	2.34E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Anthracene*	2.40E-06	lb/MMBtu	3.12E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Benz(a)anthracene*	1.80E-06	lb/MMBtu	2.34E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Benzo(a)pyrene*	1.20E-06	lb/MMBtu	1.56E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Benzo(b)fluoranthene*	1.80E-06	lb/MMBtu	2.34E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Benzo(g,h,i)perylene*	1.20E-06	lb/MMBtu	1.56E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Benzo(k)fluoranthene*	1.80E-06	lb/MMBtu	2.34E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Chrysene*	1.80E-06	lb/MMBtu	2.34E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Dibenzo(a,h)anthracene*	1.20E-06	lb/MMBtu	1.56E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Fluoranthene	3.00E-06	lb/MMBtu	3.90E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Fluorene	2.80E-06	lb/MMBtu	3.64E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Indeno(1,2,3-cd_pyrene*	1.80E-06	lb/MMBtu	2.34E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Phenanathrene	1.75E-05	lb/MMBtu	2.27E+00	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Pump Jack	Natural Gas	Pyrene	5.00E-06	lb/MMBtu	6.49E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Total VOC	5.5	lb/MMscf burned		AP-42, Sections 1.4 (U.S. EPA 2002)
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Acetaldehyde	0.0089	lb/MMscf burned	1.6127E-01	Air Resources Board. California Environmental Protection Agency. http://www.arb.ca.gov/app/emsinv/catef_form.html
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Benzene	0.0021	lb/MMscf burned	3.8182E-02	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Dichlorobenzene	1.2000E-03	lb/MMscf burned	2.1818E-02	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	7,12-Dimethylbenz(a)anthracene*	1.6000E-05	lb/MMscf burned	2.9091E-04	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Formaldehyde	0.0750	lb/MMscf burned	1.3636E+00	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Hexane	1.8000E+00	lb/MMscf burned	3.2727E+01	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	2-Methylnaphthalene	2.4000E-05	lb/MMscf burned	4.3636E-04	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	3-Methylchloranthrene*	1.8000E-06	lb/MMscf burned	3.2727E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Naphthalene	6.1000E-04	lb/MMscf burned	1.1091E-02	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Toluene	3.4000E-03	lb/MMscf burned	6.1818E-02	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Total PM	1.9	lb/MMscf burned		AP-42, Sections 1.4 (U.S. EPA 2002)
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Acenaphthene*	1.8000E-06	lb/MMscf burned	9.4737E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Acenaphthylene*	1.8000E-06	lb/MMscf burned	9.4737E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Anthracene*	2.4000E-06	lb/MMscf burned	1.2632E-04	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Benz(a)anthracene*	1.8000E-06	lb/MMscf burned	9.4737E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Benzo(a)pyrene*	1.2000E-06	lb/MMscf burned	6.3158E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Benzo(b)fluoranthene*	1.8000E-06	lb/MMscf burned	9.4737E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Benzo(g,h,i)perylene*	1.2000E-06	lb/MMscf burned	6.3158E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Benzo(k)fluoranthene*	1.8000E-06	lb/MMscf burned	9.4737E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Chrysene*	1.8000E-06	lb/MMscf burned	9.4737E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Dibenzo(a,h)anthracene*	1.2000E-06	lb/MMscf burned	6.3158E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Fluoranthene	3.0000E-06	lb/MMscf burned	1.5789E-04	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Fluorene	2.8000E-06	lb/MMscf burned	1.4737E-04	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Indeno(1,2,3-cd)pyrene*	1.8000E-06	lb/MMscf burned	9.4737E-05	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Phenanathrene	1.7000E-05	lb/MMscf burned	8.9474E-04	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion
Boiler-Max MMBTU/hr<10-natural gas	Natural Gas	Pyrene	5.0000E-06	lb/MMscf burned	2.6316E-04	AP-42, Sections 1.4 (U.S. EPA 2002) Natural Gas Combustion

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Natural Gas Engines 2 cycle rich	Natural Gas	VOC	5.152709841	lb/MMscf		AP-42, Section 5.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Acetaldehyde	2.79E-03	lb/MMscf	5.41E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Acrolein	2.63E-03	lb/MMscf	5.10E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Benzene	1.58E-03	lb/MMscf	3.07E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	1,3-Butadiene	6.63E-04	lb/MMBtu	1.29E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Carbon Tetrachloride*	1.77E-05	lb/MMBtu	3.44E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Chlorobenzene*	1.29E-05	lb/MMBtu	2.50E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Chloroform*	1.37E-05	lb/MMBtu	2.66E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Dichlorobenzene	1.20E-03	lb/MMscf	2.33E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	1,3-Dichloropropene*	1.27E-05	lb/MMBtu	2.46E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	7,12-Dimethylbenz(a)anthracene*	1.60E-05	lb/MMscf	3.11E-04	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Ethylbenzene*	2.48E-05	lb/MMscf	4.81E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Ethylene Dibromide*	2.13E-05	lb/MMscf	4.13E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Formaldehyde	2.05E-02	lb/MMscf	3.98E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Hexane	1.80E+00	lb/MMscf	3.49E+01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Methanol	3.06E-03	lb/MMscf	5.94E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Methylene Chloride	4.12E-05	lb/MMscf	8.00E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	2-Methylnaphthalene	2.40E-05	lb/MMscf	4.66E-04	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	3-Methylchloranthrene*	1.80E-06	lb/MMscf	3.49E-05	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Naphthalene*	9.71E-05	lb/MMBtu	1.88E-03	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Propylene	0.016842105	lb/MMBtu	3.27E-01	Air Resources Board. California Environmental Protection Agency. http://www.arb.ca.gov/app/emsinv/catef_form.html
Natural Gas Engines 2 cycle rich	Natural Gas	Styrene*	1.19E-05	lb/MMBtu	2.31E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	1,1,2,2-Tetrachloroethane	2.53E-05	lb/MMBtu	4.91E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Toluene	5.58E-04	lb/MMBtu	1.08E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	1,1,2-Trichloroethane*	1.53E-05	lb/MMBtu	2.97E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Vinyl Chloride*	7.18E-06	lb/MMBtu	1.39E-04	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Xylenes (isomers and mixture)	1.95E-04	lb/MMBtu	3.78E-03	AP-42, Section 3.2 (U.S. EPA 2002)

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Natural Gas Engines 2 cycle rich	Natural Gas	o-Xylenes			0.01	EPA Speciate 4.2 Database
Natural Gas Engines 2 cycle rich	Natural Gas	m-Xylenes			0.01	EPA Speciate 4.2 Database
Natural Gas Engines 2 cycle rich	Natural Gas	PM	3.84E-02	lb/MMscf		AP-42, Section 5.2 (U.S. EPA 2002)
Natural Gas Engines 2 cycle rich	Natural Gas	Acenaphthene*	1.80E-06	lb/MMscf	4.69E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Acenaphthylene*	1.80E-06	lb/MMscf	4.69E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Anthracene*	2.40E-06	lb/MMscf	6.25E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Benz(a)anthracene*	1.80E-06	lb/MMscf	4.69E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Benzo(a)pyrene*	1.20E-06	lb/MMscf	3.13E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Benzo(b)fluoranthene*	1.80E-06	lb/MMscf	4.69E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Benzo(g,h,i)perylene*	1.20E-06	lb/MMscf	3.13E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Benzo(k)fluoranthene*	1.80E-06	lb/MMscf	4.69E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Chrysene*	1.80E-06	lb/MMscf	4.69E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Dibenzo(a,h)anthracene*	1.20E-06	lb/MMscf	3.13E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Fluoranthene	3.00E-06	lb/MMscf	7.81E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Fluorene	2.80E-06	lb/MMscf	7.29E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Indeno(1,2,3-cd_pyrene*	1.80E-06	lb/MMscf	4.69E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Phenanathrene	1.75E-05	lb/MMscf	4.56E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 2 cycle rich	Natural Gas	Pyrene	5.00E-06	lb/MMscf	1.30E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Natural Gas Engine 4 cycle lean	Natural Gas	VOC	0.12	lb/MMBtu		AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Acetaldehyde	8.36E-03	lb/MMBtu	6.97E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Acrolein	5.14E-03	lb/MMBtu	4.28E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Benzene	4.40E-04	lb/MMBtu	3.67E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Biphenyl	2.12E-04	lb/MMBtu	1.77E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	1,3-Butadiene	2.67E-04	lb/MMBtu	2.23E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Carbon Tetrachloride*	3.67E-05	lb/MMBtu	3.06E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Chlorobenzene*	3.04E-05	lb/MMBtu	2.53E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Chloroform*	2.85E-05	lb/MMBtu	2.38E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Dichlorobenzene	1.20E-03	lb/MMBtu	1.00E+00	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	1,3-Dichloropropene*	2.64E-05	lb/MMBtu	2.20E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	7,12-Dimethylbenz(a)anthracene*	1.60E-05	lb/MMBtu	1.33E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	Ethylbenzene	3.97E-05	lb/MMBtu	3.31E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Ethylene Dibromide*	4.43E-05	lb/MMBtu	3.69E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Formaldehyde	5.28E-02	lb/MMBtu	4.40E+01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Methanol	2.50E-03	lb/MMBtu	2.08E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	2-Methylnaphthalene	3.32E-05	lb/MMBtu	2.77E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	3-Methylchloranthrene*	1.80E-06	lb/MMBtu	1.50E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	Methylene Chloride	2.00E-05	lb/MMBtu	1.67E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	n-Hexane	1.11E-03	lb/MMBtu	9.25E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Naphthalene	7.44E-05	lb/MMBtu	6.20E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Phenol	2.40E-05	lb/MMBtu	2.00E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Propylene	0.012673684	lb/MMBtu	1.06E+01	Air Resources Board. California Environmental Protection Agency. http://www.arb.ca.gov/app/emsinv/catef_form.html
Natural Gas Engine 4 cycle lean	Natural Gas	Styrene*	2.36E-05	lb/MMBtu	1.97E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Tetrachloroethane	2.48E-06	lb/MMBtu	2.07E-03	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	1,1,2,2-Tetrachloroethane*	4.00E-05	lb/MMBtu	3.33E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Toluene	4.08E-04	lb/MMBtu	3.40E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	1,1,2-Trichloroethane*	3.18E-05	lb/MMBtu	2.65E-02	AP-42, Section 3.2 (U.S. EPA 2002)

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Natural Gas Engine 4 cycle lean	Natural Gas	2,2,4-Trimethylpentane	2.50E-04	lb/MMBtu	2.08E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Vinyl Chloride	1.49E-05	lb/MMBtu	1.24E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Xylene	1.84E-04	lb/MMBtu	1.53E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	o-Xylenes			0.01	EPA Speciate 4.2 Database
Natural Gas Engine 4 cycle lean	Natural Gas	m,p-Xylenes			0.01	EPA Speciate 4.2 Database
Natural Gas Engine 4 cycle lean	Natural Gas	PM	7.71E-04	lb/MMBtu		AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Acenaphthene	1.25E-06	lb/MMBtu	1.62E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Acenaphthylene	5.53E-06	lb/MMBtu	7.17E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Anthracene*	2.40E-06	lb/MMBtu	3.11E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	Benz(a)anthracene*	1.80E-06	lb/MMBtu	2.33E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	Benzo(b)fluoranthene	1.66E-07	lb/MMBtu	2.15E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Benzo(e)pyrene	4.15E-07	lb/MMBtu	5.38E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Benzo(g,h,i)perylene	4.14E-07	lb/MMBtu	5.37E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Benzo(k)fluoranthene*	1.80E-06	lb/MMBtu	2.33E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	Chrysene	6.93E-07	lb/MMBtu	8.99E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Dibenzo(a,h)anthracene*	1.20E-06	lb/MMBtu	1.56E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	Fluoranthene	1.11E-06	lb/MMBtu	1.44E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Fluorene	5.67E-06	lb/MMBtu	7.35E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Indeno(1,2,3-cd)pyrene*	1.80E-06	lb/MMBtu	2.33E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engine 4 cycle lean	Natural Gas	Phenanthrene	1.04E-05	lb/MMBtu	1.35E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engine 4 cycle lean	Natural Gas	Pyrene	1.36E-06	lb/MMBtu	1.76E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	VOC	0.03	lb/MMBtu		
Natural Gas Engines 4 cycle rich	Natural Gas	Acetaldehyde	2.79E-03	lb/MMBtu	9.30E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Acrolein	2.63E-03	lb/MMBtu	8.77E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Benzene	1.58E-03	lb/MMBtu	5.27E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	1,3-Butadiene	6.63E-04	lb/MMBtu	2.21E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Carbon Tetrachloride*	1.77E-05	lb/MMBtu	5.90E-02	AP-42, Section 3.2 (U.S. EPA 2002)

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Natural Gas Engines 4 cycle rich	Natural Gas	Chlorobenzene*	1.29E-05	lb/MMBtu	4.30E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Chloroform*	1.37E-05	lb/MMBtu	4.57E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	1,3-Dichloropropene*	1.27E-05	lb/MMBtu	4.23E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	7,12-Dimethylbenz(a)anthracene*	1.60E-05	lb/MMBtu	5.33E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Ethylbenzene*	2.48E-05	lb/MMBtu	8.27E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Ethylene Dibromide*	2.13E-05	lb/MMBtu	7.10E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Formaldehyde	2.05E-02	lb/MMBtu	6.83E+01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Methylene Chloride	4.12E-05	lb/MMBtu	1.37E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	2-Methylnaphthalene	2.40E-05	lb/MMBtu	8.00E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	3-Methylchloranthrene*	1.80E-06	lb/MMBtu	6.00E-03	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Naphthalene*	9.71E-05	lb/MMBtu	3.24E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Styrene*	1.19E-05	lb/MMBtu	3.97E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	1,1,2,2-Tetrachloroethane	2.53E-05	lb/MMBtu	8.43E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Toluene	5.58E-04	lb/MMBtu	1.86E+00	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	1,1,2-Trichloroethane*	1.53E-05	lb/MMBtu	5.10E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Vinyl Chloride*	7.18E-06	lb/MMBtu	2.39E-02	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	Xylenes (isomers and mixture)	1.95E-04	lb/MMBtu	6.50E-01	AP-42, Section 3.2 (U.S. EPA 2002)
Natural Gas Engines 4 cycle rich	Natural Gas	o-Xylenes			0.01	EPA Speciate 4.2 Database
Natural Gas Engines 4 cycle rich	Natural Gas	m-Xylenes			0.01	EPA Speciate 4.2 Database
Natural Gas Engines 4 cycle rich	Natural Gas	PM	9.50E-03	lb/MMBtu		
Natural Gas Engines 4 cycle rich	Natural Gas	Acenaphthene*	1.80E-06	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Acenaphthylene*	1.80E-06	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Anthracene*	2.40E-06	lb/MMBtu	2.53E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Benz(a)anthracene*	1.80E-06	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Benzo(a)pyrene*	1.20E-06	lb/MMBtu	1.26E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion

Appendix C. HAP Factors (Cont.)

Source Category	Fuel Type	Pollutant	Emission Factors	Emission Factor Unit	% HAP	Emission Factor Source
Natural Gas Engines 4 cycle rich	Natural Gas	Benzo(b)fluoranthene*	1.80E-06	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Benzo(g,h,i)perylene*	1.20E-06	lb/MMBtu	1.26E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Benzo(k)fluoranthene*	1.80E-06	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Chrysene*	1.80E-06	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Dibenzo(a,h)anthracene*	1.20E-06	lb/MMBtu	1.26E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Fluoranthene	3.00E-06	lb/MMBtu	3.16E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Fluorene	2.80E-06	lb/MMBtu	2.95E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Indeno(1,2,3-cd_pyrene*	1.80E-06	lb/MMBtu	1.89E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Phenanathrene	1.75E-05	lb/MMBtu	1.84E-01	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion
Natural Gas Engines 4 cycle rich	Natural Gas	Pyrene	5.00E-06	lb/MMBtu	5.26E-02	AP-42, Section 3.2 (U.S. EPA 2002) Natural Gas Combustion

Appendix D – Compressor Engine Workbook

Appendix E – Texas Oil and Gas Emissions Inventory

Appendix F – Formatted TexAer Files

APPENDIX 6

CONDENSATE TANK OIL AND GAS ACTIVITIES

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

CONDENSATE TANK OIL AND GAS ACTIVITIES

FINAL REPORT

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

October 10, 2012

ERG N0. 0292.01.011.001

Condensate Tank Oil and Gas Activities

FINAL REPORT

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List of Acronyms

Acronym	**Definition**
API	American Petroleum Institute
BBL	Barrel
BPA	Beaumont-Port Arthur
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CENRAP	Central Regional Air Planning Association
CO_2	Carbon Dioxide
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group
GOR	Gas/Oil Ratio
HAP	Hazardous Air Pollutants
HARC	Houston Advanced Research Center
HGB	Houston-Galveston-Brazoria
IPAMS	Independent Petroleum Association of Mountain States
lbs	Pounds
NSPS	New Source Performance Standard
psig	pounds per square inch gauge
QA	Quality Assurance
RRC	Texas Railroad Commission
TCEQ	Texas Commission on Environmental Quality
TERC	Texas Environmental Research Consortium
VOC	Volatile Organic Compound
VRU	Vapor Recovery Unit
WRAP	Western Regional Air Partnership

Executive Summary

This report is a deliverable for Texas Commission on Environmental Quality (TCEQ) Work Order No. 582-11-99776-FY12-11 to improve area source emission estimates for the oil and gas sector. Improvements will be gained through this effort by the development of refined emission factors for volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions from condensate storage tanks, as well as improved gas speciation profiles for different gas formations on a county-by-county basis.

Under this project, a review of available literature was conducted for data on emissions testing and emissions estimates for condensate tanks in Texas. In addition, data collected in the Barnett Shale Area Special Inventory conducted by TCEQ was evaluated, a phone survey of Texas condensate producers was conducted, and additional data on emissions estimates was obtained from several recent studies evaluating condensate storage tank emissions. ERG evaluated this data for its relevance and quality, and derived region-specific emission factors for eight geographic regions in the state. These emission factors are presented in Table E-1 below.

Table E-1. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Anderson	East Texas/Haynesville Shale	4.22	5.92
Andrews	Permian	7.07	5.90
Angelina	East Texas/Haynesville Shale	4.22	5.92
Aransas	Western Gulf	11.0	14.8
Archer	Fort Worth/Barnett Shale	9.76	16.0
Armstrong	Palo Duro	7.61	9.75
Atascosa	Eagle Ford Shale	10.5	10.0
Austin	Western Gulf	11.0	14.8
Bailey	Palo Duro	7.61	9.75
Bandera	Fort Worth/Barnett Shale	9.76	16.0
Bastrop	Western Gulf	11.0	14.8
Baylor	Fort Worth/Barnett Shale	9.76	16.0
Bee	Eagle Ford Shale	10.5	10.0
Bell	Western Gulf	11.0	14.8
Bexar	Western Gulf	11.0	14.8
Blanco	Fort Worth/Barnett Shale	9.76	16.0
Borden	Permian	7.07	5.90
Bosque	Fort Worth/Barnett Shale	9.76	16.0
Bowie	East Texas/Haynesville Shale	4.22	5.92
Brazoria	Western Gulf	11.0	14.8
Brazos	Eagle Ford Shale	10.5	10.0
Brewster	Marathon Thrust Belt	7.61	9.75

Table E-1. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Briscoe	Palo Duro	7.61	9.75
Brooks	Western Gulf	11.0	14.8
Brown	Fort Worth/Barnett Shale	9.76	16.0
Burleson	Eagle Ford Shale	10.5	10.0
Burnet	Fort Worth/Barnett Shale	9.76	16.0
Caldwell	Western Gulf	11.0	14.8
Calhoun	Western Gulf	11.0	14.8
Callahan	Fort Worth/Barnett Shale	9.76	16.0
Cameron	Western Gulf	11.0	14.8
Camp	East Texas/Haynesville Shale	4.22	5.92
Carson	Anadarko	3.15	5.87
Cass	East Texas/Haynesville Shale	4.22	5.92
Castro	Palo Duro	7.61	9.75
Chambers	Western Gulf	11.0	14.8
Cherokee	East Texas/Haynesville Shale	4.22	5.92
Childress	Palo Duro	7.61	9.75
Clay	Fort Worth/Barnett Shale	9.76	16.0
Cochran	Permian	7.07	5.90
Coke	Permian	7.07	5.90
Coleman	Fort Worth/Barnett Shale	9.76	16.0
Collin	Fort Worth/Barnett Shale	9.76	16.0
Collingsworth	Palo Duro	7.61	9.75
Colorado	Western Gulf	11.0	14.8
Comal	Western Gulf	11.0	14.8
Comanche	Fort Worth/Barnett Shale	9.76	16.0
Concho	Fort Worth/Barnett Shale	9.76	16.0
Cooke	Fort Worth/Barnett Shale	9.76	16.0
Coryell	Fort Worth/Barnett Shale	9.76	16.0
Cottle	Palo Duro	7.61	9.75
Crane	Permian	7.07	5.90
Crockett	Permian	7.07	5.90
Crosby	Permian	7.07	5.90
Culberson	Permian	7.07	5.90
Dallam	Palo Duro	7.61	9.75
Dallas	Fort Worth/Barnett Shale	9.76	16.0
Dawson	Permian	7.07	5.90
Deaf Smith	Palo Duro	7.61	9.75
Delta	East Texas/Haynesville Shale	4.22	5.92
Denton	Fort Worth/Barnett Shale	9.76	16.0
DeWitt	Eagle Ford Shale	10.5	10.0
Dickens	Permian	7.07	5.90
Dimmit	Eagle Ford Shale	10.5	10.0
Donley	Palo Duro	7.61	9.75
Duval	Western Gulf	11.0	14.8

Table E-1. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Eastland	Fort Worth/Barnett Shale	9.76	16.0
Ector	Permian	7.07	5.90
Edwards	Permian	7.07	5.90
El Paso	Permian	7.07	5.90
Ellis	Fort Worth/Barnett Shale	9.76	16.0
Erath	Fort Worth/Barnett Shale	9.76	16.0
Falls	East Texas/Haynesville Shale	4.22	5.92
Fannin	East Texas/Haynesville Shale	4.22	5.92
Fayette	Eagle Ford Shale	10.5	10.0
Fisher	Permian	7.07	5.90
Floyd	Palo Duro	7.61	9.75
Foard	Fort Worth/Barnett Shale	9.76	16.0
Fort Bend	Western Gulf	11.0	14.8
Franklin	East Texas/Haynesville Shale	4.22	5.92
Freestone	East Texas/Haynesville Shale	4.22	5.92
Frio	Eagle Ford Shale	10.5	10.0
Gaines	Permian	7.07	5.90
Galveston	Western Gulf	11.0	14.8
Garza	Permian	7.07	5.90
Gillespie	Fort Worth/Barnett Shale	9.76	16.0
Glasscock	Permian	7.07	5.90
Goliad	Western Gulf	11.0	14.8
Gonzales	Eagle Ford Shale	10.5	10.0
Gray	Anadarko	3.15	5.87
Grayson	Fort Worth/Barnett Shale	9.76	16.0
Gregg	East Texas/Haynesville Shale	4.22	5.92
Grimes	Eagle Ford Shale	10.5	10.0
Guadalupe	Western Gulf	11.0	14.8
Hale	Palo Duro	7.61	9.75
Hall	Palo Duro	7.61	9.75
Hamilton	Fort Worth/Barnett Shale	9.76	16.0
Hansford	Anadarko	3.15	5.87
Hardeman	Fort Worth/Barnett Shale	9.76	16.0
Hardin	Western Gulf	11.0	14.8
Harris	Western Gulf	11.0	14.8
Harrison	East Texas/Haynesville Shale	4.22	5.92
Hartley	Palo Duro	7.61	9.75
Haskell	Fort Worth/Barnett Shale	9.76	16.0
Hays	Western Gulf	11.0	14.8
Hemphill	Anadarko	3.15	5.87
Henderson	East Texas/Haynesville Shale	4.22	5.92
Hidalgo	Western Gulf	11.0	14.8
Hill	Fort Worth/Barnett Shale	9.76	16.0
Hockley	Permian	7.07	5.90

Table E-1. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Hood	Fort Worth/Barnett Shale	9.76	16.0
Hopkins	East Texas/Haynesville Shale	4.22	5.92
Houston	East Texas/Haynesville Shale	4.22	5.92
Howard	Permian	7.07	5.90
Hudspeth	Permian	7.07	5.90
Hunt	East Texas/Haynesville Shale	4.22	5.92
Hutchinson	Anadarko	3.15	5.87
Irion	Permian	7.07	5.90
Jack	Fort Worth/Barnett Shale	9.76	16.0
Jackson	Western Gulf	11.0	14.8
Jasper	Western Gulf	11.0	14.8
Jeff Davis	Permian	7.07	5.90
Jefferson	Western Gulf	11.0	14.8
Jim Hogg	Western Gulf	11.0	14.8
Jim Wells	Western Gulf	11.0	14.8
Johnson	Fort Worth/Barnett Shale	9.76	16.0
Jones	Fort Worth/Barnett Shale	9.76	16.0
Karnes	Eagle Ford Shale	10.5	10.0
Kaufman	East Texas/Haynesville Shale	4.22	5.92
Kendall	Fort Worth/Barnett Shale	9.76	16.0
Kenedy	Western Gulf	11.0	14.8
Kent	Permian	7.07	5.90
Kerr	Fort Worth/Barnett Shale	9.76	16.0
Kimble	Fort Worth/Barnett Shale	9.76	16.0
King	Permian	7.07	5.90
Kinney	Western Gulf	11.0	14.8
Kleberg	Western Gulf	11.0	14.8
Knox	Fort Worth/Barnett Shale	9.76	16.0
La Salle	Eagle Ford Shale	10.5	10.0
Lamar	East Texas/Haynesville Shale	4.22	5.92
Lamb	Palo Duro	7.61	9.75
Lampasas	Fort Worth/Barnett Shale	9.76	16.0
Lavaca	Eagle Ford Shale	10.5	10.0
Lee	Eagle Ford Shale	10.5	10.0
Leon	Eagle Ford Shale	10.5	10.0
Liberty	Western Gulf	11.0	14.8
Limestone	East Texas/Haynesville Shale	4.22	5.92
Lipscomb	Anadarko	3.15	5.87
Live Oak	Eagle Ford Shale	10.5	10.0
Llano	Fort Worth/Barnett Shale	9.76	16.0
Loving	Permian	7.07	5.90
Lubbock	Permian	7.07	5.90
Lynn	Permian	7.07	5.90
Madison	Western Gulf	11.0	14.8

Table E-1. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Marion	East Texas/Haynesville Shale	4.22	5.92
Martin	Permian	7.07	5.90
Mason	Fort Worth/Barnett Shale	9.76	16.0
Matagorda	Western Gulf	11.0	14.8
Maverick	Eagle Ford Shale	10.5	10.0
McCulloch	Fort Worth/Barnett Shale	9.76	16.0
McLennan	Fort Worth/Barnett Shale	9.76	16.0
McMullen	Eagle Ford Shale	10.5	10.0
Medina	Western Gulf	11.0	14.8
Menard	Fort Worth/Barnett Shale	9.76	16.0
Midland	Permian	7.07	5.90
Milam	Eagle Ford Shale	10.5	10.0
Mills	Fort Worth/Barnett Shale	9.76	16.0
Mitchell	Permian	7.07	5.90
Montague	Fort Worth/Barnett Shale	9.76	16.0
Montgomery	Western Gulf	11.0	14.8
Moore	Anadarko	3.15	5.87
Morris	East Texas/Haynesville Shale	4.22	5.92
Motley	Palo Duro	7.61	9.75
Nacogdoches	East Texas/Haynesville Shale	4.22	5.92
Navarro	East Texas/Haynesville Shale	4.22	5.92
Newton	Western Gulf	11.0	14.8
Nolan	Permian	7.07	5.90
Nueces	Western Gulf	11.0	14.8
Ochiltree	Anadarko	3.15	5.87
Oldham	Palo Duro	7.61	9.75
Orange	Western Gulf	11.0	14.8
Palo Pinto	Fort Worth/Barnett Shale	9.76	16.0
Panola	East Texas/Haynesville Shale	4.22	5.92
Parker	Fort Worth/Barnett Shale	9.76	16.0
Parmer	Palo Duro	7.61	9.75
Pecos	Permian	7.07	5.90
Polk	Western Gulf	11.0	14.8
Potter	Palo Duro	7.61	9.75
Presidio	Permian	7.07	5.90
Rains	East Texas/Haynesville Shale	4.22	5.92
Randall	Palo Duro	7.61	9.75
Reagan	Permian	7.07	5.90
Real	Fort Worth/Barnett Shale	9.76	16.0
Red River	East Texas/Haynesville Shale	4.22	5.92
Reeves	Permian	7.07	5.90
Refugio	Western Gulf	11.0	14.8
Roberts	Anadarko	3.15	5.87
Robertson	Eagle Ford Shale	10.5	10.0

Table E-1. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Rockwall	East Texas/Haynesville Shale	4.22	5.92
Runnels	Fort Worth/Barnett Shale	9.76	16.0
Rusk	East Texas/Haynesville Shale	4.22	5.92
Sabine	East Texas/Haynesville Shale	4.22	5.92
San Augustine	East Texas/Haynesville Shale	4.22	5.92
San Jacinto	Western Gulf	11.0	14.8
San Patricio	Western Gulf	11.0	14.8
San Saba	Fort Worth/Barnett Shale	9.76	16.0
Schleicher	Permian	7.07	5.90
Scurry	Permian	7.07	5.90
Shackelford	Fort Worth/Barnett Shale	9.76	16.0
Shelby	East Texas/Haynesville Shale	4.22	5.92
Sherman	Anadarko	3.15	5.87
Smith	East Texas/Haynesville Shale	4.22	5.92
Somervell	Fort Worth/Barnett Shale	9.76	16.0
Starr	Western Gulf	11.0	14.8
Stephens	Fort Worth/Barnett Shale	9.76	16.0
Sterling	Permian	7.07	5.90
Stonewall	Permian	7.07	5.90
Sutton	Permian	7.07	5.90
Swisher	Palo Duro	7.61	9.75
Tarrant	Fort Worth/Barnett Shale	9.76	16.0
Taylor	Fort Worth/Barnett Shale	9.76	16.0
Terrell	Marathon Thrust Belt	7.61	9.75
Terry	Permian	7.07	5.90
Throckmorton	Fort Worth/Barnett Shale	9.76	16.0
Titus	East Texas/Haynesville Shale	4.22	5.92
Tom Green	Permian	7.07	5.90
Travis	Western Gulf	11.0	14.8
Trinity	Western Gulf	11.0	14.8
Tyler	Western Gulf	11.0	14.8
Upshur	East Texas/Haynesville Shale	4.22	5.92
Upton	Permian	7.07	5.90
Uvalde	Western Gulf	11.0	14.8
Val Verde	Permian	7.07	5.90
Van Zandt	East Texas/Haynesville Shale	4.22	5.92
Victoria	Western Gulf	11.0	14.8
Walker	Western Gulf	11.0	14.8
Waller	Western Gulf	11.0	14.8
Ward	Permian	7.07	5.90
Washington	Western Gulf	11.0	14.8
Webb	Eagle Ford Shale	10.5	10.0
Wharton	Western Gulf	11.0	14.8
Wheeler	Anadarko	3.15	5.87

Table E-1. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Wichita	Fort Worth/Barnett Shale	9.76	16.0
Wilbarger	Fort Worth/Barnett Shale	9.76	16.0
Willacy	Western Gulf	11.0	14.8
Williamson	Western Gulf	11.0	14.8
Wilson	Eagle Ford Shale	10.5	10.0
Winkler	Permian	7.07	5.90
Wise	Fort Worth/Barnett Shale	9.76	16.0
Wood	East Texas/Haynesville Shale	4.22	5.92
Yoakum	Permian	7.07	5.90
Young	Fort Worth/Barnett Shale	9.76	16.0
Zapata	Western Gulf	11.0	14.8
Zavala	Eagle Ford Shale	10.5	10.0

Updated natural gas speciation profiles were developed through evaluation of GLYCalc emissions inventory reports submitted to TCEQ as part of the annual point source emissions inventory compilation. ERG reviewed TCEQ emissions inventory files and obtained GLYCalc data for 157 sites located in 64 counties across Texas. Using this information, average county natural gas composition profiles were developed. The 64 counties for which data were available were then grouped by basins (Anadarko, Bend Arch-Forth Worth, East Texas, Permian, and Western Gulf Basins), and basin-level average natural gas composition (wet and dry) profiles were calculated. Basin-level average natural gas composition profile and state-level average profiles were then allocated to counties with no data based on which basin the county was located in. For two basins, the Marathon Thrust Belt and Palo Duro, no data was available so a state-level average profile was developed. Table E-2 presents the basin-level and state-level average natural gas stream composition profiles for both wet and dry natural gas streams.

Table E-2. Basin-Level and State-Level Average Natural Gas Stream Composition Profiles

Composition in % Volume	Anadarko Basin		Bend Arch-Fort Worth Basin		East Texas Basin		Permian Basin		Western Gulf		State Profile	
	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream
Water	0.04	0.13	0.01	0.12	0.01	0.12	0.01	0.15	0.01	0.12	0.01	0.12
Carbon Dioxide	0.64	0.65	1.74	1.74	1.72	1.71	0.95	0.90	1.13	1.14	1.43	1.44
Hydrogen Sulfide	0.03	0.03	0.001	0.001	0.0004	0.0004	0.11	0.11	0.0003	0.25	0.03	0.09
Nitrogen	1.35	1.34	1.74	1.73	0.88	0.87	2.14	2.18	0.51	0.49	1.20	1.19
Methane	90.76	90.68	87.91	87.59	91.73	91.49	80.43	78.53	90.07	89.94	88.67	88.36
Ethane	3.99	3.98	5.23	5.21	3.57	3.64	9.02	9.07	4.51	4.51	5.03	5.00
Propane	1.74	1.74	2.14	2.18	1.04	1.06	4.48	5.39	2.04	2.05	2.13	2.21
Isobutane	0.26	0.26	0.31	0.32	0.28	0.29	0.51	0.61	0.48	0.48	0.38	0.40
n-Butane	0.54	0.54	0.62	0.68	0.31	0.32	1.19	1.63	0.51	0.51	0.58	0.64
Isopentane	0.16	0.16	0.20	0.22	0.15	0.17	0.35	0.40	0.24	0.24	0.22	0.23
n-Pentane	0.17	0.17	0.27	0.29	0.11	0.12	0.32	0.44	0.17	0.17	0.20	0.22
Cyclopentane	0.01	0.01	0.03	0.04	0.04	0.04	0.01	0.02	0.03	0.02	0.02	0.03
n-Hexane	0.10	0.06	0.05	0.12	0.05	0.05	0.16	0.18	0.05	0.06	0.06	0.09
Cyclohexane	0.01	0.01	0.04	0.03	0.03	0.03	0.09	0.11	0.05	0.06	0.04	0.05
Other Hexanes	0.14	0.14	0.07	0.06	0.10	0.11	0.24	0.29	0.17	0.15	0.13	0.13
Heptanes	0.06	0.06	0.08	0.08	0.06	0.07	0.14	0.14	0.07	0.09	0.08	0.08
Methylcyclohexane	0.02	0.02	0.02	0.02	0.01	0.02	0.04	0.04	0.04	0.04	0.03	0.04
Benzene	0.01	0.01	0.01	0.01	0.02	0.03	0.07	0.08	0.01	0.02	0.02	0.02
Toluene	0.01	0.01	0.003	0.003	0.01	0.01	0.04	0.04	0.01	0.02	0.01	0.01
Ethylbenzene	0.001	0.001	0.0005	0.001	0.001	0.001	0.01	0.01	0.001	0.002	0.001	0.002
Xylenes	0.003	0.01	0.002	0.003	0.002	0.005	0.01	0.01	0.003	0.01	0.003	0.005
C8+ Heavies	0.04	0.04	0.03	0.03	0.03	0.04	0.07	0.07	0.11	0.11	0.06	0.06

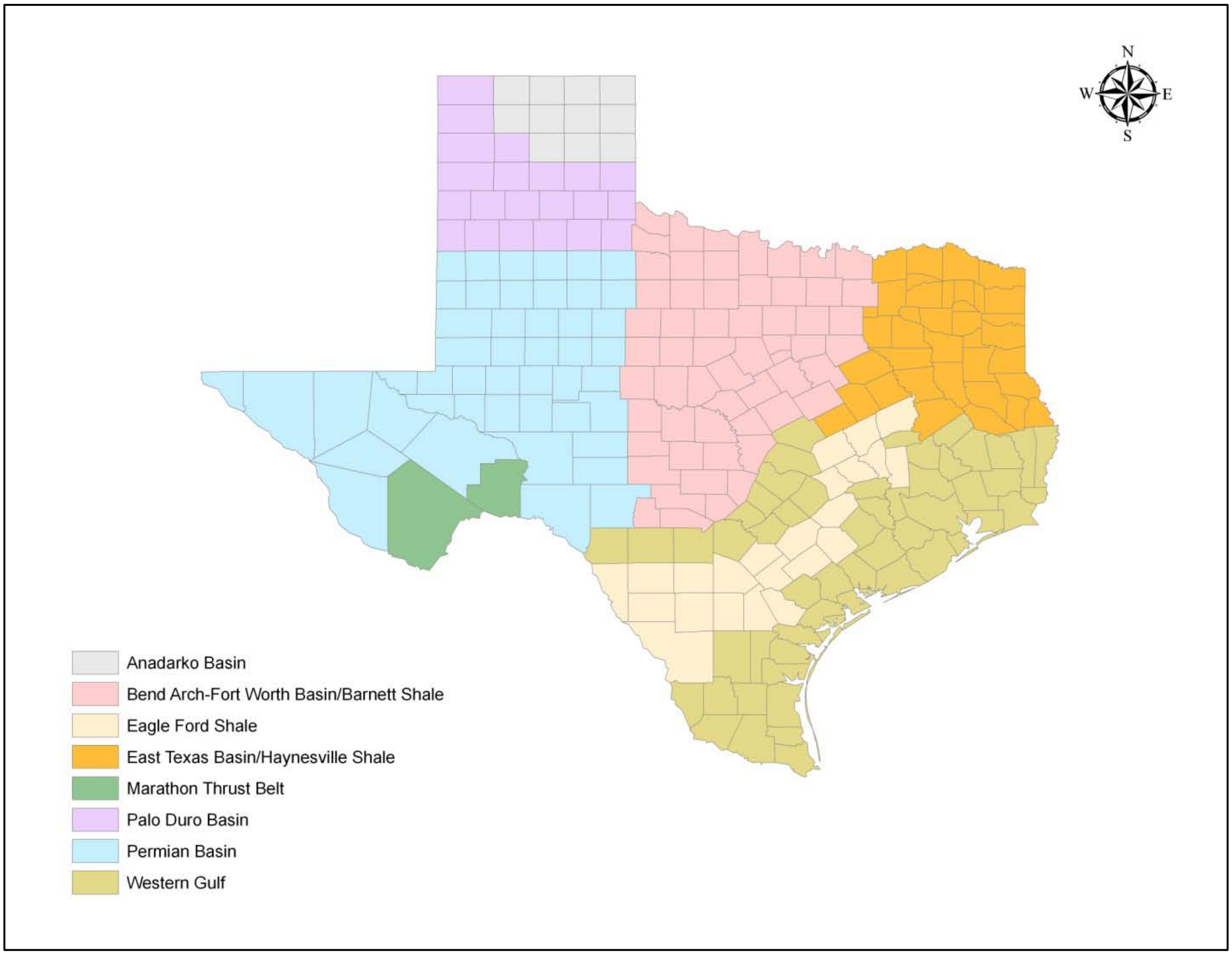
1.0 Introduction

Under contract with the Texas Commission on Environmental Quality (TCEQ), Eastern Research Group, Inc. (ERG) developed refined emission factors for volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions from condensate tanks, as well as improved gas speciation profiles for different gas formations on a county-by-county basis. This information will be used to improve area source emissions inventory estimates for the oil and gas sector. This report describes ERG's findings relative to an analysis of existing condensate tank emissions data, survey efforts to collect additional condensate tank emissions data, and development of natural gas speciation profiles in Texas.

2.0 VOC Emissions From Condensate Storage Tanks

A review of available literature was conducted for data on emissions testing and emissions estimates for condensate tanks in Texas. In addition, data collected in the Barnett Shale Area Special Inventory was evaluated, a phone survey of Texas condensate producers was conducted, and additional data on emissions estimates was obtained from TCEQ as available. ERG evaluated this data for its relevance and quality, and derived region-specific emission factors for eight geographic regions in the state. These eight regions are shown in Figure 2-1.

Figure 2-1. Condensate Producing Regions in Texas



2.1 Condensate Production

Condensate, for purposes of this survey, is defined as a hydrocarbon liquid produced at an oil or gas well and having an American Petroleum Institute (API) gravity greater than

40 degrees.[1] The API gravity of crude oil/condensate can vary from 20 to 70 degrees. In practice, most producers do not distinguish between oil and condensate, calling any petroleum liquid "oil". However, the API gravity of produced liquid is important, as a petroleum liquid with a higher API gravity will generally command a premium in the market.[2] API gravity is also important in determining what calculation method should be used to estimate the VOC emissions associated with the production of a hydrocarbon liquid. The Texas Railroad Commission (RRC) distinguishes between oil and condensate, with 'oil' being the liquid produced at oil wells and 'condensate' being the hydrocarbon liquid produced at gas wells.

TCEQ's area source emissions estimate is based upon county-level oil and condensate production as reported on the RRC website. When creating an area source emissions estimate, it is important to distinguish between the emissions from petroleum liquid storage tanks located at 'oil' wells, and the emissions from petroleum liquid storage tanks located at 'gas' wells because the VOC emission factor for tanks at oil wells (1.6 pounds (lbs) VOC/barrel (bbl)) is significantly lower than the emission factor historically used for tanks at gas wells (33.3 lbs VOC/bbl).[3] Given the difference in these estimates, it is important to distinguish between oil and condensate.

The RRC county level production data shows that the majority of petroleum-producing counties produce both 'oil' and 'condensate'. This is usually due to the fact that, within the geographic boundary of many counties, there may be two or more petroleum producing formations stacked atop one another at different depths below ground. One of the formations may produce oil, while the other may produce gas, while perhaps a third formation yields gas from shale. Therefore, the estimates of emissions from any particular county or region could reflect the emissions from wells tapping one, two, or more petroleum-producing formations underground.

2.2 Literature Review

ERG reviewed the current literature for existing studies and other sources that evaluated emissions from oil and condensate tanks in Texas. These studies included emissions measured via testing, emissions estimated through the use of software programs using

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[1] The American Petroleum Institute (API) does not define condensate in terms of its API gravity. The State of Colorado defines condensate as a hydrocarbon liquid that has an API gravity greater than or equal to 40° API at 60°F. Colorado Department of Public Health and Environment, PS Memo 05-01, Oil and Gas Atmospheric Condensate Storage Tank Batteries, Regulatory Definitions and Permitting Guidance, October 1, 2009. http://www.cdphe.state.co.us/ap/down/ps05-01.pdf

[2] Well Servicing Magazine, "Crude Oil Testing", Andy Maslowski, September/October 2009, http://wellservicingmagazine.com/crude-oil-testing

[3] These emission factors were used for estimating emissions from upstream area sources in the oil and gas industry in the report "Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions", TCEQ, 11/24/2010. The emission factors were first developed in the 2006 HARC study "VOC Emissions From Oil and Condensate Storage Tanks".

equations-of-state, and comparisons of measured emissions with estimated emissions. The data in these studies were analyzed for their validity and utility, and a refined emission factor for estimating emissions from condensate storage tanks was developed. A brief description follows of the available literature, the information they contain, and the information from the study used in developing updated emission factors.

2.2.1 Emissions Data Derived from Testing

This section examines studies where emissions data was generated via direct measurement (testing) of emissions from oil and condensate tanks.

"VOC Emissions from Oil and Condensate Storage Tanks" (Houston Advanced Research Center (HARC), 2006, and Texas Environmental Research Consortium (TERC), 2009).[4]

This study is widely referred to as the "HARC" or "HARC H051C" study. In this study, researchers examined 2 oil and 13 gas (condensate) sites in the Fort Worth basin, and 9 oil and 9 gas sites in the Western Gulf basin. This study measured oil and condensate tank emissions from each site and includes information such as API gravity and separator pressure. The HARC 2006 study noted that the emission estimates had a high uncertainty, due in part to the very low condensate production rates at well sites in Parker and Denton counties. The HARC 2006 study also noted that these measurements were taken during a period when recorded daytime high temperatures ranged from 98 to 107 degrees Fahrenheit at the nearby Dallas-Fort Worth Airport. The VOC emission factor of 33.3 lbs VOC/bbl condensate and the HAP emission factors used in TCEQ's 2008 upstream oil and gas area source inventory are derived from this report.

API provided comments[5] to the U.S. Environmental Protection Agency (EPA) on the derivation of this emission factor in their comments on EPA's proposed changes to the New Source Performance Standard (NSPS) for Oil and Gas Production (Subpart OOOO) on November 30, 2011.[6] API called into question the validity of two of the data points used in developing the emission factor. API also questioned the use of emissions data from several sites where the measured condensate production was minimal. API noted in their comments that the 24-hour production measurement methodology used in the HARC study (manual gauging of oil level in the tank) may be subject to error, as the onsite measurements for two barrels of production would require accurately

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[4] Houston Advanced Research Center, VOC Emissions from Oil and Condensate Storage Tanks, October 31, 2006. http://files.harc.edu/Projects/AirQuality/Projects/H051C/H051CFinalReport.pdf

[5] The API comments relative to condensate storage tank emissions were made by Dr. Ed Ireland of the Barnett Shale Energy Education Council.

[6] American Petroleum Institute, API Comments on the Proposed Rulemaking – Oil and Gas Sector Regulations, November 30, 2011, http://www.api.org/Newsroom/testimony/upload/2011-11-30-API-Oil-and-Gas-Rule-Final-Comments-Text.pdf

determining a difference of 0.71 to 1.2 inches in oil level via manual gauging of these 300 bbl condensate tanks.[7] However, in the 2009 revisions to the original report, the study authors noted that daily average production rates during the sampling period were obtained from site operating logs, not manual measurement as first erroneously reported.

API also questioned the presumption that emissions are solely a function of throughput and presented evidence that the VOC emissions per barrel of condensate produced are a non-linear function, dependent primarily upon separator pressure, and, to a lesser extent, API gravity. The comments suggest that each well/tank combination has unique emissions, based on: the composition of the liquids and gas produced, the API gravity of the liquid, the types of separator equipment in use, and the operating parameters of the separator. In general, liquids with a higher API gravity tend to have higher flash emissions per barrel than liquids with a lower API gravity. Also, the larger the pressure drop at the last stage of liquid-gas separation prior to moving the liquid to the storage tank, the higher the flash emissions. Therefore, any emission factor that is dependent solely upon production and does not take these other factors into account may not accurately estimate emissions for a specific well/tank combination.

While such a multivariate approach is feasible for estimating point source emissions at any individual location, this approach would be impractical for estimating county-level, area source emissions where site-specific operating data is not readily available. The approach used by this study overcomes these limitations and provides a reasonably accurate means for estimating emissions from the condensate-producing regions of Texas by developing regional emission factors based on testing data and emissions estimates developed using TCEQ's published preferred methodologies.

ERG re-examined the data from all 33 oil and condensate sites examined in the HARC 2006 study. Although 27 sites produce liquids having an API gravity of 40 degrees or greater, only data from the 22 sites designated as producing condensate have been considered in this analysis. In this re-analysis, three additional data points were removed from the data set. Data for tank 17 was removed because the calculated flash emissions (145 pounds VOC per barrel condensate produced (lbs/bbl)) indicated that 55% of the condensate flashed when reduced in pressure from 200 pounds per square inch gauge (psig). Data for tank 25 was removed because the calculated flash emissions (215 lbs/bbl) indicated that 82% of the condensate flashed when reduced in pressure from 200 psig. According to API, neither of these flash emission values is possible at this separator pressure.[6] Data for tank 26 was also removed from the dataset, as the recorded emissions (1,217.6 lbs/bbl) seem to indicate an equipment failure (such as a

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[7] Information in Appendix A of the study report indicates that, for the sites having production of two or less barrels of condensate per day, condensate was stored in a single 300 BBL capacity tank. 300 BBL oil tanks typically come in 12 foot and 15.5 foot diameters, and have capacities of 1.68 bbl/inch and 2.8 bbl/inch, respectively.

separator dump valve stuck in the open position) or a measurement error as a 42 gallon barrel of condensate weighs approximately 270 pounds. An emission factor for each of the remaining 19 sites was calculated. Table 2-1 shows the emissions measurement data from the HARC 2006 study.

Table 2-1. Condensate Tank Emission Data from the HARC 2006 Study

Tank Battery	County	Region	API Gravity	Separator Discharge Pressure (psi)	VOC (lbs/day)	Production (bbl/day)	VOC Emission Factor (lbs/bbl)
2	Montgomery	Western Gulf	42	41	383.2	105	3.65
3	Montgomery	Western Gulf	41	38	688.9	87	7.92
4	Montgomery	Western Gulf	40	34	93.7	120	0.78
5	Montgomery	Western Gulf	43	46	67.4	100	0.67
6	Montgomery	Western Gulf	39	33	384.7	130	2.96
13	Denton	Fort Worth	61	200	78.5	2	39.25
14	Denton	Fort Worth	59	200	118	4	29.50
15	Denton	Fort Worth	61	200	60	5	12.00
16	Denton	Fort Worth	61	200	121.2	2	60.60
18	Denton	Fort Worth	58	200	73.4	10	7.34
19	Denton	Fort Worth	58	200	26.3	2	13.15
20	Denton	Fort Worth	59	200	304.3	10	30.43
23	Parker	Fort Worth	48	39	150.2	27	5.56
24	Parker	Fort Worth	41	36	4.2	1	4.20
27	Denton	Fort Worth	59	200	28.8	2	14.40
28	Brazoria	Western Gulf	46	38	125.2	30	4.17
29	Brazoria	Western Gulf	42	41	2,055	61	33.69
30	Brazoria	Western Gulf	42	36	91.6	15	6.11
32	Galveston	Western Gulf	48	121	9,016	142	63.49

The production-weighted average emission factor for these 19 condensate tanks is 16.22 lbs/bbl, whereas the arithmetic average is 17.89 lbs/bbl. The production-weighted approach reduces the effect of measurement error (as noted in the API comments) on the emissions estimate, as the error attributable to measurement error from tanks with very low production has minimal 'weight' in the computation of the overall estimate.

2.2.2 Comparisons of Emissions Data Derived from Testing with Emissions Estimates Derived from Models/Software Programs

There is only a small amount of data from testing available at present. Emission estimates derived through use of emissions estimation software utilizing equations-of-state can provide useful information in developing regional emission factors. Therefore, emissions data estimated with software and models were used to supplement the existing testing data.

This section examines two studies where researchers conducted emissions testing on tanks and then generated emission estimates for those same tanks using models or software programs.

"*Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation*" (TCEQ, 2009)

This 2009 study conducted by Hy-Bon Engineering for TCEQ compared actual measured emissions from 30 test sites to estimated emissions from those same sites. Emissions estimates were created using onsite data and several different emissions estimating models and software[8]. At each test site, extensive data was taken on tanks and equipment, operating parameters, environmental conditions, and liquids production. Liquid and gas samples were taken for lab analysis and direct measurements were taken of vapors vented. The measured emissions from the 30 test sites were then compared to the estimated emissions from those same sites.

This report concludes that the calculated emissions using the E&P Tank – AP 42 model typically overestimated measured emissions in 85.7% of the cases, while the E&P Tank - RVP model overestimated emissions for 82.1% of the cases. Calculated emissions using HYSYS Process Simulation software overestimated measured emissions in 64.3% of the cases. Therefore, it was assumed that emissions estimated using E&P Tank – AP 42, E&P Tank – RVP, or HYSYS may over-estimate emissions, and are conservative. This same study showed that the Gas/Oil Ratio (GOR) method in combination with Tanks 4.09 underestimated flashing, breathing and working emissions in 76.7% of the cases. Therefore, any information obtained that utilizes the GOR method to estimate emissions will be, on average, an underestimate of the actual emissions. TCEQ has issued guidance[9] stating that testing, the various process simulation software packages, E&P Tank, and GOR, in combination with site sampling and analysis, are the preferred methods for estimating flash emissions, in order of most preferred to least preferred.

There are eleven sites out of the thirty whose API gravity is less than 40 degrees, the lower bound for condensate in this study. Therefore, data from these eleven sites will

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[8] The emissions estimation methods used in this study include: E&P TANK 2.0, AspenTech HYSYS 2006.5, GRI-HapCalc 3.0, the Environmental Consultant Research (EC/R) Algorithm, Vasquez-Beggs Correlation, Gas-Oil Ratio (GOR), and Valko-McCain Correlation. TANKS 4.09 was used to estimate breathing and working emissions for the GOR, Vasquez-Beggs, and Valko-McCain methods, which only calculate flash emissions.

[9] "Calculating Volatile Organic Compounds (VOC) Flash Emissions from Crude Oil and Condensate Tanks at Oil and Gas Production Sites", APDG 5942, May 2012, http://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/guidance_flashemission.pdf

not be considered. Emissions measurement data from the 19 remaining sites in this report are shown in Table 2-2.

The production-weighted average emission factor from testing for all of these sites is 4.59 lbs/bbl of condensate, whereas the arithmetic average is 11.0 lbs/bbl. The emission measurement tests on these tanks were conducted during the months of July, August, and September.

Table 2-2. Operating Parameters, Production, and Measured Emissions

Site ID #	County	Region	API Gravity (deg.)	Separator Pressure (psia)	Liquid Production (bbl/day)	VOC Emissions (ton/yr)	VOC Emission Factor (lbs/bbl)
WTB# 1	Ector	Permian	43.7	83.82	976	1134.9	6.37
WTB# 4	Terrell	Permian	50	88.82	34	12.6	2.03
WTB# 5	Terrell	Permian	48.3	103.82	18	53	16.1
WTB# 11	Crane	Permian	42.8	33.82	250	72	1.58
WTB# 15	Martin	Permian	40.6	30.82	332	98.8	1.63
WTB# 17	Martin	Permian	41.4	35.82	166	13.1	0.43
WTB# 19	Ector	Permian	42.8	73.82	1979	1790	4.96
WTB# 23	Andrews	Permian	43.3	53.82	327	93.5	1.57
NTB# 1	Ochiltree	Anadarko	44.8	62.14	69	36.7	2.91
NTB# 2	Hansford	Anadarko	45.3	48.44	74	8.3	0.62
NTB# 3	Hansford	Anadarko	42.3	40.44	98	6.9	0.386
NTB# 5	Ochiltree	Anadarko	67.5	44.44	50	154.8	17.0
NTB# 6	Denton	Fort Worth	55.7	158.44	13	19.3	8.14
NTB# 7	Wise	Fort Worth	58.6	161.44	34	38.1	6.14
NTB# 8	Wise	Fort Worth	58.9	139.44	16	100.3	34.3
NTB# 9	Wise	Fort Worth	55.2	167.44	12	38.6	17.6
NTB# 11	Wise	Fort Worth	63.7	245.44	5	71.5	78.4
NTB# 12	Wise	Fort Worth	63.7	239.44	14	14.8	5.79
NTB# 13	Wise	Fort Worth	56.2	139.44	62	39.3	3.47

Table 2-3 shows the estimated emission factors for the 19 test sites using the methods preferred by TCEQ. The emissions factor based on measured emissions is also included for comparison purposes.

Table 2-3. Comparison of Estimated Emissions with Measured Emissions

Site ID #	County	Liquid Production (bbl/day)	VOC Emission Factors (lbs/bbl)				
			Testing	E&P TANK - AP 42 LPO	E&P TANK - RVP LPO	HYSYS	GOR + TANKS 4.09
WTB# 1	Ector	976	6.37	24.67	37.41	13.42	1.99
WTB# 4	Terrell	34	2.03	14.83	17.89	8.70	9.15
WTB# 5	Terrell	18	16.13	12.48	14.61	8.16	6.03
WTB# 11	Crane	250	1.58	8.90	19.66	8.97	0.48
WTB# 15	Martin	332	1.63	13.04	18.07	6.88	0.61
WTB# 17	Martin	166	0.43	20.76	35.35	15.72	0.86
WTB# 19	Ector	1979	4.96	30.52	55.26	22.69	4.51
WTB# 23	Andrews	327	1.57	46.60	55.48	42.44	1.79
NTB# 1	Ochiltree	69	2.91	9.69	26.13	11.91	1.23
NTB# 2	Hansford	74	0.62	9.70	17.92	7.26	0.32
NTB# 3	Hansford	98	0.39	12.52	26.50	4.98	1.59
NTB# 5	Ochiltree	50	16.96	53.81	59.84	4.71	13.63
NTB# 6	Denton	13	8.14	13.49	24.03	12.64	2.74
NTB# 7	Wise	34	6.14	8.22	17.57	1.77	1.43
NTB# 8	Wise	16	34.35	15.07	26.37	3.77	4.28
NTB# 9	Wise	12	17.63	37.44	72.60	4.57	27.03
NTB# 11	Wise	5	78.36	12.60	17.53	8.77	4.60
NTB# 12	Wise	14	5.79	18.79	24.27	2.74	9.00
NTB# 13	Wise	62	3.47	25.98	30.58	0.53	8.15

It is instructive to see how much the various emissions estimation methods over-estimate or under-estimate emissions when compared to measured emissions values. This can help place the estimates generated via emissions estimation methods in context with the measured emissions, and give a sense of their value in estimating actual emissions from condensate tanks. Table 2-4 shows the ratio that the various estimation models over- or under- estimated emissions. The ratio is presented as (estimated emission/measured emission). A ratio of 1 indicates the estimate is in perfect agreement with the measurement, whereas a ratio of 10 indicates the estimated emission rate is ten times higher than the measured emission rate. A ratio of 0.5 indicates the estimated emissions are half of the measured emissions, while a ratio of 0.1 indicates the estimated emissions are 1/10th of the measured emissions. For simplicity, some values have been rounded.

Table 2-4. Ratio Between Estimated Emissions and Measured Emissions

Site ID #	Emission Factor From Measurement (lbs/bbl)	Ratio of Over Estimate or Under Estimate			
		E&P TANK - AP 42 LPO	E&P TANK - RVP LPO	HYSYS	GOR + Tank 4.09
WTB# 1	6.37	4.0	6.0	2.0	0.3
WTB# 4	2.03	7.0	9.0	4.3	4.5
WTB# 5	16.13	0.8	0.9	0.5	0.4
WTB# 11	1.58	5.6	12.5	5.7	0.3
WTB# 15	1.63	8.0	11	4.0	0.4
WTB# 17	0.43	48	82	36	2.0
WTB# 19	4.96	6.0	11	4.6	0.9
WTB# 23	1.57	30	35	27	1.1
NTB# 1	2.91	3.3	9.0	4.0	0.4
NTB# 2	0.62	16	29	12	0.5
NTB# 3	0.39	32	69	13	4.0
NTB# 5	16.96	3.0	3.5	0.3	0.8
NTB# 6	8.14	1.7	3.0	1.6	0.3
NTB# 7	6.14	1.3	3.0	0.3	0.2
NTB# 8	34.35	0.4	0.8	0.1	0.1
NTB# 9	17.63	2.0	4.0	0.3	1.5
NTB# 11	78.36	0.2	0.2	0.1	0.1
NTB# 12	5.79	3.0	4.0	0.5	1.6
NTB# 13	3.47	7.5	9.0	0.2	2.3
	Average	9.5	15.9	6.1	1.1

As can be seen in the table, the discrepancy between the estimated emissions and measured emissions is quite high. Only 18% of these estimates are within the range of half to twice (0.5 to 2) of the actual measured value. In this comparison, the emissions estimation models are shown to be inconsistent.

"Upstream Oil and Gas Tank Emission Measurements" (TCEQ, 2010)

This 2010 study conducted by TCEQ examined 7 gas wells/condensate tank sites in the Barnett Shale. This study compared actual measured emissions to estimated emissions using an emissions estimations model (E&P TANK). The research team collected extensive information on the equipment, operating parameters, production, and vented emissions. Vented emissions were measured with both a thermal mass flow meter and an ultrasonic flow meter. Samples of vent gas were collected and analyzed at two different labs. Production of water and condensate were measured. VOC emission rates and emission factors were calculated using this data. Liquid samples were collected from the pressurized separators and analyzed in a lab. The lab data on the pre-flash liquid composition and equipment operating parameter data were used as inputs to E&P TANK software, and emissions were estimated.

This study is notable for its duplication of all critical measurements and analyses. However, only three of the wells produced condensate during the study period. One of those wells produced only one barrel of condensate, and this production was measured with manual gauging of two tanks of unknown size operating in parallel. The accuracy of this measurement could be subject to the same questions about measurement precision noted by API in their comments on the 2006 HARC study.[10] The other four wells produced no condensate, but VOC emissions were measured from the associated produced water tanks at two of these sites. The study was conducted in July 2010, and the average ambient temperatures recorded on the sites ranged from 74.8 to 86.3 degrees Fahrenheit.

In Table 2-5, the VOC emissions are calculated for the three tanks having condensate production. This table shows the emissions measured using the production data from the thermal mass flow meter and the ultrasonic flow meter. The emissions estimated using E&P TANK are also shown.

If the emissions data from the three sites that produced condensate are averaged using a production-weighted average of the data from the two measurement methods, the average emission factor from both the measurement methods is 12.11 lbs VOC/bbl condensate, whereas the arithmetic average for these three sites from both the measurement methods is 17.52 lbs VOC/bbl condensate. In this study, the estimates of emissions produced with the E&P TANK model varied significantly from the values for actual measured emissions.

2.2.3 Emissions Estimates Derived Solely from Models/Software Programs

This section examines a study which provided a set of emission estimates that were generated using only models or software programs.

"Control of VOC Flash Emissions from Oil and Condensate Storage Tanks in East Texas" (TCEQ, 2010)

This 2010 study conducted by TCEQ assessed the impact of Title 30 Texas Administrative Code 115.112(d)(5) on the implementation of VOC control devices on oil and condensate tanks in the Houston-Galveston-Brazoria (HGB) ozone nonattainment area. In this study, producers in the target areas were surveyed to assess the number of

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[10] American Petroleum Institute, API Comments on the Proposed Rulemaking – Oil and Gas Sector Regulations, November 30, 2011, http://www.api.org/Newsroom/testimony/upload/2011-11-30-API-Oil-and-Gas-Rule-Final-Comments-Text.pdf

Table 2-5. Condensate Tank Emission Factors from the TCEQ 2010 Study

Tank Battery	County	Region	API Gravity	Separator Pressure (psi)	Production (bbl/day)	Measured with Thermal Mass Flow Meter		Measured with Ultrasonic Mass Flow Meter		Estimated with E&P TANK
						VOC Emissions (lbs/day)	VOC Emission Factor (lbs/bbl)	VOC Emissions (lbs/day)	VOC Emission Factor (lbs/bbl)	VOC Emission Factor (lbs/bbl)
Gage Pitts	Wise	Fort Worth	61.2	171	58.5	717.9	12.3	639.9	10.9	11.5
Waggoner Crystelle	Wise	Fort Worth	61.2	119	3.34	12.7	3.8	105.3	31.5	7.6
First Baptist Church Slidell No.1	Wise	Fort Worth	51	NR	1	11.3	11.3	35.3	35.3	0.7

tanks that were controlled and the type of controls installed. Although this report does not include any new emissions measurements, it is valuable as it contains E&P TANK and HYSYS reports for 21 condensate batteries in the Haynesville Shale area. One company provided a summary of VOC emissions calculated using E&P TANK run with site-specific sampling inputs for 13 condensate tank batteries in the Haynesville Shale area.

Another company provided emissions estimated using the HYSYS Version 2006.5 process simulator for eight natural gas condensate tank batteries in the Haynesville Shale. These estimates are shown in Table 2-6. As no production figures were given, a production-weighted average cannot be calculated. The arithmetic average is 5.80 lbs VOC/ bbl condensate.

Table 2-6. Producer-Supplied VOC Emission Estimates for Condensate Tank Batteries in Haynesville Shale Area

Site Number	Region	Separator Pressure (psig)	Separator Temperature (°F)	API Gravity @ 60°F	Estimation Model	VOC Emissions (lbs/bbl)
1	Haynesville Shale	45	80	50.6	E&P TANK	2.67
2		40	80	49.6	E&P TANK	8.45
3		25	86	54.2	E&P TANK	5.38
4		95	89	55.4	E&P TANK	1.67
5		16	97	59.5	E&P TANK	1.09
6		30	70	55.3	E&P TANK	1.45
7		60	78	64.6	E&P TANK	8.91
8		120	89	55.0	E&P TANK	10.24
9		95	80	55.0	E&P TANK	11.97
10		60	75	52.4	E&P TANK	4.62
11		80	72	57.0	E&P TANK	3.98
12		120	85	55.0	E&P TANK	11.97
13		60	77	53.8	E&P TANK	3.49
14		40	85	N/A	HYSYS	1.16
15		108	98	N/A	HYSYS	0.31
16		752	82	N/A	HYSYS	15.84
17		76	90	N/A	HYSYS	0.32
18		110	80	N/A	HYSYS	0.85
19		690	70	N/A	HYSYS	14.79
20		560	98	N/A	HYSYS	0.73
21		230	90	N/A	HYSYS	11.83
				Average		5.80

2.2.4 Other Studies

The following study was evaluated for its utility in contributing estimates for the regional emission factors being developed in this study.

"*Recommendations for Improvements to the CENRAP State's Oils and Gas Emissions Inventories*" (Central Regional Air Planning Association (CENRAP), 2008)

This report contains emission factors for flashing, working, and breathing emissions for condensate tanks in the Anadarko basin. The CENRAP 2008 report states that this emission factor (13.86 lbs VOC/bbl) was obtained from the Independent Petroleum Association of Mountain States (IPAMS)/Western Regional Air Partnership (WRAP) Phase III work (Bar-Ilan, et al, 2008). The IPAMS/WRAP Phase III report states that the emission factors were derived from producer surveys conducted in 2008, but this information and the emission factor could not be verified. The CENRAP 2008 report also contains an emission factor for flashing, working, and breathing emissions from condensate tanks in the East Texas, Western Gulf, Fort Worth, and Permian basins. However, as this emission factor (33.3 lbs VOC/bbl) was taken from the HARC H051C study, it will not be used. Therefore, the emission factors from the CENRAP 2008 report will not be used.

2.3 Emission Factor Development Using the Barnett Shale Area Special Inventory, Phase II (2009)

TCEQ provided ERG with data from the "Barnett Shale Area Special Inventory, Phase II 2009" (Barnett Shale Inventory) information in spreadsheet format. The Barnett Shale Inventory data contains 2,268 records with reported condensate production rates and calculated VOC emissions. The VOC emissions were estimated using a variety of methods, including direct measurement of tank emissions, test data, and flash emission and working and breathing emissions models. ERG analyzed this data and developed emission factors for condensate tanks in the Bend-Arch-Fort Worth and Barnett Shale counties.

The original data from 4 separate spreadsheet pages was uploaded into an Access database so that data for individual facilities could be joined into one record. The data was then downloaded back into Excel for analysis. Records were sorted to remove: all records using non-preferred emission estimations methods (Vasquez-Beggs equation, derived emission factors, and HARC H051C emission factor), all records where condensate tank emissions were equal to zero, and all records where annual throughput of condensate was equal to zero. Individual records were examined for internal consistency, and were rejected if the recorded site values for annual throughput were not equal to condensate production. Emission factors were calculated using the values for emissions and throughput. All records with emission factors above 140 lbs/bbl were rejected, as it was deemed that emissions above 50% of the weight of produced condensate were indicative of equipment malfunction or an error in the data, estimating method, or record. The records were then sorted by estimation method. Records in which the estimation method was not noted were not analyzed, as these records lacked critical information for determining their usefulness and accuracy. Both a production-weighted average and an arithmetic average emission factor, before controls, were calculated for each of the emission estimation methods. The percent of total production that is reported in the special inventory as controlled was also calculated. The results are presented in Table 2-7.

The production-weighted average of the emission factors developed using the estimation methods preferred by TCEQ is 6.77 lbs/bbl, before the effect of controls. The arithmetic average of the emission factors developed using the estimation methods preferred by TCEQ is 12.95 lbs/bbl, before the effect of controls. As discussed in the report "*Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation*", the E&P TANK and the Process Simulator models tended to produce higher emission estimates, while the GOR method produced lower estimates. This is reflected in the Barnett Shale Inventory data; the emission estimates generated with E&P TANK (6.58, 6.71, and 10.13 lbs/bbl) and process simulator models (7.51 lbs/bbl) are generally, but not always, higher than the emission estimates generated using the GOR method (3.96 and 8.12 lbs/bbl).

Table 2-7. Condensate Tank VOC Emission Factors by Method – Barnett Shale Inventory

Flash Emission Calculation Method	**Working and Breathing Emission Calculation Method**	**Total Production (bbl)**	**Number of Sources (Count)**	**Production-Weighted Emission Factor (lbs/bbl)**	**Arithmetic Average Emission Factor (lbs/bbl)**	**% of Production Controlled**
Process Simulator Models	EPA TANKS Program	62,112	32	7.51	10.8	0%
E&P TANK	Other:	112,651	142	6.58	23.3	7.7%
E&P TANK	EPA TANKS Program	94,544	29	6.71	13.5	15.2%
E&P TANK	E&P TANK	947,655	918	10.13	12.9	0.26%
GOR Method	EPA TANKS Program	74,652	36	8.12	9.60	6.71%
GOR Method	E&P TANK	1,175,194	407	3.96	9.87	25.8%
Direct Measurement of Emissions	Other:	12,601	11	7.82	13.3	0%
Preferred Methods	Totals	2,479,409	1,575	6.77	12.95	13.5%

One survey respondent indicated that they used direct measurement to estimate emissions, but, since no other details were given, these data points were treated as being calculated by a preferred method.

The Barnett Shale Inventory data was also sorted by county, and emission factors for condensate tanks were developed at the county level. The data analysis was similar to that done for the entire Barnett Shale region. Emission factors were created using the values for emissions and throughput. The records were then sorted by estimation method, and only records using the preferred estimation methods for flashing emissions (direct measurement, process simulator, E&P Tank, GOR) were analyzed. Records in which the estimation method was unknown were not analyzed. Records were then sorted by county. A production-weighted average emission factor, and an arithmetic average of the emission factors, before controls, was calculated for each of the counties. The results are presented in Table 2-8.

Table 2-8. Condensate Tank VOC Emission Factors by County – Barnett Shale Inventory

Emission Calculation Methods	County	Total Production (bbl)	Number of Sources (Count)	Production-Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)	% of Production Controlled
Flash Emissions: Process Simulator Models, E&P Tank, Direct Measurement, GOR Working and Breathing Emissions: E&P Tank, EPA TANKS Program, Other	Clay	6,404	3	3.83	7.10	0.0%
	Cooke	155,352	41	4.15	4.53	35.7%
	Denton	180,295	226	9.51	13.98	2.6%
	Erath	35,520	72	16.88	18.75	0.0%
	Hood	199,738	183	7.70	12.10	1.9%
	Jack	62,590	40	4.86	8.57	0.0%
	Johnson	62,207	71	9.77	16.74	3.5%
	Montague	588,385	135	3.55	5.39	42.1%
	Palo Pinto	333,620	53	2.25	5.14	0.2%
	Parker	164,973	231	10.70	13.58	5.6%
	Somervell	6,753	23	10.24	16.50	0.0%
	Stephens	4,156	4	3.96	3.96	0.0%
	Tarrant	42,517	81	11.09	12.39	6.0%
	Wise	636,347	411	9.75	15.58	0%

For certain counties, sufficient data may be available to develop a county-specific emission factor based only on the data available for that particular county. However, a careful examination of these county-specific emission factors (see Attachment C) shows that they vary widely within any one region. This may be indicative of the variation in properties of the condensate produced, or it may be due to an inadequate sample size. Due to the variation observed in the county-specific factors and the uncertainties associated with these factors, the regional emission factors presented in Table 2-15 (see discussion below) are recommended for developing the state-wide area source inventory.

2.4 Phone Survey of Area Sources

ERG attempted to contact 54 producers operating in the six regions of interest and request condensate tank emissions data. The companies selected were identified by a search of the RRC website[11] as major producers of condensate in the six regions of interest for the survey. The six regions of interest were the Anadarko, East Texas, Permian, and Western Gulf basins and the Haynesville and Eagle Ford shales. Table 2-9 and Figure 2-2 show the counties within each of the regions that were targeted. These counties were chosen due to their high condensate production relative to all of the counties in that region.[12]

Table 2-9. Target Survey Counties

Anadarko	**Permian**	**East Texas**	**Western Gulf**	**Eagle Ford Shale**	**Haynesville Shale**
Hemphill, Lipscomb, Ochiltree, Roberts, and Wheeler	Crane, Crockett, Loving, Midland, Pecos, Upton, and Ward	Anderson, Cass, Cherokee, Franklin, Freestone, Henderson, Houston, Limestone, Navarro, Smith, and Upshur	Brazoria, Brooks, Galveston, Hardin, Harris, Hidalgo, Jasper, Jefferson, Liberty, Matagorda, Newton, Nueces, Orange, Polk, San Jacinto, San Patricio, Starr, Tyler, and Wharton	DeWitt, Dimmit, Fayette, Karnes, LaSalle, Lavaca, Leon, Live Oak, McMullen, and Webb	Gregg, Harrison, Marion, Nacogdoches, Panola, Rusk, San Augustine, and Shelby

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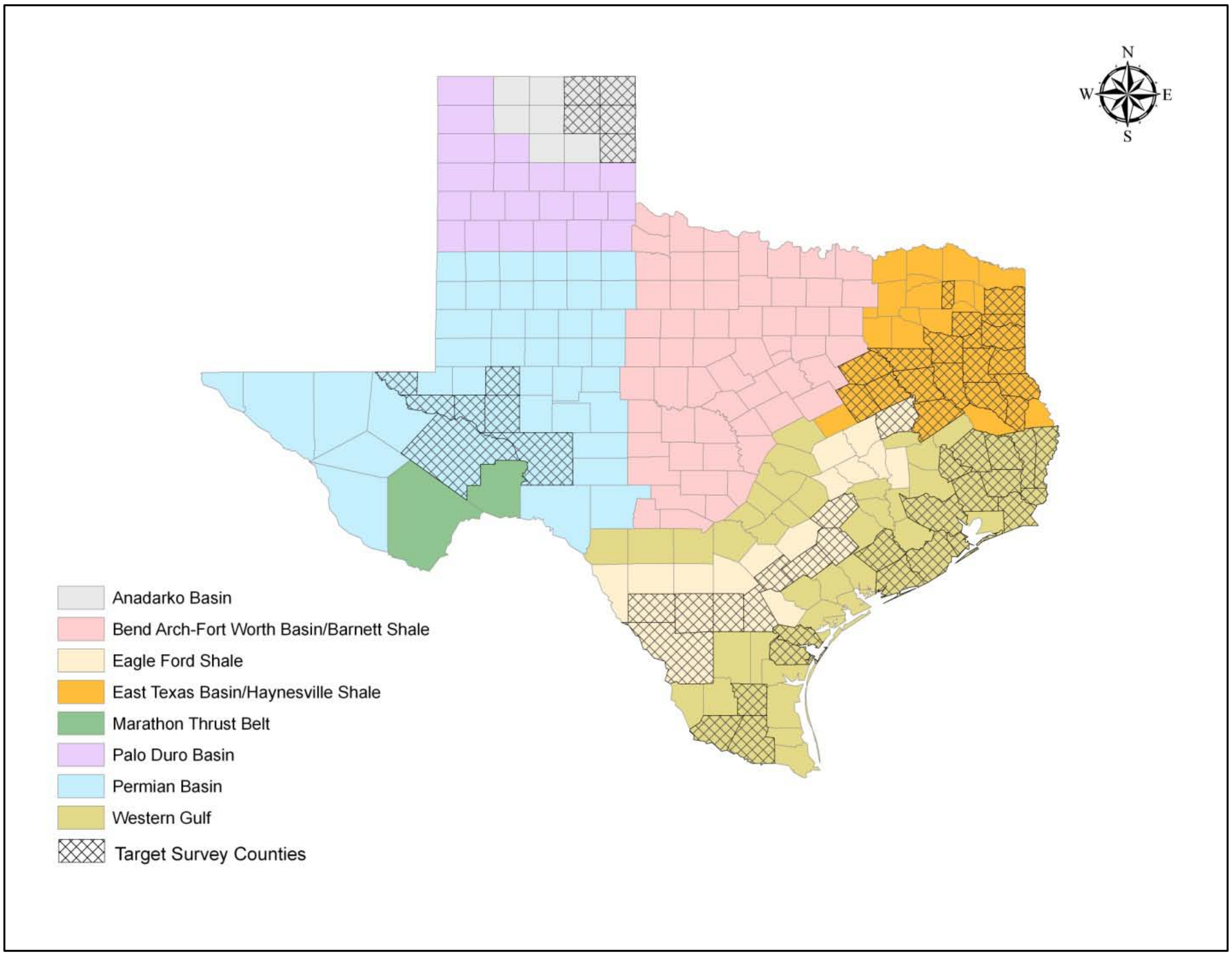
[11] Railroad Commission of Texas, Statewide Production data Query System, http://www.rrc.state.tx.us/data/online/index.php

[12] Condensate production data at the county level was mapped in ARC GIS, and the top-producing counties in each region were identified. The RRC database was then queried for operators of gas wells in these top-producing counties in each region. Operator production data was compiled for each region and the top producers were identified. These companies were contacted.

Figure 2-2. Target Survey Counties



The Bend Arch-Fort Worth basin and Barnett Shale were not surveyed, as adequate data on condensate tank emissions had already been gathered during the Barnett Shale Area Special Inventory.[13] As the survey progressed, it became apparent that much of the condensate produced in the counties designated as Haynesville Shale was actually being produced from another petroleum formation (Cotton Valley Group) located in the same counties as the Haynesville Shale. Therefore, for purposes of calculating emissions, the East Texas and Haynesville Shale regions were merged into one region.

Letters were sent to a total of 61 regional offices at 54 separate companies. Letters were sent to 116 contacts at these companies explaining the survey and requesting cooperation in gathering data. The letter requested data on county, separator pressure, API gravity, 2011 condensate production, 2011 VOC emissions, emissions estimation method, control technology, and control efficiency. This letter is shown in

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[13] Texas Commission on Environmental Quality (TCEQ), Barnett Shale Area Special Inventory, Phase Two, http://www.tceq.texas.gov/airquality/point-source-ei/psei.html#barnett2

Attachment A. The initial contact list was obtained from RigData© as it provided the names of people involved in the production (drilling) operation for the respective companies. In most cases, each contact was called 3 or 4 times in order to get a referral to someone in the environmental department of the company. Once phone contact was made with a person in a position to provide the requested information, ERG explained the purpose of the survey and requested participation. ERG obtained email addresses and sent survey materials via email directly to the contact person. The survey materials explained the background and purpose of the survey in greater detail, asked for the voluntary participation of the company, and stated that information would be held confidential. Since many of the companies surveyed only had production in one or two regions, the survey materials were tailored for each company to provide a specific and detailed listing of the region(s) and counties of interest. These materials included a Word document with a table for reporting the data, and an Excel spreadsheet with individual tabs for reporting data from each of the regions. The intent with providing these user-friendly survey materials was to make response as easy as possible and also to gather the data in a format that could be easily copied into spreadsheets for data analysis. These survey materials are shown in Attachment B. Once survey materials had been sent, a follow-up phone call was made a week later to ask if there were any questions and to determine if the company was willing to participate in the survey.

Active survey outreach efforts spanned a six-week period, and included sending the initial contact letters, calling sources to establish contact, sending follow-up letters to the proper contact as needed, making follow-up phone calls, sending emails with survey materials, and making phone calls/sending emails to determine if companies would be willing to participate. Fifteen companies participated in the survey, providing information on more than 251 separate wells/tanks.

2.4.1 Analysis of Data Collected via Phone Survey

Fifteen companies responded to the survey, and provided data from more than 251 separate wells/tank batteries. One company sent data for nine representative wells that represented production from 140 separate wells. Other companies sent data for a few sites that were representative of their other wells in that region.

Certain data received in the survey were not used in the analysis. One company provided data for ten wells but no estimates of VOC emissions, and several companies sent data for wells with API gravity less than 40 degrees. Several companies also provided data for wells with a final separator pressure less than 5 psig; this data was not used in the calculations as these low separator pressures are more indicative of wells producing oil and were not consistent with the separator pressures observed in the survey results for the primary condensate producing regions in Texas. Finally, the emissions data generated using non-preferred methods was not included in the analysis.

The raw data collected in the ERG survey, along with notes on which data was excluded from the analysis, is provided in Attachment C.

Data was collected from a sufficient number of tank batteries in each target region. ERG developed a region-wide emission factor for each of the five gas-producing regions targeted in the phone survey. This data was sorted by region. Emission factors were calculated for each of the regions. The survey also requested information on any recovery or control methods used at each well. A very high percentage of respondents indicated that they used recovery or control methods on their wells/tanks. For purposes of comparing the survey results with the test results and emission estimates from earlier studies, emission factors for the emissions before the effect of any controls were calculated.

The producers who responded to this survey used a variety of calculation models (testing, E&P Tank, ProMax, WinSim, VMGSim, HYSYS, GOR, and Vasquez Beggs) for estimating flash emissions. ERG examined these results in light of the evaluation of the accuracy of these models presented in "Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation" (TCEQ, 2009)[14] and TCEQ's guidance on calculating flash emissions[15]. ERG used only records where the flash emissions calculation method was one of the methods preferred by TCEQ. One producer sent test results for three tanks. Since only the results and no underlying data or test reports were submitted, these three data points were treated as being calculated by a preferred method.

Table 2-10 summarizes the findings from the survey. The data show a clear difference in the emission factors by region.

Table 2-10. Survey Results Using all Valid Survey Data Estimated with Preferred Estimation Methods

Region	Total Production Represented in Survey (bbl)	Data Points	Production-Weighted VOC Emission Factor (lbs/bbl)	Arithmetic Average VOC Emission Factor (lbs/bbl)	Percent of Surveyed Production Controlled
Anadarko	533,419	18	1.63	7.47	99.4%
Eagle Ford	10,538,273	41	11.3	9.41	92.2%

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[14] Texas Commission on Environmental Quality, Upstream Oil and Gas Storage Tank Project Flash Emissions Models Evaluation, 2009, http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/20090716-ergi-UpstreamOilGasTankEIModels.pdf

[15] "Calculating Volatile Organic Compounds (VOC) Flash Emissions from Crude Oil and Condensate Tanks at Oil and Gas Production Sites", APDG 5942, May 2012, http://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/guidance_flashemission.pdf

Table 2-10. Survey Results Using all Valid Survey Data Estimated with Preferred Estimation Methods

Region	Total Production Represented in Survey (bbl)	Data Points	Production-Weighted VOC Emission Factor (lbs/bbl)	Arithmetic Average VOC Emission Factor (lbs/bbl)	Percent of Surveyed Production Controlled
East Texas	518,691	83	5.91	5.75	82.1%
Permian	245,545	5	10.75	8.13	79.5%
Western Gulf	182,349	28	1.84	5.32	46.5%

2.4.2 Use of Vapor Recovery and Controls to Reduce Emissions

The ERG survey data indicates that companies are installing vapor recovery units (VRU) or control devices (flares or combustors) on their highest producing wells. VRUs may be installed for economic reasons as any vapor recovery equipment installed on a high-producing well will deliver a higher return of saleable product per dollar invested in equipment. Similarly, for companies using flares or combustors to control emissions, these control devices are being used on the highest-producing wells.

Survey data indicated that surveyed companies have installed vapor recovery or control devices on 34% of their wells/tanks, representing 91.1% of their total production. The data indicate that the emissions before controls for nearly all of the wells/tanks that had recovery devices or controls installed is greater than 25 tons per year of VOC. Producers reported that emissions from 5.7% of surveyed production were recovered with VRUs, and emissions from 85.4% of surveyed production were controlled with flares or combustors, and the average percent reduction was 97.6%.

This level of control is much higher than the results reported in the 2010 TCEQ study “Control of VOC Flash Emissions from Oil and Condensate Storage Tanks in East Texas”, in which survey respondents reported that 72% of surveyed production in the Beaumont-Port Arthur (BPA) counties were controlled, 25% of surveyed production in the HGB area were controlled, and 9% of surveyed production in the Haynesville Shale counties were controlled. The survey data also shows a much higher percentage of control than was observed in the Barnett Shale Area Special Inventory, where 13.2% of total surveyed production was reported as recovered or controlled.[16] This may be due to the differences in production in the Barnett Shale and Haynesville Shale versus the other regions of Texas. The Barnett Shale and Haynesville Shale both produce a ‘dry’ gas, with limited condensate production. Therefore, it may not have been economically

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[16] These data are shown in Table 17 of this report.

feasible or necessary from a regulatory standpoint at the time this survey was taken to control the emissions from the condensate tanks in the Barnett and Haynesville Shale.

The higher level of control observed in the ERG survey may also be due to the increasing awareness and implementation of recovery and control technologies over time, and the effect of new regulations. The Barnett Shale Inventory and the TCEQ surveys were conducted in 2009, whereas the ERG survey was conducted in 2012 and covers production and emissions in 2011. Title 30 Texas Administrative Code 106.352, Permit by Rule for Oil and Gas Handling and Production Facilities[17], became effective on February 2, 2012, which may account for the higher control percentages observed during this survey.

2.4.3 Self-Selection Bias

For any survey, the researchers need to consider if the respondents have given them data that is representative of all of their operations. ERG specifically requested in the survey materials and phone conversations that companies submit a random, representative sampling of their wells. ERG has no direct knowledge that any of the companies who responded to this survey biased the data that they submitted. However, the percent of surveyed production with emissions being recovered or controlled (91.1%) is very high when compared to the results obtained from the Barnett Shale Area Special Inventory and other studies. In reviewing the differences in the percentage of production that was reported as recovered or controlled in the ERG survey, versus the amount that was reported as controlled in the Barnett Shale Area Special Inventory, it must be noted that the results of the ERG survey were obtained voluntarily, whereas the Barnett Shale Area Special Inventory was a mandatory survey of all producers operating in that region. ERG collected survey data from 15 large and medium sized companies. A significant portion of the larger companies operate the highest producing wells in many regions. Also, larger companies may have the capital to purchase and install control devices, and may also have more resources to respond to surveys.

2.4.4 Innovative Practices that Lower Area Emissions

Two innovative practices in use that have the effect of lowering emissions were identified as part of the survey. During initial phone conversations, two companies declared that they had no tank emissions at upstream sites (well pads) because they no longer routinely used tanks in the field for their day to day operations. While these companies would install a portable liquids tank during the initial phase of well completion, the tank would soon be replaced with piping that collected all gas and condensate from multiple wells in an area and route them to a single gathering station. All gas and liquids would be processed at that station, which utilized vapor recovery and

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[17] Texas Commission on Environmental Quality, Rules, http://www.tceq.state.tx.us/rules/indxpdf.html

control equipment such that condensate tank emissions were negligible. This company replaced the traditional tank at the well site with piping and a centralized processing facility.

Another company submitted data with very low emission factors, despite the fact that tank emissions were uncontrolled. When questioned, the company official stated that the emissions factors were low as a result of their operating practices. This company captures as much flash gas as possible and has designed their facilities such that when liquids reach the tanks the pressure has been released to 2 psi [above ambient] allowing flash gas in the liquids to be released prior to the tank, captured by a vapor recovery system, and sent to the gas pipeline. This company also routes the vapors from their storage tanks to a flare. Finally, the emissions from the trucks loading liquids from the field tanks is sent back to the storage tank with vapor balance piping and routed to the flare.

Both of these practices lower the emissions from storage tanks substantially, as they recover or control nearly 100% of the VOC that would normally be emitted in an uncontrolled operation. Ultimately, these potential survey participants did not provide data as part of this survey as they had no upstream tanks and no tank emissions.

2.5 Weighting the Data

2.5.1 Weighting Data based on Method

This study compiled emissions data produced by both testing and emissions estimation methods, with the data coming from four published studies, one TCEQ inventory, and the survey associated with this report. All of this data was evaluated for its accuracy and relative merit in compiling regional and county-specific emission factors. TCEQ's guidance "Calculating Volatile Organic Compounds (VOC) Flash Emissions from Crude Oil and Condensate Tanks at Oil and Gas Production Sites"[18] was used as the basis for weighting the data obtained from testing and the various emissions estimation methods. Data obtained from testing is considered the most accurate source of emissions data, and is weighted the highest. Emissions estimates produced through use of process simulation models, E&P TANK, and the Gas-Oil-Ratio method are weighted in decreasing order of preference, consistent with the TCEQ guidance.

Table 2-11 shows the weighting factors applied to each estimation method.

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[18] "Calculating Volatile Organic Compounds (VOC) Flash Emissions from Crude Oil and Condensate Tanks at Oil and Gas Production Sites", APDG 5942, May 2012, http://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/guidance_flashemission.pdf

Table 2-11. Weighting Factors by Emissions Estimation Method

Emissions Estimation Method	Weight
Testing	4
Process Simulator (HYSIM, HYSIS, VMG, PROMAX)	2
E&P TANK	1.5
Gas-Oil-Ratio	1

The equation used to derive the regional emission factors is shown below:

$$\text{Regional Emission Factor (lbs/bbl)}_{\text{Region } i} = [(EF_{\text{Region } i \text{ TESTING}} \times 4) + (EF_{\text{Region } i \text{ PROCESS SIMULATOR}} \times 2) + (EF_{\text{Region } i \text{ E\&P TANK}} \times 1.5) + (EF_{\text{Region } i \text{ GAS-OIL-RATIO}} \times 1)]/(4+2+1.5+1) \qquad \text{(Eq. 2-1)}$$

Where:

$EF_{\text{Region } i \text{ TESTING}}$ = emission factor for the region based on testing (lbs/bbl)

$EF_{\text{Region } i \text{ PROCESS SIMULATOR}}$ = emission factor for the region based on process simulator (lbs/bbl)

$EF_{\text{Region } i \text{ E\&P TANK}}$ = emission factor for the region based on E&P Tank (lbs/bbl)

$EF_{\text{Region } i \text{ GAS-OIL-RATIO}}$ = emission factor for the region based on the GOR method (lbs/bbl)

2.5.2 Weighting Data based on Production

In addition to the method weighting discussed above, a production weighted average was used to assess the average emission rate for the wells/tanks in each particular county or region. This approach more accurately reflects the overall total emissions in a region containing a mix of high and low production sites and is appropriate for area source emissions estimation.

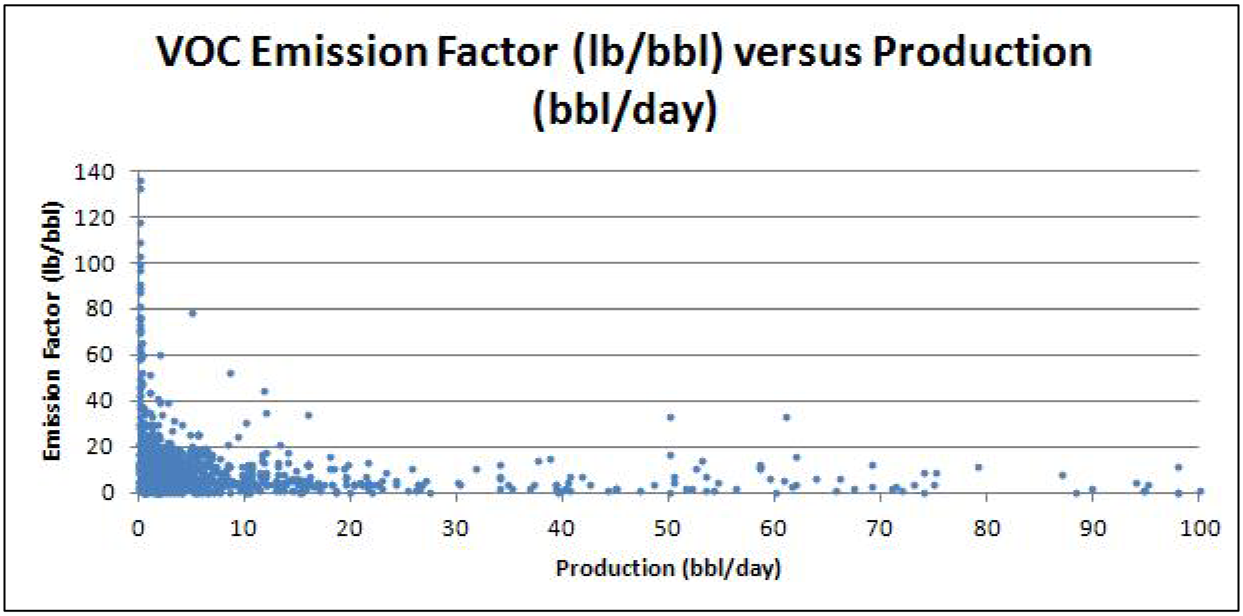
For example, if a region contains ten well sites, and there are 5 sites each producing 2 barrels of condensate per day and having measured emissions of 40 lbs/ bbl, and there are another 5 sites each producing 130 barrels per day and having measured emissions of 4 lbs/bbl, by using a production-weighted approach, the average emissions from these 10 wells/tanks is:

$$(5 \times 2 \times 40 + 5 \times 130 \times 4)/(5 \times 2 + 5 \times 130) = 4.55 \text{ lbs VOC/bbl}$$

The straight arithmetic average for these sites is 22 lbs/bbl. The actual total VOC emissions from the ten sites in this region are 3,000 pounds per day, and the total production from the ten sites in the region is 660 barrels. On a region-wide basis, the actual emissions are 3,000/660 = 4.55 lbs/bbl.

A scatter plot of the data points compiled in this report provides a useful visual depiction of the relationship between emissions on a per barrel basis and production at a given well. Figure 2-3 shows the production for each tank on the x-axis and the VOC emission factor for each tank on the y-axis. The data show a clear relationship between low production and high per-barrel emission factors, yet most of the production in any region comes from the wells with high production, which typically have lower per barrel emission factors.

Figure 2-3. Relationship between Production and Emission Factor



2.6 Regional Emission Factors

A two-step process was used in compiling the emissions data into regional emission factors for VOC and HAP. First, data was separated into subgroups by region. Subsequently, data records from each regional subgroup were separated into categories by the estimation method used (testing, process simulator, E&P Tank, GOR). A production weighted average emission factor was calculated for each subgroup for each region. The production-weighted average emission factors for each region were then combined into a single regional emission factor using the weighting factors shown in Table 2-11 as described above.

The compiled results of the testing data and estimates from the studies and surveys are shown in the Tables 2-12 through 2-16. Table 2-12 shows the compiled average of emission factors derived from testing. The test results are grouped by region, and a production-weighted average and arithmetic average is calculated for each region. These emission factors show the emissions before the effect of any controls.

Table 2-12. Average Regional VOC Emission Factors Derived from Testing Data

Studies	Region	Count of Data Points	Production-Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Flash[a]	Anadarko	4	3.89	5.22
HARC 51C, Flash[a], Upstream[b]	Fort Worth	23	12.26	20.67
Flash[a]	Permian	8	4.39	4.34
HARC 51C	Western Gulf	9	16.34	13.72

[a] Upstream Oil & Gas Storage Tank Project Flash Emissions Models Evaluation (2009).

[b] Upstream Oil & Gas Tank Emissions Measurement (2010).

Table 2-13 shows the compiled emission factors derived from the three studies referenced in this report. These emission factors (all based on E&P TANK, process simulation models, or GOR data) are grouped by region, and a production-weighted average and arithmetic average is calculated for each region. The averages for each region were developed using the weighting factors in Table 2-11. These emission factors show the emissions before the effect of any controls.

Table 2-13. Average Regional VOC Emission Factors Derived from Estimation Methods

Studies	Region	Count of Data Points	Production-Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Flash[a]	Anadarko	4	14.65	16.36
Control of VOC Flash Emissions[b]	East Texas	21	5.78	5.78
Upstream[c], Flash[a]	Fort Worth	10	13.69	12.89
Flash[a]	Permian	8	23.51	18.06

[a] Upstream Oil & Gas Storage Tank Project Flash Emissions Models Evaluation (2009).

[b] Control of VOC Flash Emissions from Oil and Condensate Storage Tanks in East Texas (2010).

[c] Upstream Oil & Gas Tank Emissions Measurement (2010).

Table 2-14 shows the compiled average emission factors derived from the ERG 2012 survey responses and the 2009 Barnett Shale Special Area Inventory. In these surveys, producers used direct measurement and estimation methods (E&P TANK, process simulation models, GOR) to estimate emissions from their condensate tanks. However, for the testing data, only the test results and no underlying data or test reports were submitted. Therefore, the testing data were treated as being calculated by a preferred method and given a weight of 1.5 instead of 4.

These emission estimates are grouped by region, and a production-weighted average and arithmetic average is calculated for each region. The averages for each region were weighted according to the weighting factors in Table 2-11. These emission factors show the emissions before the effect of any controls.

Table 2-14. Average Regional VOC Emission Factors from ERG Survey Data and Barnett Shale Inventory Data

Survey	Region	Count of Data Points	Production-Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
ERG 2012 survey	Anadarko	18	2.49	6.45
ERG 2012 survey	Eagle Ford	41	10.5	10.0
ERG 2012 survey	East Texas	83	3.51	6.22
ERG 2012 survey	Permian	5	6.25	6.08
ERG 2012 survey	Western Gulf	28	4.95	16.1
Barnett Shale Inventory	Fort Worth	1,575	7.54	12.2

Table 2-15 shows the compiled average emission factors when the data from the testing results (Table 2-12), studies (Table 2-13), and the ERG 2012 and Barnett Shale surveys (Table 2-14) is combined. The testing and emission estimate data is grouped by region, and a production-weighted average and an arithmetic average is determined for each region. The production-weighted average and arithmetic average for each region were weighted according to the weighting factors in Table 2-11. As there are no data available for the Palo Duro Basin and the Marathon Thrust Belt, a statewide average is used for these two regions. These emission factors show the emissions before the effect of any controls.

Table 2-15. Average Regional VOC Emission Factors

Region	Count of Data Points	Production-Weighted Emission Factor (lb/bbl)	Arithmetic Average Emission Factor (lb/bbl)
Anadarko	26	3.15	5.87
Eagle Ford Shale	41	10.5	10.0
East Texas/Haynesville Shale	104	4.22	5.92
Fort Worth/Barnett Shale	1,604	9.76	16.0
Permian	21	7.07	5.90

Table 2-15. Average Regional VOC Emission Factors

Region	Count of Data Points	Production-Weighted Emission Factor (lb/bbl)	Arithmetic Average Emission Factor (lb/bbl)
Western Gulf	37	11.0	14.8
Palo Duro[a]	N/A	7.61	9.75
Marathon Thrust Belt[a]	N/A	7.61	9.75

[a] Statewide average.

Figure 2-4 provides the geographical distribution of the data sources used to compile the regional emission factors in Table 2-15 on a county-basis.

Figure 2-4. Condensate Tank Emission Data Sources by County

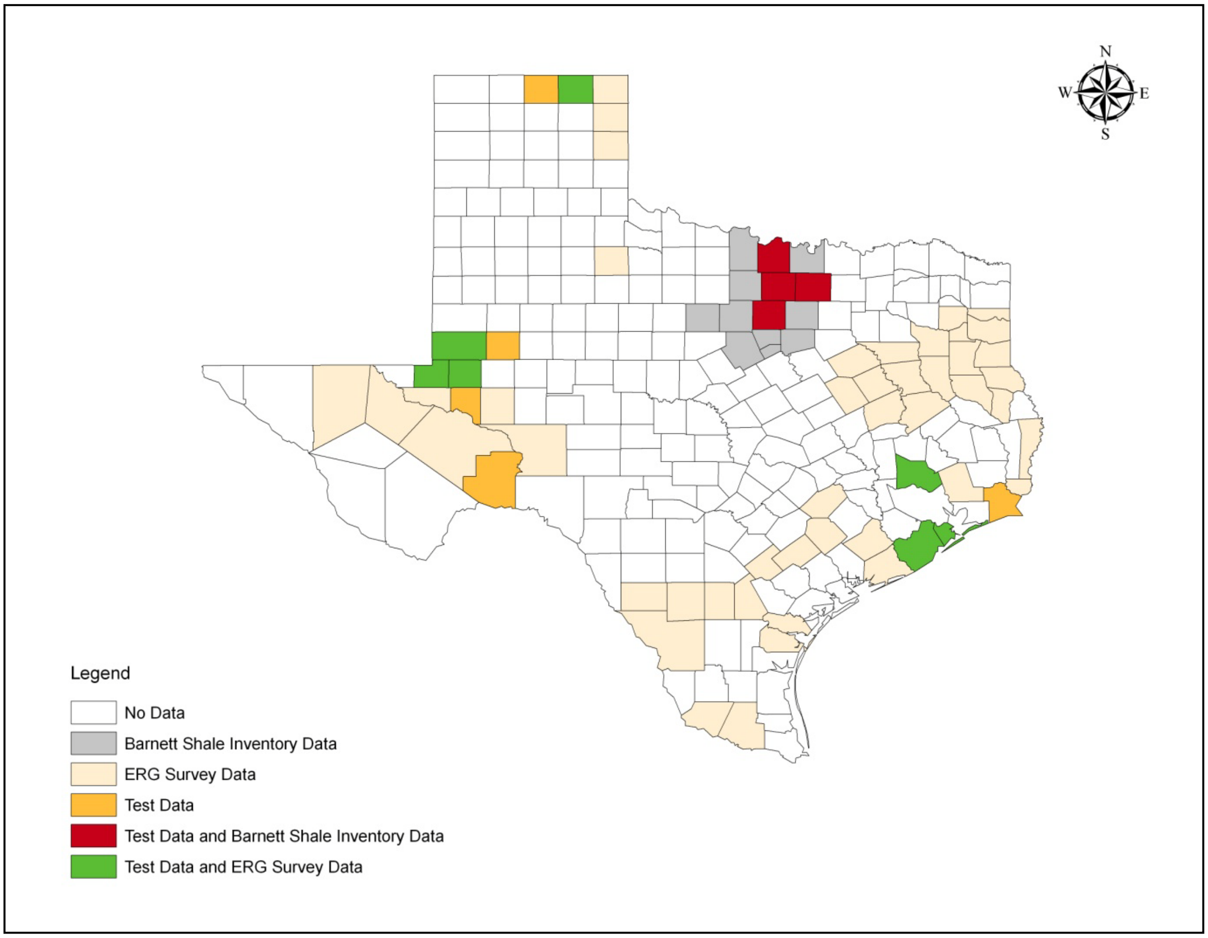
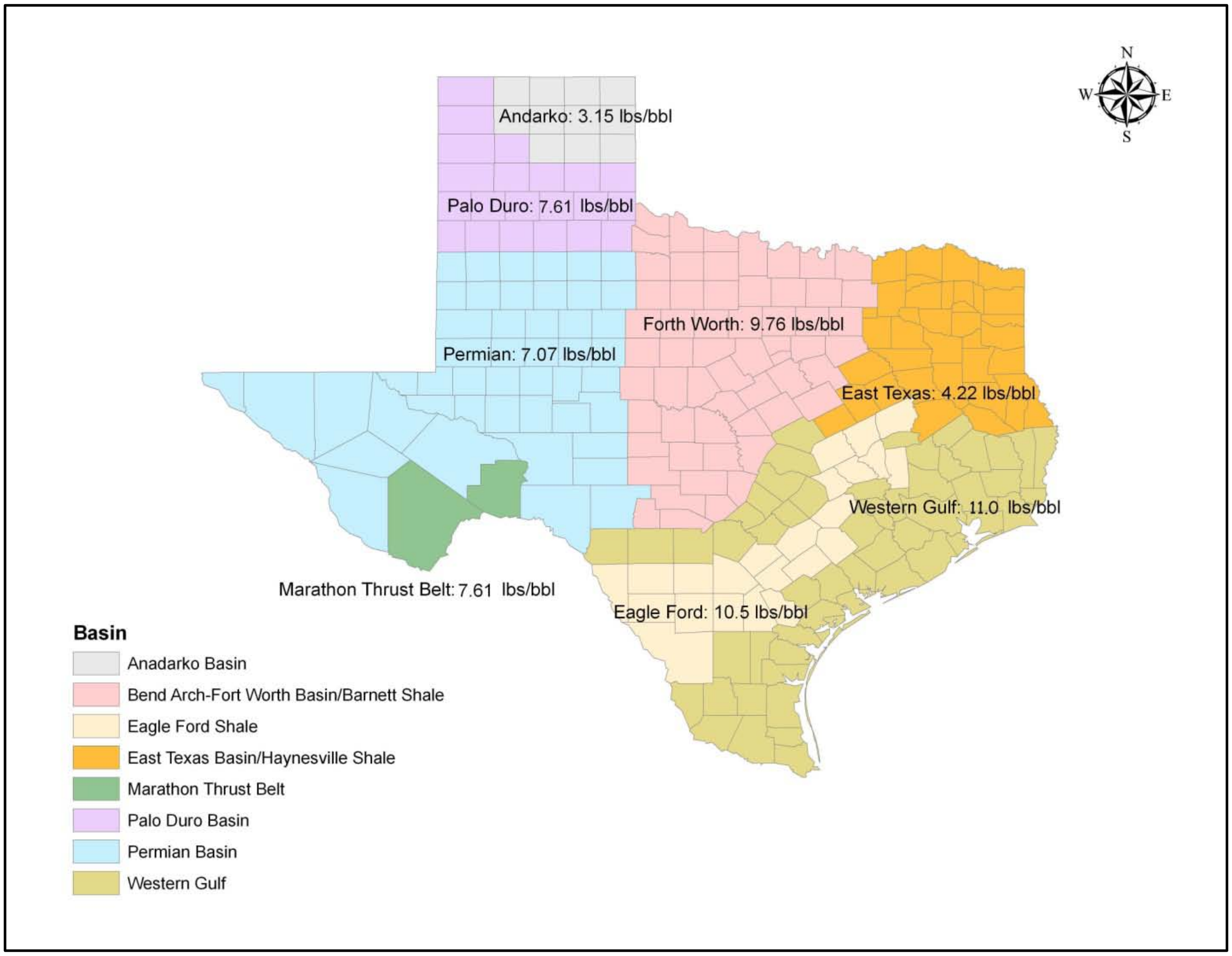


Figure 2-5 shows the results from Table 2-15 geographically. Determination of which counties are included in each region is from the United States Geological Survey.[19] Counties in the Eagle Ford Shale were identified by the RRC.[20] For certain counties, there was sufficient data available to develop a county-specific emission factor based only on the data available for that particular county. However, a careful examination of these county-specific emission factors (see Attachment C) shows that they vary widely within any one region. This may be indicative of the variation in properties of the condensate produced, or it may be due to an inadequate sample size. Due to the variation observed in the county-specific factors and the uncertainties associated with these factors, the regional emission factors presented in Table 2-15 are recommended for developing the state-wide area source inventory.

Figure 2-5. Average Regional Emission Factors, Before Controls



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[19] United States Geological Survey, National Oil and Gas Assessment, http://energy.usgs.gov/OilGas/AssessmentsData/NationalOilGasAssessment.aspx

[20] Texas Railroad Commission, Eagle Ford Information, http://www.rrc.state.tx.us/eagleford/

The region-specific condensate tank emission factors can then be assigned on a county basis by allocating each county in the state to one of the regions identified in Table 2-15. The county-level VOC emission factor (both production weighted and arithmetic average) for each county in Texas is shown in Table 2-16.

Table 2-16. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Anderson	East Texas/Haynesville Shale	4.22	5.92
Andrews	Permian	7.07	5.90
Angelina	East Texas/Haynesville Shale	4.22	5.92
Aransas	Western Gulf	11.0	14.8
Archer	Fort Worth/Barnett Shale	9.76	16.0
Armstrong	Palo Duro	7.61	9.75
Atascosa	Eagle Ford Shale	10.5	10.0
Austin	Western Gulf	11.0	14.8
Bailey	Palo Duro	7.61	9.75
Bandera	Fort Worth/Barnett Shale	9.76	16.0
Bastrop	Western Gulf	11.0	14.8
Baylor	Fort Worth/Barnett Shale	9.76	16.0
Bee	Eagle Ford Shale	10.5	10.0
Bell	Western Gulf	11.0	14.8
Bexar	Western Gulf	11.0	14.8
Blanco	Fort Worth/Barnett Shale	9.76	16.0
Borden	Permian	7.07	5.90
Bosque	Fort Worth/Barnett Shale	9.76	16.0
Bowie	East Texas/Haynesville Shale	4.22	5.92
Brazoria	Western Gulf	11.0	14.8
Brazos	Eagle Ford Shale	10.5	10.0
Brewster	Marathon Thrust Belt	7.61	9.75
Briscoe	Palo Duro	7.61	9.75
Brooks	Western Gulf	11.0	14.8
Brown	Fort Worth/Barnett Shale	9.76	16.0
Burleson	Eagle Ford Shale	10.5	10.0
Burnet	Fort Worth/Barnett Shale	9.76	16.0
Caldwell	Western Gulf	11.0	14.8
Calhoun	Western Gulf	11.0	14.8
Callahan	Fort Worth/Barnett Shale	9.76	16.0
Cameron	Western Gulf	11.0	14.8
Camp	East Texas/Haynesville Shale	4.22	5.92
Carson	Anadarko	3.15	5.87
Cass	East Texas/Haynesville Shale	4.22	5.92
Castro	Palo Duro	7.61	9.75
Chambers	Western Gulf	11.0	14.8
Cherokee	East Texas/Haynesville Shale	4.22	5.92
Childress	Palo Duro	7.61	9.75
Clay	Fort Worth/Barnett Shale	9.76	16.0

Table 2-16. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Cochran	Permian	7.07	5.90
Coke	Permian	7.07	5.90
Coleman	Fort Worth/Barnett Shale	9.76	16.0
Collin	Fort Worth/Barnett Shale	9.76	16.0
Collingsworth	Palo Duro	7.61	9.75
Colorado	Western Gulf	11.0	14.8
Comal	Western Gulf	11.0	14.8
Comanche	Fort Worth/Barnett Shale	9.76	16.0
Concho	Fort Worth/Barnett Shale	9.76	16.0
Cooke	Fort Worth/Barnett Shale	9.76	16.0
Coryell	Fort Worth/Barnett Shale	9.76	16.0
Cottle	Palo Duro	7.61	9.75
Crane	Permian	7.07	5.90
Crockett	Permian	7.07	5.90
Crosby	Permian	7.07	5.90
Culberson	Permian	7.07	5.90
Dallam	Palo Duro	7.61	9.75
Dallas	Fort Worth/Barnett Shale	9.76	16.0
Dawson	Permian	7.07	5.90
Deaf Smith	Palo Duro	7.61	9.75
Delta	East Texas/Haynesville Shale	4.22	5.92
Denton	Fort Worth/Barnett Shale	9.76	16.0
DeWitt	Eagle Ford Shale	10.5	10.0
Dickens	Permian	7.07	5.90
Dimmit	Eagle Ford Shale	10.5	10.0
Donley	Palo Duro	7.61	9.75
Duval	Western Gulf	11.0	14.8
Eastland	Fort Worth/Barnett Shale	9.76	16.0
Ector	Permian	7.07	5.90
Edwards	Permian	7.07	5.90
El Paso	Permian	7.07	5.90
Ellis	Fort Worth/Barnett Shale	9.76	16.0
Erath	Fort Worth/Barnett Shale	9.76	16.0
Falls	East Texas/Haynesville Shale	4.22	5.92
Fannin	East Texas/Haynesville Shale	4.22	5.92
Fayette	Eagle Ford Shale	10.5	10.0
Fisher	Permian	7.07	5.90
Floyd	Palo Duro	7.61	9.75
Foard	Fort Worth/Barnett Shale	9.76	16.0
Fort Bend	Western Gulf	11.0	14.8
Franklin	East Texas/Haynesville Shale	4.22	5.92
Freestone	East Texas/Haynesville Shale	4.22	5.92
Frio	Eagle Ford Shale	10.5	10.0
Gaines	Permian	7.07	5.90

Table 2-16. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Galveston	Western Gulf	11.0	14.8
Garza	Permian	7.07	5.90
Gillespie	Fort Worth/Barnett Shale	9.76	16.0
Glasscock	Permian	7.07	5.90
Goliad	Western Gulf	11.0	14.8
Gonzales	Eagle Ford Shale	10.5	10.0
Gray	Anadarko	3.15	5.87
Grayson	Fort Worth/Barnett Shale	9.76	16.0
Gregg	East Texas/Haynesville Shale	4.22	5.92
Grimes	Eagle Ford Shale	10.5	10.0
Guadalupe	Western Gulf	11.0	14.8
Hale	Palo Duro	7.61	9.75
Hall	Palo Duro	7.61	9.75
Hamilton	Fort Worth/Barnett Shale	9.76	16.0
Hansford	Anadarko	3.15	5.87
Hardeman	Fort Worth/Barnett Shale	9.76	16.0
Hardin	Western Gulf	11.0	14.8
Harris	Western Gulf	11.0	14.8
Harrison	East Texas/Haynesville Shale	4.22	5.92
Hartley	Palo Duro	7.61	9.75
Haskell	Fort Worth/Barnett Shale	9.76	16.0
Hays	Western Gulf	11.0	14.8
Hemphill	Anadarko	3.15	5.87
Henderson	East Texas/Haynesville Shale	4.22	5.92
Hidalgo	Western Gulf	11.0	14.8
Hill	Fort Worth/Barnett Shale	9.76	16.0
Hockley	Permian	7.07	5.90
Hood	Fort Worth/Barnett Shale	9.76	16.0
Hopkins	East Texas/Haynesville Shale	4.22	5.92
Houston	East Texas/Haynesville Shale	4.22	5.92
Howard	Permian	7.07	5.90
Hudspeth	Permian	7.07	5.90
Hunt	East Texas/Haynesville Shale	4.22	5.92
Hutchinson	Anadarko	3.15	5.87
Irion	Permian	7.07	5.90
Jack	Fort Worth/Barnett Shale	9.76	16.0
Jackson	Western Gulf	11.0	14.8
Jasper	Western Gulf	11.0	14.8
Jeff Davis	Permian	7.07	5.90
Jefferson	Western Gulf	11.0	14.8
Jim Hogg	Western Gulf	11.0	14.8
Jim Wells	Western Gulf	11.0	14.8
Johnson	Fort Worth/Barnett Shale	9.76	16.0
Jones	Fort Worth/Barnett Shale	9.76	16.0

Table 2-16. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Karnes	Eagle Ford Shale	10.5	10.0
Kaufman	East Texas/Haynesville Shale	4.22	5.92
Kendall	Fort Worth/Barnett Shale	9.76	16.0
Kenedy	Western Gulf	11.0	14.8
Kent	Permian	7.07	5.90
Kerr	Fort Worth/Barnett Shale	9.76	16.0
Kimble	Fort Worth/Barnett Shale	9.76	16.0
King	Permian	7.07	5.90
Kinney	Western Gulf	11.0	14.8
Kleberg	Western Gulf	11.0	14.8
Knox	Fort Worth/Barnett Shale	9.76	16.0
La Salle	Eagle Ford Shale	10.5	10.0
Lamar	East Texas/Haynesville Shale	4.22	5.92
Lamb	Palo Duro	7.61	9.75
Lampasas	Fort Worth/Barnett Shale	9.76	16.0
Lavaca	Eagle Ford Shale	10.5	10.0
Lee	Eagle Ford Shale	10.5	10.0
Leon	Eagle Ford Shale	10.5	10.0
Liberty	Western Gulf	11.0	14.8
Limestone	East Texas/Haynesville Shale	4.22	5.92
Lipscomb	Anadarko	3.15	5.87
Live Oak	Eagle Ford Shale	10.5	10.0
Llano	Fort Worth/Barnett Shale	9.76	16.0
Loving	Permian	7.07	5.90
Lubbock	Permian	7.07	5.90
Lynn	Permian	7.07	5.90
Madison	Western Gulf	11.0	14.8
Marion	East Texas/Haynesville Shale	4.22	5.92
Martin	Permian	7.07	5.90
Mason	Fort Worth/Barnett Shale	9.76	16.0
Matagorda	Western Gulf	11.0	14.8
Maverick	Eagle Ford Shale	10.5	10.0
McCulloch	Fort Worth/Barnett Shale	9.76	16.0
McLennan	Fort Worth/Barnett Shale	9.76	16.0
McMullen	Eagle Ford Shale	10.5	10.0
Medina	Western Gulf	11.0	14.8
Menard	Fort Worth/Barnett Shale	9.76	16.0
Midland	Permian	7.07	5.90
Milam	Eagle Ford Shale	10.5	10.0
Mills	Fort Worth/Barnett Shale	9.76	16.0
Mitchell	Permian	7.07	5.90
Montague	Fort Worth/Barnett Shale	9.76	16.0
Montgomery	Western Gulf	11.0	14.8
Moore	Anadarko	3.15	5.87

Table 2-16. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Morris	East Texas/Haynesville Shale	4.22	5.92
Motley	Palo Duro	7.61	9.75
Nacogdoches	East Texas/Haynesville Shale	4.22	5.92
Navarro	East Texas/Haynesville Shale	4.22	5.92
Newton	Western Gulf	11.0	14.8
Nolan	Permian	7.07	5.90
Nueces	Western Gulf	11.0	14.8
Ochiltree	Anadarko	3.15	5.87
Oldham	Palo Duro	7.61	9.75
Orange	Western Gulf	11.0	14.8
Palo Pinto	Fort Worth/Barnett Shale	9.76	16.0
Panola	East Texas/Haynesville Shale	4.22	5.92
Parker	Fort Worth/Barnett Shale	9.76	16.0
Parmer	Palo Duro	7.61	9.75
Pecos	Permian	7.07	5.90
Polk	Western Gulf	11.0	14.8
Potter	Palo Duro	7.61	9.75
Presidio	Permian	7.07	5.90
Rains	East Texas/Haynesville Shale	4.22	5.92
Randall	Palo Duro	7.61	9.75
Reagan	Permian	7.07	5.90
Real	Fort Worth/Barnett Shale	9.76	16.0
Red River	East Texas/Haynesville Shale	4.22	5.92
Reeves	Permian	7.07	5.90
Refugio	Western Gulf	11.0	14.8
Roberts	Anadarko	3.15	5.87
Robertson	Eagle Ford Shale	10.5	10.0
Rockwall	East Texas/Haynesville Shale	4.22	5.92
Runnels	Fort Worth/Barnett Shale	9.76	16.0
Rusk	East Texas/Haynesville Shale	4.22	5.92
Sabine	East Texas/Haynesville Shale	4.22	5.92
San Augustine	East Texas/Haynesville Shale	4.22	5.92
San Jacinto	Western Gulf	11.0	14.8
San Patricio	Western Gulf	11.0	14.8
San Saba	Fort Worth/Barnett Shale	9.76	16.0
Schleicher	Permian	7.07	5.90
Scurry	Permian	7.07	5.90
Shackelford	Fort Worth/Barnett Shale	9.76	16.0
Shelby	East Texas/Haynesville Shale	4.22	5.92
Sherman	Anadarko	3.15	5.87
Smith	East Texas/Haynesville Shale	4.22	5.92
Somervell	Fort Worth/Barnett Shale	9.76	16.0
Starr	Western Gulf	11.0	14.8
Stephens	Fort Worth/Barnett Shale	9.76	16.0

Table 2-16. County-Level VOC Emission Factors

County	Region	Production Weighted Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Sterling	Permian	7.07	5.90
Stonewall	Permian	7.07	5.90
Sutton	Permian	7.07	5.90
Swisher	Palo Duro	7.61	9.75
Tarrant	Fort Worth/Barnett Shale	9.76	16.0
Taylor	Fort Worth/Barnett Shale	9.76	16.0
Terrell	Marathon Thrust Belt	7.61	9.75
Terry	Permian	7.07	5.90
Throckmorton	Fort Worth/Barnett Shale	9.76	16.0
Titus	East Texas/Haynesville Shale	4.22	5.92
Tom Green	Permian	7.07	5.90
Travis	Western Gulf	11.0	14.8
Trinity	Western Gulf	11.0	14.8
Tyler	Western Gulf	11.0	14.8
Upshur	East Texas/Haynesville Shale	4.22	5.92
Upton	Permian	7.07	5.90
Uvalde	Western Gulf	11.0	14.8
Val Verde	Permian	7.07	5.90
Van Zandt	East Texas/Haynesville Shale	4.22	5.92
Victoria	Western Gulf	11.0	14.8
Walker	Western Gulf	11.0	14.8
Waller	Western Gulf	11.0	14.8
Ward	Permian	7.07	5.90
Washington	Western Gulf	11.0	14.8
Webb	Eagle Ford Shale	10.5	10.0
Wharton	Western Gulf	11.0	14.8
Wheeler	Anadarko	3.15	5.87
Wichita	Fort Worth/Barnett Shale	9.76	16.0
Wilbarger	Fort Worth/Barnett Shale	9.76	16.0
Willacy	Western Gulf	11.0	14.8
Williamson	Western Gulf	11.0	14.8
Wilson	Eagle Ford Shale	10.5	10.0
Winkler	Permian	7.07	5.90
Wise	Fort Worth/Barnett Shale	9.76	16.0
Wood	East Texas/Haynesville Shale	4.22	5.92
Yoakum	Permian	7.07	5.90
Young	Fort Worth/Barnett Shale	9.76	16.0
Zapata	Western Gulf	11.0	14.8
Zavala	Eagle Ford Shale	10.5	10.0

2.7 Accounting for the Effect of Recovery and Control Devices

The effect of existing vapor recovery and control devices should be accounted for in determining emissions from area sources. However, there is limited information on the use of control devices in the condensate producing regions of Texas, and the quantity of the information varies.

2.7.1 Barnett Shale

The TCEQ Barnett Shale Special Inventory data indicates whether condensate tank emissions are recovered or controlled at each site. This dataset contains 1,575 records covering the 14 counties listed in Table 2-8 above. The Barnett Shale Inventory data indicate that 13.2% of total surveyed production in these 14 counties was controlled, and the average percent reduction was 97.2%. The 2009 RRC condensate production data for these 14 counties is 2,680,019 bbl. The surveyed production (2,479,409 bbl from Table 2-8) represents 92.5% of total 2009 condensate production in these counties. Because the Barnett Shale Inventory was a mandatory survey of all producers in these counties, and had a very high response rate, we can assume that 12.2% (92.5% x 13.2%) of total production in that region should be considered to be controlled by 97.2%, for an overall reduction of 11.8%.

2.7.2 HGB, BPA, and Haynesville Shale

The 2010 study conducted by ENVIRON for TCEQ titled "*Control of VOC Flash Emissions from Oil and Condensate Storage Tanks in East Texas*" reported on control of emissions from oil and condensate storage tanks in three geographic regions of Texas. This study investigated the effect on VOC emissions reductions in the HGB nonattainment area due to the implementation of requirements in Title 30 Texas Administrative Code 115.112(d)(5). The report investigated the possible effects should this same rule be implemented in the BPA area and the Haynesville Shale area. This report also considered the effect of the Texas Permit by Rule (Title 30 TAC 106.352) requirements, which allow a well/tank site with emissions less than 25 tons of VOC per year to qualify for a more streamlined permit. [21]

This report included results from surveys of the HGB area, the BPA area, the Haynesville Shale, and a TCEQ Region 12 survey for the HGB area. 82 producers responded to these two surveys and submitted control information for 1,940 sites.[22]

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[21] The Permit By Rule for Oil and Gas sites (Title 30 TAC 106.352) allows new or modified facilities that meet certain conditions and that emit less than 25 tons per year of VOC to be obtain authorization per rule requirements. It has the effect of encouraging larger oil and gas sources to install control devices on their oil and condensate tanks so as to limit emissions.

[22] There is a small overlap in data collected for the HGB area (Table ES-3 of the report). It does not affect the results, as the overlap has been accounted for in analyzing the data.

The data collected for this report[23] indicated that 25% of the surveyed production in the HGB area was controlled, 9% of the surveyed production in the Haynesville Shale area was controlled, and 72% of the surveyed production in the BPA area was controlled. The high surveyed percentage of controlled production in the BPA area can be attributed to a group of large condensate producing sites (accounting for more than 1000 bbl/day) equipped with a suite of control devices. These sites accounted for approximately half of the surveyed BPA area production and significantly contribute to the high percentage of surveyed controlled production.

This study also requested information from producers about tank emissions controls. When this information is combined with production information, it gives an estimate of the percent of total surveyed production in each of the surveyed areas that is controlled.

2.7.3 Calculation of Control Factor

Each region-specific or county-specific control factor should reflect the percentage of production in that region/county that was reported as controlled per the survey. For the percentage of production that was not reported in these surveys, instead of assuming this production is uncontrolled, a default control percentage is applied. The assumed default control factor for the production not reported in these surveys was developed from the TCEQ Barnett Shale Special Inventory data. The large sample size of this special inventory data combined with the characteristics of the Barnett Shale formation represents a conservative control estimate.

To calculate an overall control factor, a multi-step calculation was developed that accounts for reported versus unreported survey condensate production. This calculation is outlined for the HGB area in detail below; the same calculation was employed with area-specific data for the other areas. The calculation methodology was as follows:

1. 68 % of HGB condensate production was reported in the survey.
    a. 25% of reported production is controlled at a 95% level
    b. 75% of reported production is not controlled
2. 32 % of HGB production data was not reported in the survey
3. To account for the different categories of data, each category will be treated separately and the results summed to produce the control factor.
    a. For the controlled category, category 1a, the basic formula is:
        i. Portion of control factor = (percent of production represented by category) * (percent of controlled production) * (control efficiency)
        ii. For category 1a, this equals: (0.680*0.25*0.95) = 0.161 or 16.1%
    b. For the category where production was not reported, category 2, default data is assumed and the basic formula is:

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[23] TCEQ provided ERG with three spreadsheets containing the survey data obtained from the ENVIRON surveys.

        i. Portion of control factor = (percent of production represented by category) * (percent of controlled production, default from Barnett Shale special inventory) * (control efficiency, default from Barnett Shale special inventory)
        ii. For category 2, this equals: (0.320*0.122*0.972) = 0.0379 or 3.8%
    c. Total control for 100% of production in the HGB area is therefore the sum of portion of controls from categories 1a and 2, or (16.1+3.8) % or 19.9%.

Table 2-17 below presents the findings of this analysis and includes a recommended control factor for each region.

2.7.4 ERG 2012 Survey

The ERG 2012 survey collected data from 15 companies for 251 sites in 50 counties. Data from 175 of these sites was used in calculating results. The survey data show that emissions from 91.1% of all surveyed production was either recovered with a VRU or controlled with a flare or combustor, and the average percent reduction was 97.6%. These are exceptionally high percentages when compared with the amount of production reported as controlled in the Barnett Shale Inventory and the TCEQ 2010 study above. The ERG 2012 survey data was voluntary, and may not be representative of all producers or other counties in the regions surveyed. This difference may also be due to the characteristics of the Barnett Shale and Haynesville Shale formations versus the other regions of Texas. The Barnett Shale and Haynesville Shale both produce a 'dry' gas, with little condensate production. Therefore, it may not have been economical or necessary from a regulatory standpoint at the time this survey was taken to control the emissions from the condensate tanks in the Barnett and Haynesville Shale.

The higher level of control observed in the ERG survey may also be due to the increasing implementation of recovery and control technologies over time, and the effect of new regulations limiting air pollutant emissions in specific areas. The Barnett Shale Inventory and the TCEQ surveys were conducted in 2009, whereas the ERG survey was conducted in 2012 and covers production and emissions in 2011. Title 30 Texas Administrative Code 106.352, Permit by Rule for Oil and Gas Handling and Production Facilities[24], became effective on February 2, 2012, which may account for the higher control percentages observed during this survey.

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[24] Texas Commission on Environmental Quality, Rules, http://www.tceq.state.tx.us/rules/indxpdf.html

Table 2-17. Percentage of Surveyed Production with Tank Emissions Controlled in the HGB, BPA, and Haynesville Shale Areas

Region (counties)	2009 Total Production Reported to RRC [a] (bbl)	Number of Sites/Tank Batteries Surveyed [b]	Total Surveyed Production [c]	Total Controlled Production Reported in Survey [d] (bbl)	Percent of Reported Production That is Controlled [d] (%)	Percent of Production Not Reported in the Survey [e] (%)	Control Efficiency (%)	Control Factor (%)
Houston-Galveston-Brazoria (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller)	3,436,859	180	2,335,837	583,462	25.0	32.0	95	19.9
Beaumont - Port Arthur (Hardin, Jefferson, Orange)	5,456,431	26	1,196,723	863,250	72.1	78.1	90	23.5
Haynesville Shale (Gregg, Harrison, Marion, Nacogdoches, Panola, Rusk, San Augustine, Smith, Shelby, Upshur)	5,445,378	523	2,018,527	182,525	9.04	62.9	90	10.5
Barnett Shale (Clay, Cooke, Denton, Erath, Hood, Jack, Johnson, Montague, Palo Pinto, Parker, Somervell, Stephens, Tarrant, Wise) [f]	2,680,019	1,575	2,478,858	326,545	13.2	7.5	97.2	11.8

[a] Data for 2009 condensate production from these counties is from a production data query at the Railroad Commission of Texas website.

[b] Data for the number of sites/tank batteries surveyed in the HGB, BPA, and Haynesville Shale areas comes from Tables 14a and 14b of the "*Control of VOC Flash Emissions from Oil and Condensate Storage Tanks in East Texas*" (TCEQ, 2010) report.

[c] Data for the total surveyed production for the HGB, BPA, and Haynesville Shale areas comes from Table 8 of the "*Control of VOC Flash Emissions from Oil and Condensate Storage Tanks in East Texas"* report.

[d] Data for the total controlled production for the HGB, BPA, and Haynesville Shale areas comes from spreadsheets provided to ERG by TCEQ.

[e] This percentage is derived from the 2009 total production reported to RRC (column 2) and the total surveyed production (column 4).

[f] The data for the Barnett Shale counties comes from the TCEQ Barnett Shale Special Inventory (Table 2-8 and Attachment C of this report).

In assessing whether the surveyed data is representative of all basin operations, ERG has no direct knowledge that any of the companies who responded to this survey biased the data that they submitted. However, as noted above, the percent of surveyed production with emissions being recovered or controlled (91.1%) is very high when compared to the results obtained from the Barnett Shale Area Special Inventory and other studies. ERG collected survey data from 15 large and medium sized companies. A significant portion of the larger companies operate the highest producing wells in many regions. Also, larger companies may have the capital to purchase and install control devices, and may also have more resources to respond to surveys.

The figures for surveyed production as a percentage of total production reported by the RRC also indicate that the survey counts as 'condensate' a significant percentage of liquids production that the RRC considers to be oil. Although ERG requested data for condensate production, data was also requested for wells producing liquids with an API gravity greater than 40 degrees. Since the RRC condensate production values are ultimately used for TCEQ area source emissions inventory development, survey data was reviewed and outlier data suspected of representing oil production (e.g., extremely low separator pressure) was not used for emissions and control factor development. The majority of outlier data appeared in the Permian Basin region, where oil production is at least 100 times greater than condensate production.[25] Survey responses for certain basins in the state captured a limited amount of basin production. With the varying amount of data available for analysis, uncertainties exist about applying the control factor from the surveyed data to the remainder of condensate production in those counties and areas.

Table 2-18 shows the control information developed from the ERG survey data.

2.8 Summary of Findings and Recommended Emission Factors

Analysis of data from four studies and two surveys indicates that there exists a distinct regional variation in emissions from condensate storage tanks across the oil and gas producing regions of Texas. Emission estimates from testing and software models were considered and each of these data sources has limitations.

Survey data indicate that producers are installing recovery and control devices on an increasing percentage of their condensate wells. The Barnett Shale Inventory data indicates that emissions from 12.2% of total surveyed production were controlled, and data from the 15 producers participating in the ERG 2012 survey indicated that emissions from 91.0% of their total production was recovered or controlled. Other innovative techniques, such as piping all production directly to a centralized processing facility, or using multi-stage separators with ultra-low final stage pressure drop, also

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[25] Railroad Commission of Texas, http://www.rrc.state.tx.us/permianbasin/index.php

reduce emissions from condensate production at area sources. An accurate assessment of area source emissions will need to account for the effect of these techniques, and for any increase in their implementation over time.

ERG recommends use of the uncontrolled, production-weighted VOC emission factors in Table 2-16 when calculating the emissions from area source condensate production. Application of the control factors to the percentage of surveyed, controlled condensate production presented in Table 2-17 is recommended for the HGB, BPA, Haynesville Shale, and Barnett Shale counties listed. Despite the availability of ERG 2012 survey data for other regions as shown in Table 2-18, the 11.8% control factor derived from the comprehensive Barnett Shale Inventory is recommended for the remainder of condensate production in these regions and throughout the state until additional data for a large number of producers in the other regions can be obtained. These emission reduction factors will capture the effect of emission recovery and control devices that producers have installed on their production equipment in the counties listed, while conservatively estimating emissions for the remainder of condensate production.

Alternatively, the control factors presented in both Tables 2-17 and 2-18 can be applied to the percentage of surveyed, controlled condensate production for the counties in each region. For the remainder of production, application of the 11.8% control factor derived from the Barnett Shale Inventory is recommended.

Table 2-18. Surveyed Production, Total Production, Percent of Surveyed Production Controlled, and Control Factor, by Region

Region	Total Production Represented in Survey (bbl)	Total Annual Production[a] (bbl)	Percent of 2011 Production Represented by the Survey	Total Controlled Production Reported in Survey (bbl)	Percent of Surveyed Production Controlled	Control Efficiency (%)	Control Factor (%)[b]	Alternate Control Factor (%)[c]
Anadarko	533,419	8,609,960	6.2	530,324	99.4	97.9	6.03	17.1
Eagle Ford	10,538,273	24,343,253	43.3	9,716,987	92.2	98.5	39.3	46.0
East Texas	518,691	4,681,732	11.1	425,644	82.1	98.1	8.92	19.4
Permian	245,545	2,036,996	12.1	195,275	79.5	94.7	9.08	19.5
Western Gulf	182,349	18,241,171	1.0	84,785	46.5	98.0	0.46	12.2

[a] Data for 2009 condensate production from the Barnett Shale area and 2011 condensate production for the other five regions is from the RRC.

[b] Control factor assumes that only the surveyed production is controlled.

[c] Control factor assumes that surveyed production is controlled at the surveyed control rate, and that the unsurveyed production is controlled at a default rate of 11.8 percent.

3.0 Hazardous Air Pollutant Emissions from Condensate Storage Tanks

As part of the study to refine the condensate tank VOC emission factor used in the TCEQ area source inventory, ERG accumulated a significant amount of data on emissions of benzene, toluene, ethylbenzene, and xylene (BTEX) from condensate storage tanks. This data was obtained from the 2006 HARC study, the Barnett Shale Area Special Inventory Phase II survey of producers, and E&P TANK report data submitted by producers in response to the ERG 2012 survey. ERG determined that the amount and quality of this data was sufficient to allow development of region-specific emission factors for BTEX emissions from storage tanks for four geographic regions in the state. These four regions are: Eagle Ford Shale, East Texas/Haynesville Shale, Bend Arch-Fort Worth/Barnett Shale, and Western Gulf. These regions are shown in Figure 2-1 above.

3.1 BTEX Emissions Data Derived from Testing

The researchers who conducted the study "*VOC Emissions from Oil and Condensate Storage Tanks*" (Houston Advanced Research Center, 2006, and Texas Environmental Research Consortium, 2009)[26] also made measurements of BTEX content of the emissions from each of the oil and condensate storage tanks. The report provided data for the weight percent of benzene, toluene, ethylbenzene, and xylene in the tank vent gas; data on the weight percent of VOC in the tank vent gas; the liquid production in barrels per day; and the VOC emissions in pounds per day and pounds per barrel. ERG re-examined the data from the sites examined in the HARC 2006 study. Although 27 sites produce liquids having an API gravity of 40 degrees or greater, only data from the 22 sites designated as being condensate is considered. In this analysis, three data points were removed from the data set as was done for the VOC emission factor development process as described above. An emission factor for each of the remaining 19 sites was calculated. Table 2-1 (above) and Table 3-1 (below) show the measurement data from the HARC 2006 study for these 19 condensate tanks.

Table 3-1. VOC and BTEX Content in the Vent Gas

Tank Battery	Weight % VOC	Weight % Benzene	Weight % Toluene	Weight % Ethylbenzene	Weight % Xylene
2	47	0.34	0.53	0.04	0.21
3	62	0.63	1.10	0.06	0.46
4	57	0.57	1.02	0.06	0.41
5	70	0.75	1.32	0.07	0.55
6	65	0.49	0.56	0.03	0.14
13	81	0.19	0.40	0.01	0.14
14	53	0.13	0.33	0.02	0.16

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[26] Houston Advanced Research Center, VOC Emissions from Oil and Condensate Storage Tanks, October 31, 2006. http://files.harc.edu/Projects/AirQuality/Projects/H051C/H051CFinalReport.pdf

Table 3-1. VOC and BTEX Content in the Vent Gas

Tank Battery	Weight % VOC	Weight % Benzene	Weight % Toluene	Weight % Ethylbenzene	Weight % Xylene
15	82	0.18	0.25	0.01	0.09
16	85	0.20	0.41	0.02	0.19
18	70	0.23	0.65	0.03	0.38
19	77	0.25	0.58	0.02	0.25
20	89	0.17	0.35	0.01	0.18
23	81	0.39	1.08	0.03	0.48
24	70	0.19	0.67	0.22	0.36
27	86	0.27	0.83	0.02	0.33
28	55	1.07	0.68	0.07	0.28
29	83	0.28	0.10	0.02	0.03
30	62	1.35	0.67	0.03	0.16
32	87	0.44	0.48	0.03	0.19

Emission factors in terms of lbs/bbl can be calculated with the following formula:

$$\text{HAP Pollutant}_i \text{ (lbs/bbl)} = (\text{weight \% HAP Pollutant}_i/\text{weight \% VOC}_i) \times \text{VOC Emissions}_i \text{ (lbs/bbl)} \quad \text{(Eq. 3-1)}$$

Table 3-2 shows the VOC and BTEX emission factors for these 19 sites. As all data was obtained through testing, preferential weighting is not used to calculate the average emission factors.

Table 3-2. VOC and BTEX Emission Factors

Tank Battery Site #	Region	VOC Emission Factor (lbs/bbl)	Benzene Emission Factor (lbs/bbl)	Toluene Emission Factor (lbs/bbl)	Ethylbenzene Emission Factor (lbs/bbl)	Xylene Emission Factor (lbs/bbl)
2	Western Gulf	3.65	0.0264	0.0412	0.0031	0.0163
3	Western Gulf	7.92	0.0805	0.1405	0.0077	0.0588
4	Western Gulf	0.78	0.0078	0.0140	0.0008	0.0056
5	Western Gulf	0.67	0.0072	0.0126	0.0007	0.0053
6	Western Gulf	2.96	0.0223	0.0255	0.0014	0.0064
13	Fort Worth	39.23	0.0920	0.1937	0.0048	0.0678
14	Fort Worth	29.51	0.0724	0.1837	0.0111	0.0891
15	Fort Worth	11.99	0.0263	0.0366	0.0015	0.0132
16	Fort Worth	60.58	0.1425	0.2922	0.0143	0.1354
18	Fort Worth	7.34	0.0241	0.0682	0.0031	0.0398
19	Fort Worth	13.16	0.0427	0.0991	0.0034	0.0427
20	Fort Worth	30.43	0.0581	0.1197	0.0034	0.0615
23	Fort Worth	5.56	0.0268	0.0741	0.0021	0.0329

Table 3-2. VOC and BTEX Emission Factors

Tank Battery Site #	Region	VOC Emission Factor (lbs/bbl)	Benzene Emission Factor (lbs/bbl)	Toluene Emission Factor (lbs/bbl)	Ethylbenzene Emission Factor (lbs/bbl)	Xylene Emission Factor (lbs/bbl)
24	Fort Worth	4.22	0.0115	0.0404	0.0133	0.0217
27	Fort Worth	14.39	0.0452	0.1389	0.0033	0.0552
28	Western Gulf	4.17	0.0811	0.0516	0.0053	0.0212
29	Western Gulf	33.68	0.1136	0.0406	0.0081	0.0122
30	Western Gulf	6.11	0.1330	0.0660	0.0030	0.0158
32	Western Gulf	63.49	0.3211	0.3503	0.0219	0.1387
Production-Weighted Average Emission Factor (lbs/bbl)			0.0864	0.0981	0.0063	0.0387
Arithmetic Average Emission Factor (lbs/bbl)			0.0702	0.1047	0.0059	0.0442

3.2 BTEX Emissions Data Derived from the Barnett Shale Area Special Inventory, Phase II (2009)

TCEQ provided ERG with data from the "Barnett Shale Area Special Inventory, Phase II 2009" (Barnett Shale Inventory) information in spreadsheet format. The Barnett Shale Inventory data contains records of condensate tanks with reported condensate production rates and calculated BTEX emissions. ERG analyzed the BTEX emissions data and developed emission factors for condensate tanks in the Bend-Arch-Fort Worth and Barnett Shale counties. The data analysis was similar to that done for VOC for the entire Barnett Shale region. All records with emission factors above 140 lbs/bbl were rejected. Only records using the preferred estimation methods for flashing emissions (direct measurement, process simulator, E&P TANK, GOR) were analyzed. A production-weighted average of the emission factors, before controls, was calculated for each HAP pollutant as shown in Table 3-3. The data is grouped by estimation method, and a production-weighted average and an arithmetic average is used in determining an emission factor for each estimation method. The production-weighted average and arithmetic average for each estimation method were weighted according to the weighting factors in Table 2-11.

Table 3-3. Condensate Tank BTEX Emission Factor Estimates Using Data from the Barnett Shale Phase II 2009 Inventory

Emission Calculation Methods	Pollutant	Total Emissions (lbs)	Total Production (bbl)	Production-Weighted Average Emission Factor (lbs/bbl)	Arithmetic Average Emission Factor (lbs/bbl)
Flash Emissions: Process Simulator Models, E&P TANK, Direct Measurement, GOR Working and Breathing Emissions: E&P TANK, EPA TANKS Program, Other	Benzene	17,393	723,298	0.019	0.084
	Toluene	28,926	734,626	0.042	0.13
	Ethylbenzene	2,057	310,139	0.011	0.036
	Xylene	20,047	730,722	0.067	0.20

3.3 BTEX Emissions Data Derived from E&P TANK Reports Submitted in Response to the ERG Survey

One respondent to the ERG Survey provided paper copies of the E&P Tank V 2.0 Calculation Reports for 85 well/tank sites. The E&P TANK reports contain detailed information on a tank, its equipment, and its emissions, including: API gravity, separator pressure, separator temperature, and annual liquids production; and annual emissions of methane, non-methane volatile organic compounds, benzene, toluene, ethylbenzene, and xylene. As E&P TANK is one of the methods preferred by TCEQ for calculating flashing, working, and breathing emissions, this data was used in evaluating BTEX emissions in the three regions (Eagle Ford Shale, East Texas/Haynesville Shale, and Western Gulf) in which the tanks are located. Eight sites produced liquids having an API gravity of less than 40 degrees, so these sites were removed from the dataset. Data from the remaining 77 records is shown in Table 3-4.

Table 3-4. Condensate Tank BTEX Emission Factor Estimates Using Data from E&P TANK Reports Submitted for ERG Survey

Region	County	API Gravity (deg.)	Separator Pressure (psig)	Condensate Production (bbl)	Emission Factors (lbs/bbl)				
					VOC	Benzene	Toluene	Ethylbenzene	Xylene
Eagle Ford	Fayette	49.2	25.4	2,555	0.53	0.0039	0.0078	0.0008	0.0047
Eagle Ford	Fayette	49.2	25.2	2,811	0.52	0.0043	0.0078	0.0007	0.0050
Eagle Ford	Fayette	49.2	28.5	2,190	0.58	0.0046	0.0091	0.0009	0.0055
Eagle Ford	Lavaca	40.8	35	949	0.27	0.6322	0.0358	0.0243	0.0084
Eagle Ford	Leon	45.2	14	1,460	0.92	0.0288	0.0055	0.0014	0.0055
Eagle Ford	Leon	45.2	52.9	219	1.28	0.0822	0.0183	0.0091	0.0183
Eagle Ford	Leon	45.2	108.9	256	1.33	0.0783	0.0157	0.0078	0.0235
Eagle Ford	Leon	45.2	64.1	146	1.51	0.1096	0.0274	0.0137	0.0274
Eagle Ford	McMullen	54.7	48	14,856	1.51	0.0059	0.0125	0.0003	0.0040
Eagle Ford	McMullen	54.7	48	8,322	1.80	0.0077	0.0166	0.0002	0.0053
Eagle Ford	McMullen	59.3	38	220,570	3.91	0.0226	0.0336	0.0007	0.0156
Eagle Ford	McMullen	59.3	38	86,943	3.94	0.0228	0.0340	0.0008	0.0157
Eagle Ford	Webb	64.5	65	149,139	3.42	0.0139	0.0172	0.0003	0.0077
Eagle Ford	Webb	64.5	200	276,816	3.47	0.0142	0.0176	0.0003	0.0079
East Texas	Anderson	42	58.8	37	1.64	0.1644	0.1644	0.0205	0.1096
East Texas	Cherokee	45.2	142.4	146	1.64	0.1096	0.0274	0.0137	0.0274
East Texas	Cherokee	45.2	76.9	256	1.33	0.0783	0.0157	0.0078	0.0235
East Texas	Cherokee	45.2	84.9	110	1.46	0.1096	0.0365	0.0183	0.0365
East Texas	Freestone	60	205	4,271	12.96	0.1892	0.1321	0.0037	0.0239
East Texas	Freestone	60	75.4	329	16.32	0.3592	0.2740	0.0061	0.0548
East Texas	Freestone	60	69.3	1,679	14.71	0.2418	0.1739	0.0048	0.0322
East Texas	Freestone	60	81.2	730	15.21	0.2767	0.2055	0.0055	0.0384
East Texas	Freestone	60	77.6	1,971	14.50	0.2334	0.1674	0.0051	0.0315
East Texas	Harrison	53.5	100	1,095	0.20	0.0091	0.0018	0.0004	0.0018
East Texas	Henderson	50.4	40	219	0.46	0.0457	0.0183	0.0057	0.0091
East Texas	Henderson	50.4	267.3	475	0.46	0.0253	0.0084	0.0032	0.0042
East Texas	Henderson	50.4	78.1	3,650	0.36	0.0077	0.0027	0.0010	0.0011
East Texas	Henderson	50.4	45.8	621	0.42	0.0193	0.0064	0.0024	0.0032
East Texas	Henderson	50.4	34	730	0.44	0.0192	0.0082	0.0024	0.0027
East Texas	Henderson	50.4	36	803	0.42	0.0174	0.0075	0.0022	0.0025

Table 3-4. Condensate Tank BTEX Emission Factor Estimates Using Data from E&P TANK Reports Submitted for ERG Survey

Region	County	API Gravity (deg.)	Separator Pressure (psig)	Condensate Production (bbl)	Emission Factors (lbs/bbl)				
					VOC	Benzene	Toluene	Ethylbenzene	Xylene
East Texas	Houston	50.6	40	219	0.18	0.0183	0.0091	0.0018	0.0051
East Texas	Houston	50.6	146.5	256	0.23	0.0157	0.0078	0.0016	0.0043
East Texas	Houston	50.6	54.5	183	0.22	0.0219	0.0110	0.0022	0.0061
East Texas	Houston	50.6	59.2	621	0.19	0.0064	0.0032	0.0006	0.0018
East Texas	Limestone	42	40	183	0.55	0.0767	0.0438	0.0015	0.0219
East Texas	Limestone	42	69.8	73	1.10	0.1370	0.1096	0.0027	0.0548
East Texas	Limestone	42	77.3	37	1.64	0.1644	0.1644	0.0033	0.1096
East Texas	Limestone	42	66.2	110	0.91	0.1096	0.0731	0.0022	0.0365
East Texas	Limestone	42	64.3	183	0.55	0.0767	0.0438	0.0015	0.0329
East Texas	Marion	45.2	20	876	0.98	0.0365	0.0068	0.0023	0.0091
East Texas	Marion	45.2	50	1,424	0.91	0.0281	0.0056	0.0014	0.0056
East Texas	Marion	45.2	40	840	1.02	0.0381	0.0071	0.0024	0.0095
East Texas	Marion	45.2	40	219	1.37	0.0822	0.0183	0.0091	0.0183
East Texas	Nacogdoches	58.8	807	110	1.28	0.0548	0.0731	0.0183	0.0913
East Texas	Navarro	46.3	38	6,023	3.22	0.0306	0.0186	0.0007	0.0040
East Texas	Panola	45.2	76	1,497	0.88	0.0281	0.0053	0.0013	0.0053
East Texas	Panola	45.2	102	4,709	0.76	0.0174	0.0030	0.0008	0.0038
East Texas	Panola	45.2	99.5	1,314	0.91	0.0304	0.0061	0.0015	0.0061
East Texas	Panola	45.2	90	2,044	0.88	0.0245	0.0039	0.0010	0.0049
East Texas	Panola	45.2	40.2	1,825	0.91	0.0252	0.0044	0.0011	0.0055
East Texas	Rusk	55.5	105	21,681	6.46	0.0540	0.0564	0.0017	0.0167
East Texas	Rusk	55.5	40	183	6.36	0.0548	0.0548	0.0034	0.0219
East Texas	San Augustine	58.8	168	146	1.10	0.0411	0.0548	0.0137	0.0685
East Texas	Shelby	58.8	40	1,460	0.33	0.0082	0.0082	0.0014	0.0096
East Texas	Upshur	55.6	230	1,095	20.31	0.2466	0.0731	0.0037	0.0511
East Texas	Upshur	55.6	112.4	4,818	21.02	0.2665	0.0797	0.0037	0.0556
East Texas	Upshur	55.6	233.2	730	19.78	0.2411	0.0712	0.0027	0.0493
East Texas	Upshur	55.6	222.7	1,095	21.39	0.2612	0.0767	0.0037	0.0530
East Texas	Upshur	55.6	215	3,030	20.73	0.2535	0.0753	0.0040	0.0522
Western Gulf	Liberty	49.9	50	511	1.06	0.0352	0.0783	0.0039	0.0391

Table 3-4. Condensate Tank BTEX Emission Factor Estimates Using Data from E&P TANK Reports Submitted for ERG Survey

Region	County	API Gravity (deg.)	Separator Pressure (psig)	Condensate Production (bbl)	Emission Factors (lbs/bbl)				
					VOC	Benzene	Toluene	Ethylbenzene	Xylene
Western Gulf	Liberty	53.9	25	475	1.35	0.0126	0.0421	0.0042	0.0337
Western Gulf	Newton	59.8	70	6,607	3.55	0.0061	0.0127	0.0009	0.0070
Western Gulf	Newton	59.8	70	2,373	3.57	0.0059	0.0126	0.0008	0.0067
Western Gulf	Nueces	49.2	20	6,789	0.36	0.0024	0.0044	0.0003	0.0027
Western Gulf	Nueces	49.2	20	1,935	0.60	0.0052	0.0093	0.0010	0.0062
Western Gulf	Nueces	51.9	35	3,723	0.59	0.0038	0.0064	0.0005	0.0043
Western Gulf	Orange	40.9	40	35,770	0.18	0.0003	0.0008	0.0001	0.0004
Western Gulf	Orange	40.9	40	1,351	0.47	0.0015	0.0044	0.0005	0.0030
Western Gulf	San Patricio	58.1	20	61,466	58.03	0.4031	0.3360	0.0257	0.1990
Western Gulf	Starr	49.2	213.8	438	1.05	0.0137	0.0320	0.0046	0.0183
Western Gulf	Starr	49.2	213.8	1,095	0.69	0.0073	0.0146	0.0018	0.0091
Western Gulf	Starr	49.2	215.7	949	0.74	0.0084	0.0148	0.0021	0.0105
Western Gulf	Wharton	47.2	30	10,001	0.60	0.0052	0.0126	0.0004	0.0060
Western Gulf	Wharton	47.2	32	2,519	0.85	0.0095	0.0222	0.0008	0.0111
Western Gulf	Wharton	47.2	31	767	1.12	0.0183	0.0470	0.0026	0.0235
Western Gulf	Wharton	47.2	27	3,650	0.75	0.0077	0.0181	0.0005	0.0088
Western Gulf	Wharton	47.2	25	1,570	0.89	0.0115	0.0280	0.0013	0.0140
Arithmetic Average Emission Factor (lbs/bbl)						0.0772	0.0438	0.0040	0.0230
Production-Weighted Average Emission Factor (lbs/bbl)						0.0465	0.0441	0.0022	0.0227

3.4 Summary of Findings and Recommended Regional BTEX Emission Factors

ERG compiled emission factor data for each region for which data was available using the data from the testing results (Table 3-2), Barnett Shale Area Special Inventory (Table 3-3), and the E&P TANK reports from the ERG survey (Table 3-4). Table 3-5 shows the production-weighted average emission factors for each region, before the effect of any controls. Table 3-6 shows the arithmetic average emission factors for each region, before the effect of any controls. A statewide average emission factor can be used in estimating BTEX emissions from condensate tanks in the other regions of the state (Anadarko, Palo Duro, Permian, and Marathon Thrust Belt).

Table 3-5. Production-Weighted Average Regional BTEX Emission Factors, from Testing Data, Barnett Shale Inventory, and Survey Data

Region	Number of Data Points	Production-Weighted Average Emission Factors (lbs/bbl)			
		Benzene	Toluene	Ethylbenzene	Xylene
Eagle Ford	14	0.0181	0.0238	0.0005	0.0108
East Texas	45	0.0914	0.0512	0.0023	0.0190
Fort Worth	537	0.0164	0.0351	0.0068	0.0433
Western Gulf	30	0.0866	0.0829	0.0063	0.0429
All Other Counties	-	0.0385	0.0494	0.0063	0.0466

Table 3-6. Arithmetic Average Regional BTEX Emission Factors, from Testing Data, Barnett Shale Inventory, and Survey Data

Region	Number of Data Points	Arithmetic Average Emission Factors (lbs/bbl)			
		Benzene	Toluene	Ethylbenzene	Xylene
Eagle Ford	14	0.0736	0.0185	0.0044	0.0110
East Texas	45	0.0968	0.0537	0.0044	0.0270
Fort Worth	537	0.0956	0.1574	0.0222	0.1571
Western Gulf	30	0.0562	0.0552	0.0041	0.0244
All Other Counties	-	0.0998	0.1389	0.0161	0.1491

4.0 Recommendations for Future Condensate Tank Investigations

ERG makes the following recommendations with respect to future investigations.

- The timing of this survey coincided with the requirement for many producers to file information with EPA in compliance with Subpart W of the Greenhouse Gas rules. Based upon discussions with survey recipients, this had a negative impact on survey participation by producers.

- If high participation rates are required, ERG recommends that the TCEQ consider collecting information from oil and gas producers through mandatory information collection requests. If mandatory surveys are not feasible, then any voluntary survey should be initiated with a list of the environmental contacts at each of the companies to be surveyed.

- A consistent definition of condensate based on API gravity should be developed by TCEQ in combination with the RRC so that the most appropriate emission factors are applied to tank liquids, including those tanks that store what operators consider to be a combination of oil and condensate.

5.0 Natural Gas Composition Data Collection and Analysis

In June of 2012, ERG staff visited TCEQ's office in Austin to review annual point source emissions inventory reports submitted by facilities throughout Texas identified as having dehydrators on site. The purpose of this visit was to obtain copies of GLYCalc reports to obtain natural gas composition data. GLYCalc is a software tool used to estimate emissions from dehydrators. Required GLYCalc inputs include natural gas composition data, temperature, and pressure.

TCEQ originally identified a possible 368 facilities across the state with dehydrators. ERG reviewed these files and obtained approximately 240 inventory reports related to dehydrator emissions, including many GLYCalc reports. These reports were reviewed and all incomplete reports were flagged and set aside. These incomplete reports did not contain natural gas stream composition data, or contained data in a format inconsistent with the GLYCalc reporting or output forms and were not evaluated further.

Ultimately, ERG was able to compile complete GLYCalc data for 157 sites located in 64 counties. Based on TCEQ's initial identification of 368 facilities, there are 101 counties in Texas that contain sites with dehydrators that submit an annual point source emissions inventory.

The following constituents were available in the GLYCalc natural gas stream composition data (% volume):

- Water,
- Carbon Dioxide (CO_2),
- Hydrogen Sulfide,
- Nitrogen,
- Methane,
- Ethane,
- Propane,
- Isobutane,
- n-Butane,
- Isopentane,
- n-Pentane,
- Cyclopentane,
- n-Hexane,
- Cyclohexane,
- Other Hexanes,
- Heptanes,
- Methylcyclohexane,
- Benzene,
- Toluene,

- Ethylbenzene,
- Xylenes, and
- C8+ Heavies

The natural gas stream composition data, both for dry stream and wet stream, were then transcribed into Microsoft Excel spreadsheets. This spreadsheet file consisted of composition data for 314 natural gas streams (wet and dry) in 64 counties. Once the data transcription was complete, these data were quality assured for accuracy and completeness. During the Quality Assurance (QA) steps, ERG staff identified a few data points that seemed indicative of a CO_2 well instead of a natural gas well. The CO_2 concentration for these streams was above 85% (by volume). These data points were present in Kent, Pecos, and Terrell counties. These data were excluded from further analysis. Also, the excluded data for Kent and Terrell counties were the only data points available for these two counties. Table 5-1, below, lists the number of GLYCalc reports used in the analysis by natural gas stream type and County.

Table 5-1. Counties Included in the Natural Gas Composition Analysis

County	Dry Gas Stream	Wet Gas Stream	County	Dry Gas Stream	Wet Gas Stream
Anderson	2	2	Jack	1	1
Atascosa	1	1	Jefferson	1	1
Bastrop	1	1	Johnson	17	17
Brazoria	11	11	Kenedy	1	1
Brooks	3	3	Kent [a]	1	1
Caldwell	1	1	Liberty	7	7
Callahan	1	1	Martin	1	1
Camp	1	1	Matagorda	2	2
Carson	1	1	Montague	1	1
Cass	1	1	Nacogdoches	2	2
Chambers	1	1	Nueces	1	1
Clay	2	2	Orange	2	2
Coke	1	1	Palo Pinto	1	1
Crockett	4	4	Panola	2	2
De Witt	1	1	Parker	5	5
Denton	2	2	Pecos [a]	4	4
Eastland	2	2	Refugio	2	2
Erath	1	1	Robertson	1	1
Fort Bend	1	1	Rusk	2	2
Freestone	5	5	San Patricio	2	2
Gaines	1	1	Smith	3	3
Galveston	3	3	Sterling	2	2
Gray	1	1	Tarrant	12	12
Gregg	4	4	Terrell [a]	1	1
Hansford	1	1	Upshur	1	2
Hardin	2	2	Upton	1	0
Harris	6	6	Ward	1	1

Table 5-1. Counties Included in the Natural Gas Composition Analysis

County	Dry Gas Stream	Wet Gas Stream	County	Dry Gas Stream	Wet Gas Stream
Harrison	3	3	Webb	1	1
Hemphill	1	1	Wheeler	1	1
Henderson	2	2	Wilbarger	1	1
Hood	1	1	Winkler	1	1
Houston	1	1	Wise	5	5
Irion	1	1	Young	1	1
			Total	**157**	**157**

[a] As described above, the data for Kent and Terrell counties was not used and only 3 of the 4 records for Pecos county were used.

After all the QA checks were completed, average county profiles were developed for the counties for which natural gas composition data were available (listed in Table 5-1 above). Both wet and dry natural gas composition averages were calculated. The 64 counties for which data were available were then grouped by basins (Anadarko, Bend Arch-Forth Worth, East Texas, Permian, and Western Gulf Basins). Basin-level average natural gas composition (wet and dry) profiles were calculated for all the basins where data was available at county level. No data were available for counties in Marathon Thrust Belt Basin and Palo Duro Basin. Table 5-2 lists the counties in Marathon Thrust Belt Basin and Palo Duro Basin.

Table 5-2. List of Counties Located in Marathon Thrust Belt Basin and Palo Duro Basin

Basin	Counties	
Marathon Thrust Belt	Brewster	Terrell
Palo Duro Basin	Armstrong	Hale
	Bailey	Hall
	Briscoe	Hartley
	Castro	Lamb
	Childress	Motley
	Collingsworth	Oldham
	Cottle	Parmer
	Dallam	Potter
	Deaf Smith	Randall
	Donley	Swisher
	Floyd	

Basin-level average natural gas composition profile and state-level average profile were then allocated to counties with no data based on which basin the county was located in. Except for the counties listed in Table 5-2, basin-level average profiles were allocated to all counties with no GLYCalc reports available. For the counties in Marathon Thrust Belt and Palo Duro basin, state-level average profile was allocated. Table 5-3 below

Table 5-3. Basin-Level and State-Level Average Natural Gas Stream Composition Profiles

Composition in % Volume	Anadarko Basin		Bend Arch-Fort Worth Basin		East Texas Basin		Permian Basin		Western Gulf		State Profile	
	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream
Water	0.04	0.13	0.01	0.12	0.01	0.12	0.01	0.15	0.01	0.12	0.01	0.12
Carbon Dioxide	0.64	0.65	1.74	1.74	1.72	1.71	0.95	0.90	1.13	1.14	1.43	1.44
Hydrogen Sulfide	0.03	0.03	0.001	0.001	0.0004	0.0004	0.11	0.11	0.0003	0.25	0.03	0.09
Nitrogen	1.35	1.34	1.74	1.73	0.88	0.87	2.14	2.18	0.51	0.49	1.20	1.19
Methane	90.76	90.68	87.91	87.59	91.73	91.49	80.43	78.53	90.07	89.94	88.67	88.36
Ethane	3.99	3.98	5.23	5.21	3.57	3.64	9.02	9.07	4.51	4.51	5.03	5.00
Propane	1.74	1.74	2.14	2.18	1.04	1.06	4.48	5.39	2.04	2.05	2.13	2.21
Isobutane	0.26	0.26	0.31	0.32	0.28	0.29	0.51	0.61	0.48	0.48	0.38	0.40
n-Butane	0.54	0.54	0.62	0.68	0.31	0.32	1.19	1.63	0.51	0.51	0.58	0.64
Isopentane	0.16	0.16	0.20	0.22	0.15	0.17	0.35	0.40	0.24	0.24	0.22	0.23
n-Pentane	0.17	0.17	0.27	0.29	0.11	0.12	0.32	0.44	0.17	0.17	0.20	0.22
Cyclopentane	0.01	0.01	0.03	0.04	0.04	0.04	0.01	0.02	0.03	0.02	0.02	0.03
n-Hexane	0.10	0.06	0.05	0.12	0.05	0.05	0.16	0.18	0.05	0.06	0.06	0.09
Cyclohexane	0.01	0.01	0.04	0.03	0.03	0.03	0.09	0.11	0.05	0.06	0.04	0.05
Other Hexanes	0.14	0.14	0.07	0.06	0.10	0.11	0.24	0.29	0.17	0.15	0.13	0.13
Heptanes	0.06	0.06	0.08	0.08	0.06	0.07	0.14	0.14	0.07	0.09	0.08	0.08
Methylcyclohexane	0.02	0.02	0.02	0.02	0.01	0.02	0.04	0.04	0.04	0.04	0.03	0.04
Benzene	0.01	0.01	0.01	0.01	0.02	0.03	0.07	0.08	0.01	0.02	0.02	0.02
Toluene	0.01	0.01	0.003	0.003	0.01	0.01	0.04	0.04	0.01	0.02	0.01	0.01
Ethylbenzene	0.001	0.001	0.0005	0.001	0.001	0.001	0.01	0.01	0.001	0.002	0.001	0.002
Xylenes	0.003	0.01	0.002	0.003	0.002	0.005	0.01	0.01	0.003	0.01	0.003	0.005
C8+ Heavies	0.04	0.04	0.03	0.03	0.03	0.04	0.07	0.07	0.11	0.11	0.06	0.06

presents the basin-level and state-level average natural gas stream composition profiles for both wet and dry natural gas streams.

Based on the basin and state level average natural gas composition profiles, the methane composition varies from 78% to 91%. However, individual GLYCalc reports indicated as high as 97.8% methane. Table 5-4 indicates the average natural gas composition profile allocation scheme that was adopted for counties where GLYCalc reports were not available. Figure 5-1 presents a distribution of methane concentrations across all Texas counties. Detailed county-level natural gas composition profile data are presented in Attachment D.

Table 5-4. Average Natural Gas Composition Profile Allocation Scheme

County	Profile Allocation	Basin	County	Profile Allocation	Basin
Anderson	Average County		Karnes	Average Basin	Western Gulf
Andrews	Average Basin	Permian Basin	Kaufman	Average Basin	East Texas Basin
Angelina	Average Basin	East Texas Basin	Kendall	Average Basin	Bend Arch-Fort Worth Basin
Aransas	Average Basin	Western Gulf	Kenedy	Average County	
Archer	Average Basin	Bend Arch-Fort Worth Basin	Kent[1]	Average Basin	Permian Basin
Armstrong	Average State	Palo Duro Basin	Kerr	Average Basin	Bend Arch-Fort Worth Basin
Atascosa	Average County		Kimble	Average Basin	Bend Arch-Fort Worth Basin
Austin	Average Basin	Western Gulf	King	Average Basin	Permian Basin
Bailey	Average State	Palo Duro Basin	Kinney	Average Basin	Western Gulf
Bandera	Average Basin	Bend Arch-Fort Worth Basin	Kleberg	Average Basin	Western Gulf
Bastrop	Average County		Knox	Average Basin	Bend Arch-Fort Worth Basin
Baylor	Average Basin	Bend Arch-Fort Worth Basin	La Salle	Average Basin	Western Gulf
Bee	Average Basin	Western Gulf	Lamar	Average Basin	East Texas Basin
Bell	Average Basin	Western Gulf	Lamb	Average State	Palo Duro Basin
Bexar	Average Basin	Western Gulf	Lampasas	Average Basin	Bend Arch-Fort Worth Basin
Blanco	Average Basin	Bend Arch-Fort Worth Basin	Lavaca	Average Basin	Western Gulf
Borden	Average Basin	Permian Basin	Lee	Average Basin	Western Gulf
Bosque	Average Basin	Bend Arch-Fort Worth Basin	Leon	Average Basin	East Texas Basin
Bowie	Average Basin	East Texas Basin	Liberty	Average County	
Brazoria	Average County		Limestone	Average Basin	East Texas Basin
Brazos	Average Basin	Western Gulf	Lipscomb	Average Basin	Anadarko Basin
Brewster	Average State	Marathon Thrust Belt	Live Oak	Average Basin	Western Gulf
Briscoe	Average State	Palo Duro Basin	Llano	Average Basin	Bend Arch-Fort Worth Basin
Brooks	Average County		Loving	Average Basin	Permian Basin
Brown	Average Basin	Bend Arch-Fort Worth Basin	Lubbock	Average Basin	Permian Basin
Burleson	Average Basin	Western Gulf	Lynn	Average Basin	Permian Basin
Burnet	Average Basin	Bend Arch-Fort Worth Basin	Madison	Average Basin	Western Gulf

Table 5-4. Average Natural Gas Composition Profile Allocation Scheme

County	Profile Allocation	Basin	County	Profile Allocation	Basin
Caldwell	Average County		Marion	Average Basin	East Texas Basin
Calhoun	Average Basin	Western Gulf	Martin	Average County	
Callahan	Average County		Mason	Average Basin	Bend Arch-Fort Worth Basin
Cameron	Average Basin	Western Gulf	Matagorda	Average County	
Camp	Average County		Maverick	Average Basin	Western Gulf
Carson	Average County		McCulloch	Average Basin	Bend Arch-Fort Worth Basin
Cass	Average County		McLennan	Average Basin	Bend Arch-Fort Worth Basin
Castro	Average State	Palo Duro Basin	McMullen	Average Basin	Western Gulf
Chambers	Average County		Medina	Average Basin	Western Gulf
Cherokee	Average Basin	East Texas Basin	Menard	Average Basin	Bend Arch-Fort Worth Basin
Childress	Average State	Palo Duro Basin	Midland	Average Basin	Permian Basin
Clay	Average County		Milam	Average Basin	Western Gulf
Cochran	Average Basin	Permian Basin	Mills	Average Basin	Bend Arch-Fort Worth Basin
Coke	Average County		Mitchell	Average Basin	Permian Basin
Coleman	Average Basin	Bend Arch-Fort Worth Basin	Montague	Average County	
Collin	Average Basin	Bend Arch-Fort Worth Basin	Montgomery	Average Basin	Western Gulf
Collingsworth	Average State	Palo Duro Basin	Moore	Average Basin	Anadarko Basin
Colorado	Average Basin	Western Gulf	Morris	Average Basin	East Texas Basin
Comal	Average Basin	Western Gulf	Motley	Average State	Palo Duro Basin
Comanche	Average Basin	Bend Arch-Fort Worth Basin	Nacogdoches	Average County	
Concho	Average Basin	Bend Arch-Fort Worth Basin	Navarro	Average Basin	East Texas Basin
Cooke	Average Basin	Bend Arch-Fort Worth Basin	Newton	Average Basin	Western Gulf
Coryell	Average Basin	Bend Arch-Fort Worth Basin	Nolan	Average Basin	Permian Basin
Cottle	Average State	Palo Duro Basin	Nueces	Average County	
Crane	Average Basin	Permian Basin	Ochiltree	Average Basin	Anadarko Basin
Crockett	Average County		Oldham	Average State	Palo Duro Basin
Crosby	Average Basin	Permian Basin	Orange	Average County	
Culberson	Average Basin	Permian Basin	Palo Pinto	Average County	

Table 5-4. Average Natural Gas Composition Profile Allocation Scheme

County	Profile Allocation	Basin	County	Profile Allocation	Basin
Dallam	Average State	Palo Duro Basin	Panola	Average County	
Dallas	Average Basin	Bend Arch-Fort Worth Basin	Parker	Average County	
Dawson	Average Basin	Permian Basin	Parmer	Average State	Palo Duro Basin
De Witt	Average County		Pecos[1]	Average County	
Deaf Smith	Average State	Palo Duro Basin	Polk	Average Basin	Western Gulf
Delta	Average Basin	East Texas Basin	Potter	Average State	Palo Duro Basin
Denton	Average County		Presidio	Average Basin	Permian Basin
Dickens	Average Basin	Permian Basin	Rains	Average Basin	East Texas Basin
Dimmit	Average Basin	Western Gulf	Randall	Average State	Palo Duro Basin
Donley	Average State	Palo Duro Basin	Reagan	Average Basin	Permian Basin
Duval	Average Basin	Western Gulf	Real	Average Basin	Bend Arch-Fort Worth Basin
Eastland	Average County		Red River	Average Basin	East Texas Basin
Ector	Average Basin	Permian Basin	Reeves	Average Basin	Permian Basin
Edwards	Average Basin	Permian Basin	Refugio	Average County	
El Paso	Average Basin	Permian Basin	Roberts	Average Basin	Anadarko Basin
Ellis	Average Basin	Bend Arch-Fort Worth Basin	Robertson	Average County	
Erath	Average County		Rockwall	Average Basin	East Texas Basin
Falls	Average Basin	East Texas Basin	Runnels	Average Basin	Bend Arch-Fort Worth Basin
Fannin	Average Basin	East Texas Basin	Rusk	Average County	
Fayette	Average Basin	Western Gulf	Sabine	Average Basin	East Texas Basin
Fisher	Average Basin	Permian Basin	San Augustine	Average Basin	East Texas Basin
Floyd	Average State	Palo Duro Basin	San Jacinto	Average Basin	Western Gulf
Foard	Average Basin	Bend Arch-Fort Worth Basin	San Patricio	Average County	
Fort Bend	Average County		San Saba	Average Basin	Bend Arch-Fort Worth Basin
Franklin	Average Basin	East Texas Basin	Schleicher	Average Basin	Permian Basin
Freestone	Average County		Scurry	Average Basin	Permian Basin
Frio	Average Basin	Western Gulf	Shackelford	Average Basin	Bend Arch-Fort Worth Basin
Gaines	Average County		Shelby	Average Basin	East Texas Basin
Galveston	Average County		Sherman	Average Basin	Anadarko Basin

Table 5-4. Average Natural Gas Composition Profile Allocation Scheme

County	Profile Allocation	Basin	County	Profile Allocation	Basin
Garza	Average Basin	Permian Basin	Smith	Average County	
Gillespie	Average Basin	Bend Arch-Fort Worth Basin	Somervell	Average Basin	Bend Arch-Fort Worth Basin
Glasscock	Average Basin	Permian Basin	Starr	Average Basin	Western Gulf
Goliad	Average Basin	Western Gulf	Stephens	Average Basin	Bend Arch-Fort Worth Basin
Gonzales	Average Basin	Western Gulf	Sterling	Average County	
Gray	Average County		Stonewall	Average Basin	Permian Basin
Grayson	Average Basin	Bend Arch-Fort Worth Basin	Sutton	Average Basin	Permian Basin
Gregg	Average County		Swisher	Average State	Palo Duro Basin
Grimes	Average Basin	Western Gulf	Tarrant	Average County	
Guadalupe	Average Basin	Western Gulf	Taylor	Average Basin	Bend Arch-Fort Worth Basin
Hale	Average State	Palo Duro Basin	Terrell[1]	Average State	Marathon Thrust Belt
Hall	Average State	Palo Duro Basin	Terry	Average Basin	Permian Basin
Hamilton	Average Basin	Bend Arch-Fort Worth Basin	Throckmorton	Average Basin	Bend Arch-Fort Worth Basin
Hansford	Average County		Titus	Average Basin	East Texas Basin
Hardeman	Average Basin	Bend Arch-Fort Worth Basin	Tom Green	Average Basin	Permian Basin
Hardin	Average County		Travis	Average Basin	Western Gulf
Harris	Average County		Trinity	Average Basin	Western Gulf
Harrison	Average County		Tyler	Average Basin	Western Gulf
Hartley	Average State	Palo Duro Basin	Upshur	Average County	
Haskell	Average Basin	Bend Arch-Fort Worth Basin	Upton[2]	Average County/Average Basin	Permian Basin
Hays	Average Basin	Western Gulf	Uvalde	Average Basin	Western Gulf
Hemphill	Average County		Val Verde	Average Basin	Permian Basin
Henderson	Average County		Van Zandt	Average Basin	East Texas Basin
Hidalgo	Average Basin	Western Gulf	Victoria	Average Basin	Western Gulf
Hill	Average Basin	Bend Arch-Fort Worth Basin	Walker	Average Basin	Western Gulf
Hockley	Average Basin	Permian Basin	Waller	Average Basin	Western Gulf
Hood	Average County		Ward	Average County	
Hopkins	Average Basin	East Texas Basin	Washington	Average Basin	Western Gulf
Houston	Average County		Webb	Average County	

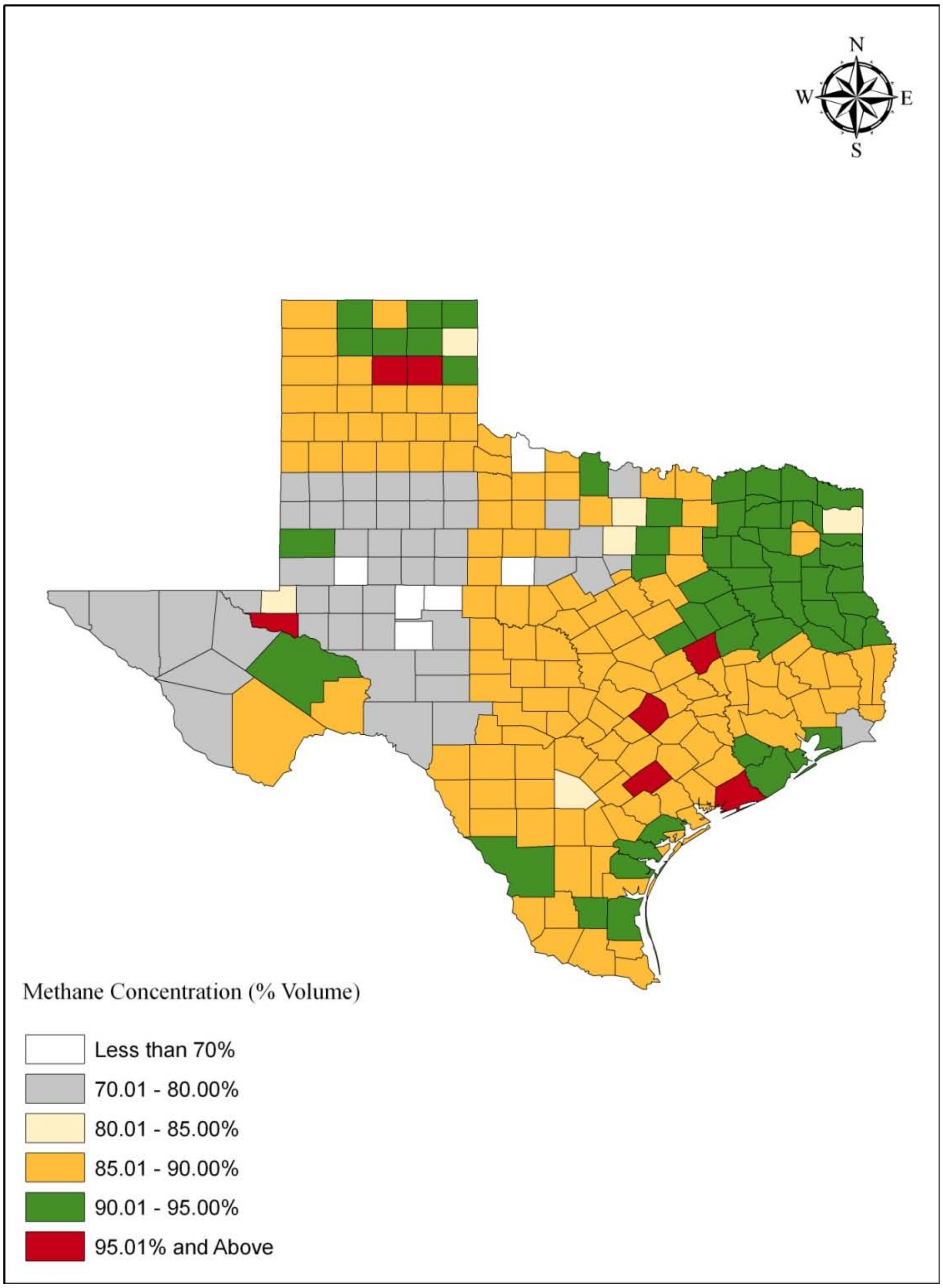
Table 5-4. Average Natural Gas Composition Profile Allocation Scheme

County	Profile Allocation	Basin	County	Profile Allocation	Basin
Howard	Average Basin	Permian Basin	Wharton	Average Basin	Western Gulf
Hudspeth	Average Basin	Permian Basin	Wheeler	Average County	
Hunt	Average Basin	East Texas Basin	Wichita	Average Basin	Bend Arch-Fort Worth Basin
Hutchinson	Average Basin	Anadarko Basin	Wilbarger	Average County	
Irion	Average County		Willacy	Average Basin	Western Gulf
Jack	Average County		Williamson	Average Basin	Western Gulf
Jackson	Average Basin	Western Gulf	Wilson	Average Basin	Western Gulf
Jasper	Average Basin	Western Gulf	Winkler	Average County	
Jeff Davis	Average Basin	Permian Basin	Wise	Average County	
Jefferson	Average County		Wood	Average Basin	East Texas Basin
Jim Hogg	Average Basin	Western Gulf	Yoakum	Average Basin	Permian Basin
Jim Wells	Average Basin	Western Gulf	Young	Average County	
Johnson	Average County		Zapata	Average Basin	Western Gulf
Jones	Average Basin	Bend Arch-Fort Worth Basin	Zavala	Average Basin	Western Gulf

[1] These counties had GLYCalc reports that were flagged as potential CO_2 wells and excluded from further analysis.

[2] Upton county had 1 GLYCalc report and that report did not include wet gas stream composition data.

Figure 5-1. Natural Gas Methane Composition Distribution across Texas Counties



Attachment A
Survey Letter

Dear [Owner/Operator Contact Name]: [Date]

Eastern Research Group (ERG), an independent research organization, is conducting a study on condensate storage tank emissions for the Texas Commission on Environmental Quality (TCEQ). The purpose of this study is to develop updated county- and region-specific emission factors for estimating condensate storage tank emissions for each of the regions in Texas. The study results will assist the TCEQ in refining the emission factors used to develop the Texas area source oil and gas air emissions inventory.

Condensate tank flashing, working, and breathing emissions of volatile organic compounds (VOC) are currently estimated using an emission factor from a 2006 Texas Environmental Research Consortium study entitled: "VOC Emissions from Oil and Condensate Storage Tanks". TCEQ uses this emission factor to develop county-level area source VOC emissions estimates from condensate tanks at upstream oil and gas operations. To further increase the accuracy of the area source inventory, the TCEQ is seeking information from operators to assist in development of a refined county-specific condensate tank emission factor.

We are asking for your ***voluntary participation*** in this study of emissions from condensate tanks at gas wells in Texas that were in production during 2011. The study will involve sharing information regarding condensate production and measured or estimated emissions from condensate tank(s). ***Individual wells and tanks do not need to be identified.*** The information your company provides will be used for statistical purposes only in order to develop county-level and basin-level estimates and will not be republished or disseminated for other purposes.

ERG will contact your company via phone to discuss this effort and collect any information you are willing to share. We are seeking basin-specific condensate tank emissions information for gas wells in the [Insert Basin_Specific_Text]. The specific information we are requesting for each condensate tank battery includes:

- County
- 2011 VOC emissions
- 2011 condensate production
- Emissions estimation method
- Control technology
- Control efficiency
- API gravity
- Separator pressure

A table on the reverse side of this letter shows the type of data we wish to collect.

We appreciate your assistance in this important study. Questions concerning the scope of this study or ERG's relationship with TCEQ may be directed to the TCEQ Project Manager, Miles Whitten, at (512) 239-5479, or via email at miles.whitten@tceq.texas.gov. If you have any questions on the technical aspects of the study, please feel free to contact me at (919) 468-7902, or via email at stephen.treimel@erg.com.

Sincerely,

Stephen Treimel
Environmental Scientist
Eastern Research Group, Inc.

Attachment B
Survey Materials – Word Table and Excel Spreadsheet

Operator Name: [Insert Operator_Name]

Basin : [Insert Basin_Name_and_Counties]

County	Condensate API Gravity (degrees)	Separator Pressure (psig)	2011 Condensate Production (bbl)	2011 VOC Emissions (tons)	Emissions Estimation Method (Testing, E&P Tank, Process Simulation model, GOR, HARC 051C, etc.)	Are Emissions vented, controlled, or recovered?	If controlled or recovered, what technology is used?	If controlled or recovered, what is the control or recovery efficiency?

Texas Commission on Environmental Quality - Condensate Tank Emissions Survey

Instructions: Provide the data listed below for up to ten separate condensate tank batteries located in the counties listed below. To avoid biasing the survey results, we ask that you please select the tanks at random from all of your producing wells in this region.

Operator Name:
Basin (Counties) : Anadarko basin (Hemphill, Lipscomb, Ochiltree, Roberts, and Wheeler counties).

County	Condensate API Gravity (degrees)	Separator Pressure (psig)	2011 Condensate Production (bbl)	2011 VOC Emissions (tons) (flashing, working, & breathing)	Emissions Estimation Method (Testing, E&P Tank, Process Simulation model, GOR, HARC 051C, TANKS 4.0, etc)	Are Emissions vented, controlled, or recovered?	If controlled or recovered, what technology is used?	If controlled or recovered, what is the control or recovery efficiency?

Completed surveys can be emailed to me at stephen.treimel@erg.com or printed and mailed to: Eastern Research Group, 1600 Perimeter Park Drive, Morrisville, NC 27560.

Attachment C
Condensate Tank Emissions Data
(Condensate_Tank_Data.xlsx)

Attachment D
County-Level Average Natural Gas Composition Profiles
(NG_Composition_Profiles.xlsx)

APPENDIX 7

SPECIFIED OIL AND GAS WELL ACTIVITIES EMISSIONS INVENTORY UPDATE

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

www.erg.com

SPECIFIED OIL & GAS WELL ACTIVITIES EMISSIONS INVENTORY UPDATE

FINAL REPORT

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

August 1, 2014

ERG N0. 0292.03.026.001

Specified Oil & Gas Well Activities Emissions Inventory Update

FINAL REPORT

Prepared for:

Michael Ege
Texas Commission on Environmental Quality
Air Quality Division
Building E, Room 245 S
Austin, TX 78711-3087

Prepared by:

Bryan Lange
Mike Pring
Stephen Treimel
Eastern Research Group, Inc.
1600 Perimeter Park Dr., Suite 200
Morrisville, NC 27560

August 1, 2014

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List of Acronyms

Acronym	**Definition**
AACOG	Alamo Area Council of Governments
AP-42	U.S. EPA's Compilation of Air Pollutant Emission Factors
API	American Petroleum Institute
bbl	Barrel
BPA	Beaumont-Port Arthur
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CenSARA	Central States Air Resource Agencies
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EDF	Environmental Defense Fund
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
ENVIRON	Environ International Corporation
HGB	Houston-Galveston-Brazoria
lbs	Pounds
MMscf	Million standard cubic feet
NO_x	Oxides of Nitrogen
NSPS	New Source Performance Standard
PM_{10}	Particulate Matter less than10 microns in aerodynamic diameter
PTE	Potential to Emit
ppm	Parts per million
psig	Pounds per square inch gauge
RRC	Railroad Commission of Texas
scf	Standard cubic feet
SO_2	Sulfur Dioxide
TCEQ	Texas Commission on Environmental Quality
TCAT	Texas Center for Applied Technology
TERP	Texas Emissions Reduction Plan
tpy	Tons per year
VOC	Volatile Organic Compound
UBD	Under-balanced drilling
URS	URS Corporation

Executive Summary

Eastern Research Group, Inc. (ERG) is currently under contract with the Texas Commission on Environmental Quality (TCEQ) under Work Order No. 582-11-99776-FY14-26 to provide nonpoint area source oil and gas emissions inventory estimates for mud degassing activities and hydraulic pump engines used at well drilling sites in Texas. ERG also determined the effects of the provisions of the recently revised New Source Performance Standards (NSPS) Subpart OOOO (Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution) on the 2013 emissions inventory estimates. This report describes ERG's findings relative to survey efforts undertaken to collect information on mud degassing activities and the use of hydraulic pump engines in the eight oil and gas basins found in Texas, an analysis of available mud degassing and hydraulic pump engine emission factor data, and an examination of the effects on emissions from the equipment located at upstream oil and gas sources as the requirements of Subpart OOOO are implemented.

Drilling mud is a blend of water, oil, or synthetic fluids, special clays, and other additives. Mud is used during drilling to cool and lubricate the drill bit, remove cuttings to the surface, and control pressure in the wellbore. As drilling proceeds through gas-bearing formations, gas becomes entrained in the drilling mud. After the mud comes to the surface, the entrained gas is released, resulting in volatile organic compound (VOC) and methane emissions.

Hydraulic pump engines are used during well completions to inject mixtures of water, proppants, and other additives at high pressure into petroleum-bearing rock formations to create fissures in the rock. The resulting fissures increase the conductivity of the source rock, increasing the flow rate of petroleum liquids and gas to the wellbore. This technique improves hydrocarbon recovery rates in petroleum-bearing formations that would otherwise be unproductive. The engines are typically diesel-fired engines and are a source of nitrogen oxides (NO_x), carbon monoxide (CO), VOC, and particulate matter (PM) emissions. These emissions typically occur only once during the completion of a well, but are significant in magnitude.

NSPS Subpart OOOO requires operators of certain equipment at upstream oil and gas production sites to control emissions from that equipment beginning in October 2012. These requirements only apply to equipment newly constructed or modified after August 23, 2011. As new wells are completed each year to replace older, non-productive wells, the requirements of Subpart OOOO will apply to an increasing percentage of the wells in Texas over time. Total emissions from the classes of affected equipment will continue to decrease over time as more equipment becomes subject to Subpart OOOO control requirements.

ERG recommends that the TCEQ calculate emissions from mud degassing activities during well drilling using county-level well spud data and the emission factor data obtained under this study. ERG recommends that the TCEQ calculate emissions from hydraulic pump engines based on the county-level horizontal well completion data and the activity and emission factor data obtained under this study. ERG recommends that the TCEQ calculate emissions from Subpart OOOO affected facilities based on county-level data on the number of new well completions since October 2012, Subpart OOOO emission standards, and the emission factors developed in this and previous studies.

1. Introduction

Eastern Research Group, Inc. (ERG) is currently under contract with the Texas Commission on Environmental Quality (TCEQ) under Work Order No. 582-11-99776-FY14-26 to provide updates to TCEQ's nonpoint area source oil and gas emissions inventory estimates. Specifically under this effort, ERG evaluated activity and emissions data needed to characterize typical emissions from hydraulic pump engines and mud degassing equipment located at upstream oil and gas production sites in Texas. Information relative to this analysis was obtained through a survey of oil and gas producers operating in Texas, as well as a comprehensive literature review and interviews with industry experts familiar with the operating characteristics and any ongoing studies for these processes.

In addition, ERG evaluated the effects of the provisions of the recently revised New Source Performance Standards (NSPS) Subpart OOOO (Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution) on the inventory estimates. The results of these analyses were then used to update TCEQ's nonpoint area source oil and gas emissions inventory calculator.

Purpose of This Study

The purpose of this study is to develop and refine the methodologies and characterization factors needed to generate emission estimates from hydraulic pump engines and mud degassing activities at oil and gas wells across Texas, as well as to evaluate and incorporate controls required under NSPS Subpart OOOO. This was accomplished by:

- Conducting a review of available literature;
- Conducting a phone and email survey of Texas oil and gas producers;
- Researching the availability of emission factors specific to hydraulic pump engines and mud degassing;
- Analyzing the requirements of NSPS Subpart OOOO; and
- Proposing control factors and revised operating/equipment parameters to reflect the requirements of the NSPS.

ERG first conducted a review of available literature, looking for data on emissions from mud degassing, hydraulic pump engines, and the impacts of NSPS Subpart OOOO, which affects new or modified sources as early as August 2011, dependent upon equipment type. Academic and technical literature on equipment characterization, emissions control techniques, and available state and federal environmental agency guidance on calculating emissions from these operations were examined. Additionally, ERG conducted a targeted phone survey of Texas oil and gas producers, requesting information on the use of hydraulic pump engines and mud degassing operations at their oil and gas wells. Several oil and gas producers were interviewed, to gather information on current practices and trends in the industry that are specific to Texas.

Using this information, ERG developed region-specific activity data and emission factors for use in updating the statewide oil and gas nonpoint area source emissions inventory for the source categories of interest.

2. Oil and Gas Producing Regions in Texas

There are several distinct oil- and gas-producing regions in Texas. These regions, also referred to as basins, reservoirs, source rock, or productive formations, are characterized by differences in petrogeology, age, depth below surface, type of petroleum hydrocarbon produced (liquids, gas, both), and many other characteristics that make them unique from one another. Even within a single region, there exists considerable heterogeneity. These differences are very important for evaluating the emissions that occur from production activities at wells in these basins. Drilling companies, fracturing companies, and production companies (operators) utilize practices that may be unique to each region, and emissions from their activities can vary accordingly. This study accounts for these differences, where they are known.

Figure 2-1 identifies eight oil and gas basins found in Texas. These basin boundaries are determined at the level of the county, and are based on geographical areas having similar petrogeology. By doing this, emissions from oil and gas production activities can be more accurately allocated to a county, based on county-level activity and production data, and emission factors determined at the basin-level. Note that the Eagle Ford Shale has historically been considered part of the Western Gulf Basin for inventory purposes, but due to the recent high level of activity in this area, it has been broken out as a separate region to more accurately characterize the unique types of processes and operations occurring to develop this play.

TCEQ's nonpoint area source air emissions inventory estimates for upstream oil and gas operations are based on county-level activity and equipment/emissions profiles. Activity data, such as oil and gas well counts and oil and gas production are as reported by the Railroad Commission of Texas (RRC)[1]. The equipment characterization and emissions data used in the inventory has been developed and refined over the last several years from a variety of studies, including TCEQ's "*Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions*" [2] and a 2012 study "*2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States*" conducted by the Central States Air Resources Agencies (CenSARA).[3]

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[1] 2013 oil and gas activity data provided by the TCEQ, based on a January 2014 extract of information by the RRC and provided to the TCEQ in March 2014.

[2] "Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide missions", TCEQ, November 24, 2010.

[3] "2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States", Environ International Corporation and Eastern Research Group, Inc. December 21, 2012.

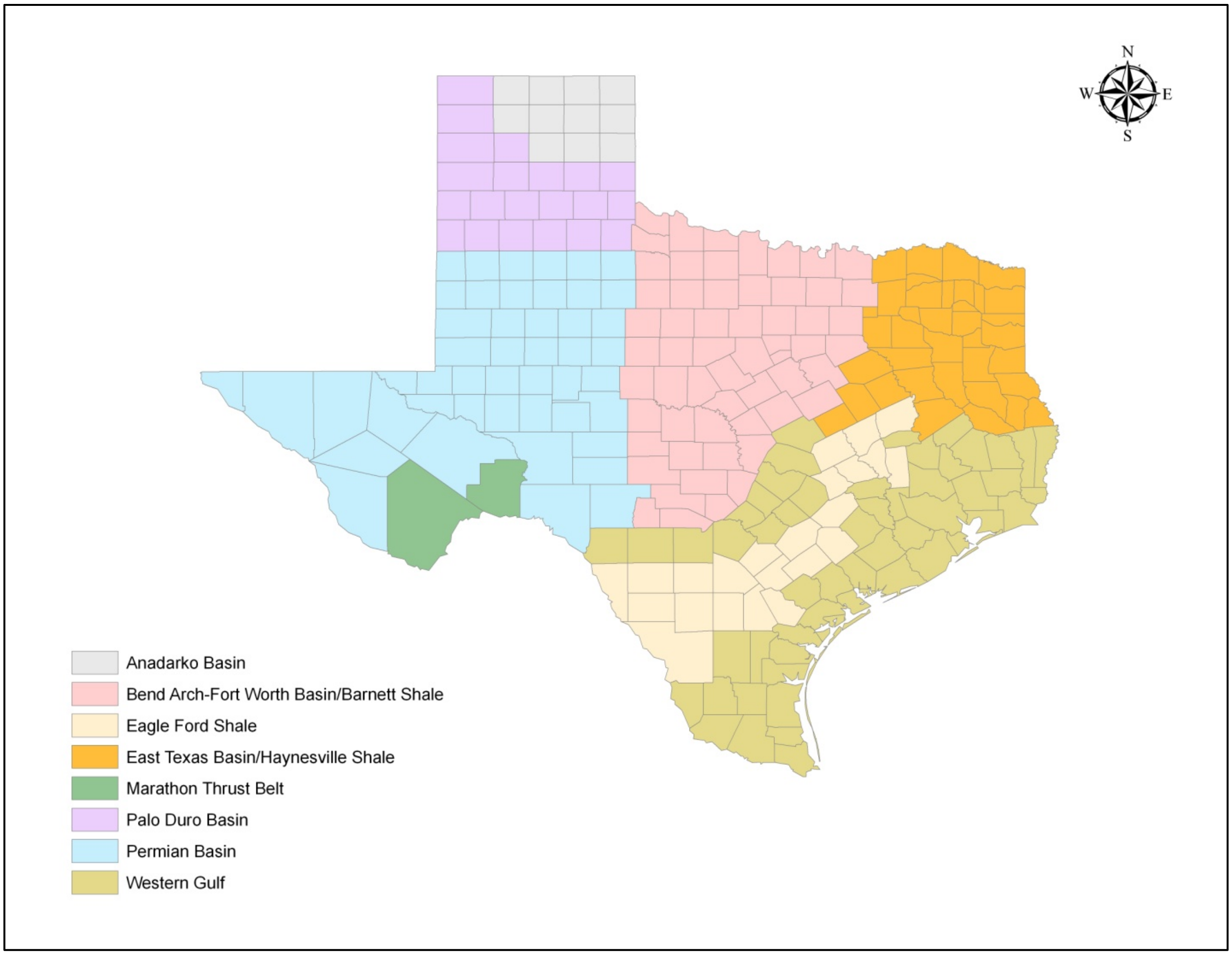

Figure 2-1. Oil and Gas Basins in Texas

This study sought to build upon these previous efforts to determine:

- Equipment characteristics and operational profiles of hydraulic pump engines used to stimulate wells in Texas;
- The appropriate emission factors to use for hydraulic pump engines used in Texas;
- The types of drilling mud used to drill oil and gas wells in Texas;
- The appropriate emissions profile data to use for mud degassing during oil and gas well drilling in Texas; and
- The implications of the recent revisions to the NSPS Subpart OOOO on the TCEQ nonpoint area source oil and gas emissions inventory.

3. Hydraulic Pump Engines

ERG investigated the use of hydraulic pump engines at drilling sites in Texas. The intent of this part of our study was to determine the frequency, quantity, location, and operating characteristics of these activities across the state, so that these emissions could be more accurately estimated in the TCEQ's nonpoint area source inventory. In arriving at the determinations presented in this report, ERG conducted a literature review, conducted a survey of oil and gas producers, gathered data on well completions from the RRC, reviewed data on engine emission factors, and interviewed industry representatives.

Hydraulic fracturing or stimulation involves the high pressure injection of a mixture of water, sand, proppants, and small amounts of chemicals and additives, to create fissures or fractures in rock formations. The fissures and fractures created during these operations stimulate an increase in the flow of natural gas and liquid hydrocarbons from the productive formation to the wellbore.[4] Hydraulic stimulation is used in petroleum-bearing formations that would normally be non-productive due to low porosity or permeability.[5] The intent is to increase the rate of recovery of petroleum liquids and gas from the reservoir surrounding the wellbore. Hydraulic stimulation is an expensive process, costing $135,000 or more per well[6], so operators use it when they judge that the increased productivity of the well will pay for the cost of this additional step.

3.1 Literature Review

ERG conducted a review of recent literature on well drilling techniques in general and hydraulic stimulation practices in particular, with the intent to gain a better understanding of the technique and the equipment required. ERG also reviewed literature on the petroleum geology in Texas, examining how well stimulation practices vary between the different oil and gas-producing formations in Texas. The following studies, articles, and web pages were found to be relevant.

3.1.1 Oil and Gas Emission Inventory, Eagle Ford Shale – Technical Report

The Alamo Area Council of Governments (AACOG), in cooperation with the TCEQ, published a study in April 2014, entitled "Oil and Gas Emission Inventory, Eagle Ford

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[4] Ginna Rodriguez and Chenchen Ouyang, "Air Emissions Characterization and Management For Natural Gas Hydraulic Fracturing Operations In the United States", Masters Thesis project, Univ. of Michigan, April 2013.

[5] Porosity of a rock is a measure of the empty spaces) in a material, and is a fraction of the volume of void spaces divided by the total volume. Permeability is a measure of the ability of a material (such as rocks) to transmit fluids.

[6] These are average cost figures for a USA well in 2011. Source: Michael Economides, "Hydraulic Fracturing: The State of the Art", Energy Tribune, August 26, 2011. Online: http://www.energytribune.com/8672/hydraulic-fracturing-the-state-of-the-art-2#sthash.rjPkQxRS.dpbs

Shale".[7] This study focused exclusively on the oil and gas operations in the Eagle Ford Shale formation in south Texas. The study examined the unique characteristics of the geology, hydrocarbon production, and production equipment used in the Eagle Ford Shale, and developed an air emissions inventory for oil and gas operations located in that region. The study gathered data on production, drill rig counts, well counts, well characteristics, and nonroad equipment from the RRC, companies that provide hydraulic pumping services,[8] TCEQ, oil and gas companies, and previous studies to compile a comprehensive view of the type and amount of equipment currently in use. The study then combined these activity data parameters with emissions factors from TCEQ's Drill Rigs Emission Inventory,[9] equipment manufacturers, the results of Texas Center for Applied Technology (TCAT) surveys,[10] and other sources, to develop an air emissions inventory. The study also examined development trends in the region, and, based on predicted production increases in the future, developed estimates of air emissions for 2015 and 2018 under three development scenarios.[11]

Of particular significance to this present study is the fact that the AACOG study estimated emissions from the use of hydraulic pump engines in the Eagle Ford Shale for the year 2012. The study examined data on hydraulic stimulation activity from studies done on other shale plays such as in Colorado,[12] the Marcellus Shale[13] in the northeast, the Barnett[14] and Haynesville[15] Shales in Texas, and from studies done by Ohio EPA and

---

[7] This study was finalized by the authors on November 30th, 2013 and accepted as final by TCEQ on April 4, 2014.

[8] Schlumberger, Baker-Hughes, and Halliburton are three of the largest companies providing hydraulic pumping services for the oil and gas production industry.

[9] Texas Commission on Environmental Quality, "Development of Texas Statewide Drilling Rigs Emission Inventories for the Years 1990, 1993, 1996, and 1999 through 2040", by Eastern Research Group, Inc., August 15, 2011. Online: http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1105-20110815-ergi-drilling_rig_ei.pdf

[10] Texas Center for Applied Technology (TCAT), "Environmentally Friendly Drilling Systems Program Hydraulic Fracturing Phase Emissions Profile (Air Emissions Field Survey No. 1)", Nov. 2011.

[11] The study predicted air emissions under low, medium and high development scenarios. These development scenarios were based on estimates of ultimate recoverable reserves from the region, the number of drill rigs available, interviews with industry representatives about their plans for future development, production decline curves for wells in the region, and the prices for natural gas and petroleum liquids.

[12] Amnon Bar-Ilan, John Grant, Rajashi Parikh, Ralph Morris, ENVIRON International Corporation, "Oil and Gas Mobile Sources Pilot Study", July 2011. Online: http://www.wrapair2.org/documents/2011-07_P3%20Study%20Report%20(Final%20July-2011).pdf

[13] All Consulting, "NY DEC SGEIS Information Requests". Prepared for Independent Oil & Gas Association, Project no.: 1284, Sept. 16, 2010. Online: http://catskillcitizens.org/learnmore/20100916IOGAResponsetoDECChesapeake_IOGAResponsetoDEC.pdf

[14] Al Armendariz, "Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements", Prepared for Environmental Defense Fund, Jan. 26, 2009. Online: http://www.edf.org/sites/default/files/9235_Barnett_Shale_Report.pdf

[15] John Grant, Lynsey Parker, Amnon Bar-Ilan, Sue Kemball-Cook, and Greg Yarwood, ENVIRON International Corporation, "Development of an Emission Inventory for Natural Gas Exploration and Production in the Haynesville Shale and Evaluation of Ozone Impacts", August 31, 2009. Online: http://www.netac.org/UserFiles/File/NETAC/9_29_09/Enclosure_2b.pdf

the U.S. Dept. of Interior.[16] The AACOG study's authors also interviewed industry representatives, gathering information on how hydraulic stimulation equipment and processes have changed over time. The interviewers gathered information on: engine horsepower, the average amount of time it took to fracture a well, the number of fracturing stages, load factor, and the amount of water used. Like this study, the previous studies cited in the AACOG report used engine count, engine horsepower, hours of operation, and load factor to determine the emissions from a typical hydraulic fracturing job. Unlike this present study, the AACOG report used aerial imagery as part of their basis for estimating the number of hydraulic pump engines used at sites in the Eagle Ford Shale. Although imagery from 14 sites indicated that an average of 13.9 engines were used, the study's authors choose to use 12 engines per site in their emissions calculations, based on data from other studies and information obtained from local fracturing companies. The AACOG study based their load factor (30%) on information collected from hydraulic pump operators in the Eagle Ford play. The factors used in the AACOG study for calculating engine emissions from hydraulic fracturing are shown in Table 3-1.

Table 3-1. Emission Factors Used for Calculating Engine Emissions

Factor Description	Factor and Units	Source:
Number of Engines	12 / job	TCAT Eagle Ford Survey, ERG's Fort Worth Natural Gas Study, Aerial Imagery, Local Sources
Engine Horsepower	2,250 hp	TCAT Eagle Ford Survey, ERG's Drill Rig Emission Inventory for TCEQ
Total Hours per Job	54 hrs / job	ENVIRON's Haynesville Shale Report
Load Factor	30%	Local Sources
Engine Emission Factors	4.56g NO_x/hp-hr 0.24g VOC/hp-hr 2.67g CO/hp-hr	TCEQ's TERP emission factors for Tier 2 Engines[17] TCEQ's TERP emission factors for Tier 2 Engines TexN Model[18]

Thus, the AACOG study concluded that the total power expended by hydraulic pump engines to stimulate a typical well in the Eagle Ford Shale is 437,400 hp-hr.

The study noted that hydraulic stimulation practices have changed in the last few years, and described some of those changes. As more wells are completed in the Eagle Ford play, operators gain a better understanding of what works best in the geologic conditions presented by the source rock in the Eagle Ford Shale. A careful comparison

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[16] U.S. Department of the Interior, Bureau of Land Management, "Tumbleweed II Exploratory Natural Gas Drilling Project", DOI-BLM-UTG010-2009-0090-EA, June 2010. Online: http://www.blm.gov/pgdata/etc/medialib/blm/ut/lands_and_minerals/oil_and_gas/november_2011.Par.24530.File.dat/

[17] TCEQ, April 24, 2010. "Texas Emissions Reduction Plan (TERP): Emissions Reduction Incentive Grants Program Technical Supplement No. 2, Non-Road Equipment".

[18] TCEQ, August 18, 2008, Texas NONROAD (TexN) Model Version 1.0, Online: ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TexN/TexN_Users_Guide.pdf

of the AACOG study data and that from studies of hydraulic completions in other shale plays revealed that the techniques in the Eagle Ford that produce the best results are qualitatively different than those practices that lead to good results in other plays. This will be examined further in the next study reviewed for this report.

3.1.2 Hydraulic Technology – Optimizing Completion Design for the Eagle Ford Shale

ERG reviewed two studies published in The American Oil and Gas Reporter that detailed new approaches to hydraulic fracturing in the Eagle Ford Shale.

A study entitled "Approach Optimizes Completion Design", published in the August 2011 edition of The American Oil and Gas Reporter[19] examined the effect of a reservoir-specific completion strategy that accounts for the site-specific characteristics of the reservoir rock. The source rock at a well in DeWitt County was studied prior to fracturing. Analysis revealed that the reservoir rock was a clay-rich limestone with low quartz content and a low Young's modulus,[20] compared to the rock in the Barnett Shale, which is a very brittle siltstone with a high Young's modulus. The study examined how the properties of the reservoir rock played a role in determining what fracturing procedures and materials would provide the best results in opening the reservoir rock to allow the maximum gas and liquids to flow to the wellbore. Whole core data from a vertical section and mud log data from the lateral section were examined for the rocks' petrophysical characteristics and used to develop a completion strategy for each stage of the completion. The fluid mix was designed to control clay swelling, decrease the viscosity of the fluid over time, and inject larger than normal sized proppants to account for the relative softness of the rock. The large proppants were chosen to prevent 100% embedment of the proppant in the fracture face, which would, in effect, seal up the fractures that the hydraulic pumps create during the process. Each stage of the lateral was completed differently to account for changes in the brittleness/ductility index of the rock. Production data from the well, compared to that from other wells, showed that the production on this hybrid completion was superior to that produced from similar wells completed in the Eagle Ford using slick-water fracs.[21] The study authors concluded that the higher conductivity achieved with the hybrid completion accounted for the higher production.

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[19] The American Oil and Gas Reporter, "Approach Optimizes Completion Design", R. Borstmayer, N. Sargent, A. Wagner, and J. Mullen, August 2011.

[20] Young's Modulus is a measure of the stiffness of an elastic isotropic material and is used to predict how much a material sample extends under tension or shortens under compression. It might also be considered a measure of the brittleness or ductility of the rock.

[21] Compared to production from the three slick-water fraced wells examined in the study, production from the hybrid fraced well ranged from 750 – 2,250% higher, based on barrel oil equivalent production of gas and oil.

This 2011 study, published in a widely-available industry publication, showed that using a site-specific hybrid completion technique unique to the Eagle Ford Shale can increase well production by significant margins over using a completion technique typically used in other shale plays. ERG assumes that all other fracturing companies working in the Eagle Ford will quickly adopt these techniques. Although the study did state that the lateral length was 3,800 feet, it did not publish any information on the engine power or time spent to fracture each of the 11 stages. Therefore, total engine power requirements for this well could not be compared to the results from other studies conducted on other shale plays.

A study entitled "Pilot Wells Test Stimulation Approach", published in the June 2011 edition of The American Oil and Gas Reporter[22] examined the effect of monitoring real-time microseismic activity in the reservoir rock during hydraulic fracturing for two wells. The study examined the effect of changing the hydraulic pumping schedule (pressure, time, proppants) using the microseismic monitoring, and found that "a stimulation technique that uses a shutdown during pumping to allow pressure relaxation, or equilibration, prior to reinitiating the fracturing process proved highly successful in increasing the estimated stimulated volume (ESV) in the reservoir rock." The stimulation team changed their techniques for each stage of fracturing, varying the pressure and timing, based on the microseismic results from previous stages, with the intent to contain the fracturing within the target zone (which ranges from 100 to 300+ feet thick). The production logs from the wells showed positive correlation "between production contribution and the ESV derived from the analysis of microseismic monitoring done during hydraulic stimulation." For the first well, pressure was slowly increased for each stage, containing the fracture in the target zone. For the second well, the stimulation team utilized significant variations in pumping pressure for five of the seventeen stages, to allow pressure relaxation for a period of 2 – 14 hours, prior to resuming pumping and finishing the fracture stage.

This article reported average lateral lengths were greater than 5,000 feet, and the number of stages at 10 -17 per lateral. The study did not publish any information on the engine power or time spent to hydraulically stimulate either of these wells. Therefore, total engine power requirements for these wells could not be compared to the results from other studies conducted on other shale plays.

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[22] The American Oil and Gas Reporter, "Pilot Wells Test Stimulation Approach" A. Inamdar, T. Ogundare, D. Purcell, R. Malpani, K. Atwood, K. Brook, and A. Erwemi, June 2011.

3.1.3 Comparing Emissions from Hydraulic Operations Using Activity Data and Fuel Consumption

A Masters' Thesis project examined emissions from hydraulic stimulation operations in both the Eagle Ford Shale and the Marcellus Shale.[23] This study was unique in that the authors evaluated five air emissions models: three models were based on activity levels per source and two models were based on fuel consumption per source. The three models based on activity levels used data and methodology similar to that used in the AACOG study described above, the differences being in the use of load factors and emission factors. The general equation for these three activity-based models is:

Emissions = emission factor x horsepower x load factor x operating time.

The models based on fuel consumption differed in that one used total fuel consumption and AP-42 emission factors[24] while the second calculated emissions based on fuel consumption rate, hours of operation, and EPA Nonroad Tier 2 standards.[25] Both fuel consumption models used a constant for fuel density (7.11 lb/gal) and brake-specific fuel consumption for the equipment. The general equation for the two fuel usage models is:

Emissions = emission factor x brake-specific fuel consumption x fuel density x fuel consumption

The authors collected detailed engine activity and fuel usage data[26] from two well fracturing sites and applied it to the five models. The five models are described in Table 3-2.

Table 3-2. Emission Models Used for Estimating Emissions

Model	Source of Engine Emission Factors	Assumptions[27]
Activity Model 1	U.S.EPA – AP-42, Chapter 3.4	100% Load
Activity Model 2	U.S.EPA – AP-42, Chapter 3.4	Average Load, based on local data
Activity Model 3	U.S.EPA – Nonroad Tier 2 standards	Average Load, based on local data
Fuel Usage Model 1	U.S.EPA – AP-42, Chapter 3.4	100% Load
Fuel Usage Model 2	U.S.EPA – Nonroad Tier 2 standards	Average Load, based on local data

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[23] Ginna Rodriguez and Chenchen Ouyang, "Air Emissions Characterization and Management For Natural Gas Hydraulic Fracturing Operations in the United States", Masters Thesis project, Univ. of Michigan, April 2013.

[24] Emission factors were from AP-42, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines, October 1996**.**

[25] All of the frac pump engines in the study were Tier 2 models.

[26] The authors determined that the average fuel used for a fracturing job is 22,100 gallons for the Eagle Ford Shale and 20,800 gallons for the Marcellus Shale.

[27] The average load factor is based on data collected onsite, and then weighting different loads during different portions of the job over the total time the frac pumps are used. For Fuel Usage Model 2, the fuel consumption rate is based on average load.

Total emissions were calculated from the engines used to power the hydraulic pumps, blender, frac control unit, hydration unit, sand king, and water transfer pump for each of the five models. By comparing results from the five models, the authors found that the magnitude of emissions is most sensitive to the emission factor and the load factor for the engines. The study found that emissions from the hydraulic pump engines account for 83-94% of all emissions from the engines used in hydraulic fracturing operations.

3.1.4 Hydraulic Stimulation in the Haynesville Shale

The Halliburton Company, a major provider of hydraulic pump services, produced a short brochure on the complex, heterogeneous conditions in the Haynesville Shale.[28] The brochure included the following information:

- The Haynesville Shale is approximately 10,500–13,500 ft deep, and its porosity is higher than other shales, indicating its ability to contain more gas;
- It has higher reservoir pressure than other North American unconventional shale plays;
- Average well vertical depths are 11,800 ft with bottomhole temperatures averaging 330°F, and wellhead treating pressures during stimulation commonly exceeding 10,000 psi. As a result, wells here *require almost twice the amount of hydraulic horsepower*[29] and more advanced fluid chemistry than other shale plays in the Southern U.S.; and
- In these deep wells, with fracture gradients of 1 psi/ft and low Young's modulus, there is also concern about the ability to sustain production with adequate fracture conductivity.

Based on the low Young's modulus, ERG would expect that the proppants used in the Haynesville Shale would be similar to that used in Eagle Ford Shale (e.g., larger in size), in order to maintain fracture conductivity to the wellbore after the fracture process is completed.

3.2 Hydraulic Pump Engine Survey and Findings

The hydraulic pump engines survey targeted oil and gas production companies and attempted to obtain information on the use of hydraulic pump engines during well completion activities at oil and gas wells. The companies targeted had significant recent activity in the six regions of interest for the survey.

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[28] Halliburton, Haynesville Shale, http://www.halliburton.com/en-US/ps/solutions/unconventional-resources/shale-gas-oil/shale-plays/haynesville-shale.page?node-id=hgjyd46z and http://www.halliburton.com/en-US/ps/solutions/unconventional-resources/shale-gas-oil/shale-plays/haynesville-shale.page?node-id=hgjyd46z

[29] While ERG's survey results for wells in the Haynesville Shale of East Texas appear to be at odds with this claim, the one company that submitted survey data gave us data for 7 vertical wells. The Halliburton Company is referencing the amount of hydraulic horsepower needed for stimulation of horizontal wells.

For the hydraulic pump engine survey, ERG attempted to contact persons at oil and gas production companies who were responsible for environmental and regulatory compliance. Letters were sent to a total of 93 contacts at 86 separate regional company offices located in Texas, Oklahoma, and surrounding states. The letters explained the survey, requested cooperation in gathering data, and included sample data collection forms. The survey letter requested data on the location, the type of well, the number of engines used, the horsepower of the engines, the percent full load for the engines, the number of fracturing stages, and the duration of each fracturing stage. The companies selected were identified from previous TCEQ surveys as companies which had provided data, and from the RRC database as operating companies that completed a significant[30] number of wells in the targeted basins during the year 2013. See Attachment A for the hydraulic pump engine letter and survey materials.

ERG followed up the letters with phone calls to each company contact until contact was made. In many cases, emails were sent to the company, either as a follow up to a telephone conversation, or in the event no telephone contact could be made. During phone calls, ERG requested participation and explained the survey to potential respondents.

ERG collected data on the use of hydraulic pump engines used during well completions for 79 wells from nine companies. The survey asked questions about:

- Location (County);
- Type of well (oil or gas well);
- Number of engines used;
- Horsepower of the engines;
- Percent full load for the engines;
- Number of fracturing stages; and
- Duration of each fracturing stage.

The data submitted for these 79 wells was compared with RRC data on the actual number of horizontal and vertical wells completed by each reporting company in 2013, by region and county, well type (oil or gas) and wellbore profile (horizontal, vertical, directional). The data was compiled into a spreadsheet, sorted by region, and calculations were performed to determine basin and state averages. This data is shown in Table 3-3:

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[30] For purposes of this survey, a ‘significant’ number of wells completed by an operating company in 2013 ranged from 12 to over 100. Companies were found by querying the RRC database on the number of well completions, by district.

Table 3-3. Hydraulic Pump Engine Survey Data, by Region

Basin	**Average Number of Engines**	**Average Horsepower**	**Average % Load**	**Average Number of Fracturing Stages**	**Average Duration of each Stage (hours)**	**Average Total Horsepower-hours Per Job**
Anadarko Basin	15	2200	48%	10.4	1.58	254,563
Eagle Ford Shale	23	2290	76%	16.6	2.28	1,223,667
East Texas Basin/Haynesville Shale	8	1814	36%	2.1	1.04	11,271
Permian Basin	10	2313	36%	16.8	1.38	266,639
Statewide Average	14	2154	49%	11.5	1.57	439,035

Seven (7) additional companies responded to the survey with information to the effect that "Our company has not fractured any wells in those counties in 2013." ERG considered this to be useful information, as it provided information on those newly completed wells that were not hydraulically stimulated.

ERG obtained information on all 16 company's wells from the RRC database[31] for the basins of interest. This data included the region and county, well type (oil or gas) and wellbore profile (horizontal, vertical, directional). The number of wells represented by companies that responded but did not fracture any wells typically only represented a few wells. Many of these companies produced natural gas, and the market prices for natural gas for the past few years have not supported any new exploration. This data is shown in Table 3-4.

Table 3-4. Companies Responding to the Survey

Region	**Companies Who Filled Out Survey Completely**	**Companies Reporting "No Wells Fractured"**	**Number of Wells Reported**	**Number of Wells Completed in 2013**	**Wells Completed in 2013 by Reporter**	**Reporter's 2013 Wells as % of Total**
Anadarko Basin	1	0	8	847	111	13.1%
Eagle Ford Shale	5	0	48	3,182	654	20.6%
East Texas Basin/Haynesville Shale	1	0	7	678	7	1.03%
Fort Worth	0	1	-	-	-	-
Permian Basin	2	2	16	8,864	382	4.3%
Western Gulf	0	4	-	-	-	-

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[31] Data for well completions in 2013 was obtained using an operator-specific data query on the Railroad Commission website. Online: http://www.rrc.state.tx.us/about-us/resource-center/research/online-research-queries/

Attachment C contains the results of the hydraulic pump engine survey.

3.3 Recommendations for Using the Survey Findings

ERG recommends that the TCEQ use the findings in Table 3-3 above for estimating emissions from hydraulic pump engines. Where basin data was available, it has been used. For all other basins, the individual basin factors were averaged to determine a statewide value, which was then used in the other basins.

3.4 Hydraulic Pump Engine Emission Factors

For the 2011 base year TCEQ oil and gas nonpoint area source inventory, TCEQ used emission factors from the 2012 CenSARA study, which were derived using EPA's NONROAD2008 model. To update these factors for this study, average emission factors for 2013 and 2014 inventory years were developed. Using EPA's NONROAD2008 model, updated factors were developed based on the oil equipment source category bin (SCC 2270010010), and a diesel sulfur content of 15 ppm. Average emission factors were developed for engines between 1,000 and 3,000 horsepower, consistent with the engine sizes observed in the survey.

Table 3-5 below shows the emission factors for hydraulic pump engines for the 2011, 2013, and 2014 inventory years. As can be seen in the table, the emission factors have decreased over time as new engines replace older engines, resulting in a higher percentage of engines subject to the more stringent Tier 4 engine standards.

Table 3-5. Hydraulic Pump Engine Emission Factors

Pollutant	2011 (g/hp-hr)[a]	2013 (g/hp-hr)[b]	2014 (g/hp-hr)[b]
PM_{10}	0.227	0.184	0.172
NO_x	5.831	5.081	4.775
CO	1.318	1.076	1.021
VOC[c]	0.368	0.328	0.317
SO_2	0.010	0.0046	0.0045

[a] 2011 emission factors from CenSARA Inventory.

[b] 2013 and 2014 emission factors from EPA's NONROAD Model.

[c] VOC emission factor includes exhaust and crankcase emissions.

To account for this updated hydraulic pump engine information in the inventory, the Hydraulic Fracturing Pumps tab of the TCEQ oil and gas nonpoint area source emissions estimation calculator was revised as follows:

- The PM_{10}, NO_x, CO, VOC, and SO_2 emission factors were updated to the 2013 values shown in Table 3-5;
- Table A was added to include the hydraulic pump engine operating characteristics for each basin from Table 3-3; and

- In the County-level emissions table: columns H through L were revised to lookup the appropriate operating factors from Table A.

Attachment D contains the updated TCEQ oil and gas nonpoint area source emissions estimation calculator (“ERG AppendixE_2013 with updates to Basin information.xls”) reflecting the changes to the inventory for hydraulic pump engines using the updated operating characteristics and emission factor data in Tables 3-3 and 3-5.

4. Mud Degassing

Drilling mud is a mixture of special clays and additives with water, oil, or synthetic matter. Considerable heat and friction are generated by the drill bit as it removes rock at the bottom of the well. During drilling, the drilling mud is continuously pumped through the drill string and out through the drill bit. The circulating drilling fluid cools and lubricates the drill bit, and moves cuttings upwards through the wellbore toward the surface. Mud must have the capacity to suspend the fragments of solid material removed by the drill bit. If the mud does not circulate quickly enough, the drilled cuttings in the wellbore may accumulate and the drill string may get stuck.

To properly control the drilled materials and cutting suspension, the properties of drilling fluid are tested frequently at the rig site by a mud engineer using procedures specified in “Recommended Practice for Field Testing Water-Based Drilling Fluids”, API Standard Method RP 13B-1. Measured properties include density and viscosity. Viscosity must be high enough that the drill cuttings will remain suspended, but low enough such that the pumps can overcome the friction and pump the mud up and out of the wellbore. Low-viscosity mud allows sand and cuttings to settle out, and gas to escape at the surface.[32] Mud density must be carefully controlled, and is gradually increased by the mud engineer through addition of special additives to the drill mud as the depth of the well increases. This is done to counteract formation pressure, which increases with depth.

As the drill bit approaches and penetrates oil and gas-bearing layers of rock (the producing formation or “play”), the mud engineer must be sure that the weight of the column of mud exceeds the pressure of fluids or gases in the productive formation. If not, and the subsurface pressure exceeds the downward pressure from the weight of the mud in the wellbore, a blowout may occur. Blowouts are both costly and dangerous, and drilling companies take extensive measures to prevent them. Still, the RRC records indicate that 24 blowouts occurred in Texas in 2013.[33]

In a broad sense, drilling mud can be classified as water-based, oil-based, synthetic, or an emulsion. The term “oil-based” is used for drilling mud prepared from petroleum distilled liquids, whereas the term “synthetic” is used for drilling mud prepared from non-aqueous liquids prepared from the reaction of organic building blocks, such as ethylene or methane.[34] Water-based muds may be fresh or saltwater based and typically include a type of clay that will stay suspended for a time after agitation has stopped. Oil-

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[32] Lyons, William C. Working Guide to Drilling Equipment and Operations. Amsterdam: Gulf Pub./Elsevier, 2010. <http://public.eblib.com/EBLPublic/PublicView.do?ptiID=535200>.

[33] Railroad Commission of Texas, “Blowouts and Well Control Problems”, Online: http://www.rrc.state.tx.us/oil-gas/compliance-enforcement/blowouts-and-well-control-problems/

[34] Growcock, Frederick B., and Arvind D. Patel. "The Revolution in Non-Aqueous Drilling Fluids (AADE-11-NTCE-33)." AADE National Technical Conference and Exhibition Held at the Hilton Houston North Hotel, Houston, Texas, April 12-14, 2011. (2011). <http://www.slb.com/resources/technical_papers/miswaco/AADE-11-NTCE-33.aspx>.

based and synthetic muds are generally expensive and hard to dispose of, but they are well suited for drilling the producing zones of deep, high temperature holes in which water-based muds solidify. [35]

Under-balanced drilling (UBD) describes a situation in which the hydrodynamic pressure of the drilling mud and circulating fluids in the well bore is less than the pressure of the well formation. This drilling technique can require surface equipment to separate drilling mud and hydrocarbons for recirculation, storage, flaring, and disposal.[36] UBD can cause a kick or a blowout to occur where there is an influx of reservoir fluid or gas into the wellbore. When properly managed, UBD allows for greater drilling velocity (aka rate of penetration). [37] When mud is over-balanced, it is forced into the surrounding rocks, and the solid particles form a filter or mud cake. This stabilizes the sides of the well and prevents subsurface fluids from flowing into the well. Over-balanced drilling is more typical.[38]

It is common to have a mud gas separator or degasser equipment located at the surface of the well to separate and safely remove large pockets of free gas from the drilling mud returned to the surface, but one is only used when drilling through the producing formation. It is necessary to remove the gas because it reduces the mud weight. Gas separators are effective on both water-based and oil-based muds. The vented gas may include toxic gases (such as hydrogen sulfide) from the drilling fluids processing system. One manufacturer of mud gas separators, GN Solids America, equips their separators with an electric ignition device to flare toxic gases.[39] Vacuum separators utilize negative pressure to withdraw entrained gases from the mud. In order for this to work, mud exiting the wellbore is pumped through a venturi choke. The pressure drops on the outlet side of the choke, enabling the entrained gases to expand and easily separate from the drilling mud. Atmospheric separators pump mud into a thin layer, relying on density differences between the gas and the mud to liberate gas. One separator design utilizes the thin layer approach inside a vacuum chamber to speed separation of gas from the drilling mud.

4.1 Available Mud Degassing Emission Factors

Limited information on the emissions from drilling mud is available, but there is a consensus opinion that a 1977 U.S. EPA publication "*Atmospheric Emissions from*

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[35] Lyons, William C. Working Guide to Drilling Equipment and Operations. Amsterdam: Gulf Pub./Elsevier, 2010. <http://public.eblib.com/EBLPublic/PublicView.do?ptiID=535200>.

[36] LeBlanc, Chris, Marco Amorim, and Roberto Piacentini. "Case Study: a High Throughput Mud-Gas Separator for Underbalanced Drilling." Offshore Technology Conference Held in Rio De Jeneiro, Brazil, 4-6 October 2011

[37] Personal communication with Bill Brannan of Nicklos Drilling Company. June 6, 2014

[38] Oil & Gas Production Protocol, published in February 2010 by The Climate Registry

[39] GN Solids America LLC. "Mud Gas Separator - GNZYQ Mud Gas Separator Features and Benefits." Web Accessed: 11 June 2014. <http://www.gnsolidsamerica.com/mud-gas-separator.html>.

Offshore Oil and Gas Development and Production"[40] is the best currently available estimate. The estimate presented in this study is based on engineering calculations of emissions from mud degassing at an offshore gas well using a water-based mud. The water-based emission rate represents gas liberated from rock drilled out of the wellbore, when drilling through a producing formation. The calculation assumes a penetration rate of 400 feet per day, 25% porosity, and reservoir pressure of 4,000 psig. The oil-based emission rate was calculated by assuming emissions from oil-based drilling mud were equivalent to emissions from diesel fuel stored in a fixed-roof storage tank with a turnover factor of 0.5.[41] The surface area of exposed mud is small. The gases separated from the mud in the mud separator are not counted. Although the mud turnover speeds vary over the course of the drilling event, this was not considered.

Four recent publications cite the 1977 EPA report as the original source for mud degassing factors:

- The American Petroleum Institute (API) publication "Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry"[42] discusses mud degassing, and recommends that "site-specific methane concentration data should be used to estimate these emissions". The API document cites the mud degassing emission factors reported by US EPA in 1977.
- The Climate Registry's "Oil and Gas Production Protocol"[43] discusses emissions from mud degassing in the case of an underbalanced drilling operation, where the pressure in the wellbore is kept lower than the gas and fluid pressure in the formation being drilled. However, the discussion lacks a specific formula, and states that the volume of gas vented must be measured or estimated based on downhole pressure, wellbore diameter, and the duration of underbalanced drilling. Although other publications have mentioned that the drilling penetration rate is faster, and formation damage is lessened using underbalanced drilling, none suggests that underbalanced drilling is used when drilling producing shale formations, due to the risk of blowout. The Climate Registry document cites the mud degassing emission factors reported by US EPA in 1977.
- A report prepared by ENVIRON and ERG for the CenSARA States[44] cites the mud degassing emission factors reported by US EPA in 1977; and
- A report prepared by ERG for the TCEQ[45] cites the mud degassing emission factors reported by US EPA in 1977.

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[40] "Atmospheric Emissions from Offshore Oil and Gas Development and Production". U.S. Environmental Protection Agency, EPA-450/3-77-026, June, 1977.

[41] Turnover factor is the ratio of throughput to tank capacity [See US EPA – Office of Air Quality Planning and Standards. Compilation of Air Pollutant Emission Factors AP-42, Section 7.1 Organic Liquid Storage Tanks. September 2006].

[42] American Petroleum Institute, "Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry", August 2009

[43] Climate Registry, "Oil and Gas Production Protocol", Version 1.0, February 2010.

[44] ENVIRON, "2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States", prepared for the Central States Air Resources Agencies, December 21, 2012.

[45] Eastern Research Group, "Offshore Oil and Gas Platform Report - Final Report", August 16, 2010.

The most generally recognized mud degassing emissions factors are shown in Table 4-1, as presented in the API Compendium document.

Table 4-1. Mud Degassing Vented Emission Factors

Mud Type	Emission Factor (tonnes CH_4 / drilling day)[a]
Water-based	0.2605
Oil-based	0.0586
Synthetic	0.0586

[a] Note: 1 tonne = 1 metric ton = 2, 204.62262 pounds.

Additionally, the following studies were reviewed:

- In a recent study[46] published in the Proceedings of the National Academy of Sciences, the results of aerial sampling of methane in the air above wells being drilled in southwestern Pennsylvania (Marcellus Shale) was examined. The authors estimated that 34 grams methane per second was being released from wells in the drilling stage. Examination of the gas composition suggested that the methane plumes did not come from the shale rock, but arose from shallow coal pockets producing coal bed methane as the well was drilled through these formations. The methane was not directly attributed to drilling mud.
- A study sponsored by the Arkansas Department of Environment Quality entitled "Emissions Inventory & Ambient Air Monitoring of Natural Gas Production in the Fayetteville Shale Region"[47] examined air emissions from gas production activities in the Fayetteville Shale of Arkansas. Ambient monitoring was performed around the perimeter of six drilling sites, three hydraulic fracturing sites, four compressor stations, and a control site. The study found that concentrations of VOC at the sites other than drilling sites were at or below instrument detection limits, but that air samples around drilling sites had average VOC concentrations around 678 parts per billion.[48] The authors identified the likely source of VOC emissions as open tanks of oil-based drilling mud and cuttings.[49] The study did not identify the chemical composition of the VOC emissions, nor did it attempt to quantify emissions. The study noted that VOC emissions from gas production in the Fayetteville Shale were relatively low due to the low VOC content of the gas produced there (0.05% VOC), relative to the VOC content of gas produced in the Barnett Shale in Texas (8.2% VOC). Also, the Fayetteville Shale is a dry gas with little or no condensable hydrocarbons.

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[46] Dana Caulton, et.al., "Toward A Better Understanding And Quantification Of Methane Emissions From Shale Gas Development", April 14, 2014. Online: http://www.pnas.org/content/early/2014/04/10/1316546111.abstract

[47] David Lyon & Toby Chu, Arkansas Dept. of Environmental Quality, "Emissions Inventory & Ambient Air Monitoring of Natural Gas Production in the Fayetteville Shale Region", November 22, 2011.

[48] Although there is no NAAQS standard for VOC, volatile hydrocarbons do contribute to ozone formation, and some of the VOCs produced during oil and gas exploration are also hazardous air pollutants. Without gas speciation data, the actual risk posed by these VOCs to the workers is unknown.

[49] A company drilling in the Fayetteville Shale reported that an average well required 8.4 days to drill with an average lateral length of 4,985 feet, and that drilling normally utilizes oil-based drilling mud.

These two studies show that knowledge of site- or region-specific VOC content of gases is necessary for accurately estimating emissions from mud degassing.

In addition to the literature review, a number of individuals were contacted in an effort to determine if there were any current or recent emissions studies directly evaluating emissions from drilling mud:

- ERG contacted Dr. David Allen at The University of Texas at Austin. Dr. Allen is part of a group researching the climate impacts of natural gas.[50] The group's paper "Measurements of methane emissions at natural gas production sites in the United States," made no reference to mud degassing measurements.[51] Dr. Allen was not aware of any ongoing efforts to further characterize emissions from mud degassing.
- ERG contacted API and URS (their contractor and lead author of the compendium). Neither was aware of any more recent studies on mud degassing. Karin C. Ritter of API was not aware of any such studies either, but agreed to relay the TCEQ's interest in evaluating emissions from mud degassing to API members. [52]
- ERG also contacted David Lyon, the author of the Fayetteville Shale study mentioned above, who is currently with the Environmental Defense Fund (EDF). EDF is currently conducting a series of studies looking at emissions from upstream and midstream oil and gas exploration and production activities. Mr. Lyon was not aware of past or present research into mud degassing beyond the studies identified above.[53]

4.2 Mud Degassing Vendor Data

ERG identified five manufacturers of mud degassers and attempted to contact them to obtain information on mud degasser usage patterns across Texas. Unfortunately, these companies were unwilling to share customer details or mud degasser usage patterns.

ERG also reviewed available online literature from companies that manufacture mud degassing equipment:

- Derrick Equipment Company,[54] based in Houston, Texas, manufactures a mud degassing machine that utilizes thin film, high surface area, impact, turbulence, and vacuum technologies to quickly and efficiently remove entrained gases from water and oil-based drilling muds. Combined with other equipment in their line of products, the degasser processes used drill mud so that it can be quickly reused in the drilling operation.

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[50] Whittenberg, Lauren. "First Academic Study Released in EDF's Groundbreaking Methane Emissions Series." Environmental Defense Fund, 13 Sept. 2013. Accessed: 11 June 2014. <http://www.edf.org/media/first-academic-study-released-edf%E2%80%99s-groundbreaking-methane-emissions-series>.

[51] Personal communication with Dr. David Allen at The University of Texas at Austin. April 30, 2014.

[52] Personal communication with Karin C. Ritter of API and Terri Shires of URS Corporation. April 24, 2014 and April 29, 2014.

[53] Personal communication with David Lyon, May 5, 2014.

[54] Derrick Equipment Company, "Vacu-Flo Degasser", http://www.derrickequipment.com/home.aspx

- National Oilwell Varco,[55] based in Houston, Texas, manufactures a complete line of drilling fluid mixing, cleaning, cooling, pumping, and monitoring equipment. Their website indicates that “The mud (drilling fluid) system components condition the drilling fluid with the goal of lowering maintenance cost and decreasing the chance of equipment failure and hole and drilling problems.”

While this vendor information provided background knowledge about the process and equipment used in mud degassing, no emissions information was available from these sources.

4.3 Mud Degassing Survey Findings

The mud degassing survey targeted drilling companies and attempted to obtain information relating to mud degassing activities during drilling operations at oil and gas wells. The drilling companies provide rigs, equipment and crews to drill and service wells. The companies targeted had significant recent activity in the six regions of interest for the survey. These regions of interest are: Anadarko basin, Permian basin, Western Gulf basin, Bend Arch-Fort Worth basin/Barnett Shale, East Texas basin/Haynesville Shale, and the Eagle Ford Shale. As there is little gas or oil production in the Palo Duro and Marathon Thrust Belt basins, these areas were not targeted in this survey.

For the mud degassing survey, ERG attempted to contact persons responsible for drilling operations at the regional offices of their respective companies. Letters were sent to a total of 111 contacts at 64 separate regional company offices, representing 38 different drilling companies. The letters explained the survey, requested cooperation in gathering data, and included sample data collection forms. The survey letter requested data on the location, the type of well, the type of drilling mud used, the number of drilling days per well, and any control equipment used. See Attachment B for the mud degassing letter and survey materials. The companies selected were identified from the RigData database as companies that had drilled a significant number of wells[56] in the six regions of interest in the past three years.

ERG followed up the letters with phone calls to each company contact until contact was made. In many cases, emails were sent to the company, either as a follow up to a telephone conversation, or in the event no telephone contact could be made. During phone calls, ERG requested participation and explained the survey to potential respondents.

The mud degassing survey failed to produce any useful results or data. Most of the drilling companies contacted did not respond to repeated voice messages left for them. Of the three contacts that ERG spoke with, all indicated that they did not have the

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[55] National Oilwell VARCO, http://www.nov.com/home.aspx?langtype=1033

[56] For purposes of this survey, a ‘significant’ number of wells drilled by a drilling company ranged from 7 to 1198, depending upon the basin, with the average being 138.

information we were seeking, or that it would be too difficult to obtain. One respondent indicated that mud formulation is the purview of the oil and gas companies, and not the drilling contractor and that they did not maintain records of mud usage or composition.[57]

The lack of response to the mud degassing survey by the drilling operations personnel may be due to several reasons:

- Some companies may feel this type of information is confidential in nature and wish to protect their operating practices;
- Drilling companies are not used to responding to air quality data collection surveys, and do not have the institutional capacity to respond;
- There was no real incentive for the drilling companies to participate, as drilling companies do not report emissions from their operations directly to TCEQ, and have no formal relationship with TCEQ as a regulated entity;
- The information requested was either not kept by the drilling companies, or was saved in different departments within a company, making it inconvenient to compile information on a particular well; and
- The operations people contacted were too busy managing drilling operations to respond.

One respondent indicated that they could not count on the roughnecks to provide the correct information on the type of mud used at every stage in the drilling process. Another indicated that the mud engineer for the operations company (the owner of the well) would be the person that would have the information, and requested that we contact them directly. This approach proved unsuccessful as well.

4.4 Mud Degassing Emission Factors

While no useful data was obtained as part of the survey, ERG was able to develop basin-specific mud degassing emission factors for Texas based upon the API emission factors originally derived from the 1977 EPA study. Using natural gas dehydrator data derived from a recent TCEQ study, [58] natural gas composition profiles for five oil and gas basins in Texas were calculated, along with a state averaged natural gas composition profile. This information is shown in Table 4-2 below.

Use of the wet stream data for estimating mud degassing emissions from gas wells is appropriate, and such data is readily available through dehydrator emissions inventory reports submitted to TCEQ. The wet stream, or “wet gas” composition data from the dehydrators is assumed to be representative of the composition of any gas released during mud degassing. This information was then used to develop updated mud degassing emission factors for mud degassing at gas wells based on the Texas-specific gas composition data. The resultant mud degassing composition data as used in the emissions calculation is shown in Table 4-3.

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[57] Personal communication with Bill Brannan of Nicklos Drilling Company. June 6, 2014

[58] “Condensate Tank Oil and Gas Activities”, Texas Commission on Environmental Quality, Air Quality Division, October 20, 2012.

Table 4-2. Basin-Level and State-Level Average Natural Gas Stream Composition Profiles

Composition in Weight %	Anadarko Basin		Bend Arch-Fort Worth Basin		East Texas Basin		Permian Basin		Western Gulf		State Average Profile	
	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream	Dry Stream	Wet Stream
Water	0.04	0.13	0.01	0.11	0.01	0.12	0.01	0.13	0.01	0.11	0.01	0.11
Carbon Dioxide	1.54	1.57	4.02	4.00	4.18	4.14	2.00	1.84	2.66	2.66	3.32	3.32
Hydrogen Sulfide	0.06	0.06	0.00	0.00	0.00	0.00	0.18	0.17	0.00	0.45	0.05	0.16
Nitrogen	2.07	2.06	2.56	2.53	1.36	1.34	2.87	2.83	0.76	0.73	1.78	1.75
Methane	79.66	79.70	73.99	73.34	81.31	80.70	61.68	58.39	77.15	76.53	75.13	74.31
Ethane	6.57	6.56	8.25	8.18	5.93	6.02	12.97	12.64	7.24	7.19	7.99	7.88
Propane	4.20	4.20	4.95	5.02	2.53	2.57	9.44	11.02	4.80	4.79	4.96	5.11
Isobutane	0.83	0.83	0.95	0.97	0.90	0.93	1.42	1.64	1.49	1.48	1.17	1.22
n-Butane	1.72	1.72	1.89	2.06	1.00	1.02	3.31	4.39	1.58	1.57	1.78	1.95
Isopentane	0.63	0.63	0.76	0.83	0.60	0.67	1.21	1.34	0.92	0.92	0.84	0.87
n-Pentane	0.67	0.67	1.02	1.09	0.44	0.48	1.10	1.47	0.66	0.65	0.76	0.83
Cyclopentane	0.04	0.04	0.11	0.15	0.16	0.15	0.03	0.07	0.11	0.07	0.07	0.11
n-Hexane	0.47	0.28	0.23	0.54	0.24	0.24	0.66	0.72	0.23	0.27	0.27	0.41
Cyclohexane	0.05	0.05	0.18	0.13	0.14	0.14	0.36	0.43	0.22	0.27	0.18	0.22
Other Hexanes	0.66	0.66	0.32	0.27	0.48	0.52	0.99	1.16	0.78	0.69	0.59	0.59
Heptanes	0.33	0.33	0.42	0.42	0.33	0.39	0.67	0.65	0.37	0.48	0.42	0.42
Methylcyclohexane	0.11	0.11	0.10	0.10	0.05	0.11	0.19	0.18	0.21	0.21	0.16	0.21
Benzene	0.04	0.04	0.04	0.04	0.09	0.13	0.26	0.29	0.04	0.08	0.08	0.08
Toluene	0.05	0.05	0.01	0.01	0.05	0.05	0.18	0.17	0.05	0.10	0.05	0.05
Ethylbenzene	0.01	0.01	0.00	0.01	0.01	0.01	0.05	0.05	0.01	0.01	0.01	0.01
Xylenes	0.02	0.06	0.01	0.02	0.01	0.03	0.05	0.05	0.02	0.06	0.02	0.03
C8+ Heavies	0.25	0.25	0.18	0.18	0.19	0.25	0.38	0.37	0.67	0.67	0.36	0.36
VOC[a]	10.06	9.93	11.17	11.84	7.20	7.68	20.30	24.00	12.17	12.32	11.72	12.46
Total Hydrocarbons[b]	96.29	96.19	93.41	93.36	94.44	94.40	94.95	95.03	96.57	96.04	94.84	94.65

[a] VOC includes Propane through C8+ Heavies

[b] Total Hydrocarbons includes VOC, Methane, and Ethane

Table 4-3. Mud Degassing Composition (Gas Wells)

Basin	CH_4 mol %	VOC MW	VOC mol %
Anadarko	90.68	55.91	3.24
Bend Arch-Fort Worth	87.59	55.48	4.09
East Texas	91.49	59.04	2.37
Marathon Thrust Belt[a]	88.36	56.35	4.22
Palo Duro[a]	88.36	56.35	4.22
Permian	78.53	54.72	9.46
Western Gulf	89.94	57.60	4.03

[a] The data for Marathon Thrust Belt and Palo Duro is the statewide average.

For oil wells, use of the same natural gas dehydrator data is not appropriate since casinghead gas (gas produced from oil wells) typically has less methane (and more VOC) than gas produced at gas wells. Additionally, as the gas from oil wells is not always collected, the gas analysis data used to estimate emissions from dehydration and needed to develop the profiles shown in Table 4-2 will not be available.

Therefore, to develop Texas-specific mud degassing information for oil wells, ERG utilized data from the 2012 CenSARA study. As part of that effort, oil well mud degassing composition information was obtained for the Anadarko and Permian basins (with data for the Permian basin used for the Marathon Thrust Belt basin, which includes two counties in southwest Texas adjacent to the Permian basin). ERG then used the data from the Anadarko and Permian basins to develop a statewide averaged profile, which was applied to the remaining basins. Table 4-4 presents the results of this analysis.

Table 4-4. Mud Degassing Composition (Oil Wells)

Basin	CH_4 mol %	VOC MW	VOC mol %
Anadarko	82.93	55.42	5.98
Bend Arch-Fort Worth[a]	81.78	54.32	6.52
East Texas[a]	81.78	54.32	6.52
Marathon Thrust Belt	80.62	53.22	7.06
Palo Duro[a]	81.78	54.32	6.52
Permian	80.62	53.22	7.06
Western Gulf[a]	81.78	54.32	6.52

[a] The data for Bend Arch-Fort Worth, East Texas, Palo Duro, and Western Gulf is the statewide average.

Attachment D contains the updated TCEQ oil and gas nonpoint area source emissions estimation calculator ("ERG AppendixE_2013 with updates to Basin information.xls") reflecting the changes to the inventory for drilling mud degassing using the updated composition data in Tables 4-3 and 4-4.

5. NSPS Subpart OOOO Inventory Evaluation

The intent of NSPS Subpart OOOO[59] is to reduce emissions of criteria pollutants at new, modified, or reconstructed affected facilities at oil and gas production, gathering, gas processing, and gas transmission/storage sites. NSPS Subpart OOOO does not regulate greenhouse gas emissions or hazardous air pollutants.

The facility types affected by Subpart OOOO include: natural gas wells that are hydraulically fractured, centrifugal compressors using wet seals, reciprocating compressors, continuous bleed natural-gas driven pneumatic controllers, storage vessels with a potential to emit (PTE) six tons per year (tpy) or more of VOC, piping component equipment (pump, pressure relief device, open-ended valve or line, valve, and flange or other connector in VOC or wet gas service) within a process unit located at onshore natural gas processing plants, and sweetening units located at onshore natural gas processing plants. NSPS Subpart OOOO applies to these facilities if they are newly constructed, modified, or reconstructed after August 23, 2011. Compliance dates vary by the facility type.

Table 5-1 shows the affected facilities, industry segment, compliance standard, and compliance dates for oil and gas units and processes regulated under Subpart OOOO. Table 5-1 also indicates if the affected facility is included in TCEQ's oil and gas nonpoint area source inventory.

Table 5-1. NSPS Subpart OOOO Summary

Affected Facility	Area Source?	Industry Segment or Location	Compliance Standard	Compliance Date
Natural gas wells hydraulically-fractured prior to 1/1/2015	Yes	Well sites (production)	Combust flowback emissions from completions	10/15/2012
Natural gas wells hydraulically-fractured on or after 1/1/2015	Yes	Well sites (production)	Recover and reuse/sell or combust flowback emissions from completions	01/01/2015
Centrifugal compressors using wet seals	No	Gathering and NG processing plants	95% reduction of VOC	10/15/2012
Reciprocating compressors	No	Gathering and NG processing plants	Change rod packing every three years	10/15/2012
Continuous bleed natural-gas driven pneumatic controllers	Yes	Production (well sites) and gathering	6 scfh bleed rate	10/15/2012
Continuous bleed natural-gas driven pneumatic controllers	No	NG processing plants	Zero bleed rate	10/15/2012

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[59] 40 CFR 60, Subpart OOOO—Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution, http://www.ecfr.gov/cgi-bin/text-idx?SID=f701fdccf601c0b3200249b0ca81fbb6&node=40:7.0.1.1.1.103&rgn=div6#40:7.0.1.1.1.103.297.2

Table 5-1. NSPS Subpart OOOO Summary

Affected Facility	Area Source?	Industry Segment or Location	Compliance Standard	Compliance Date
Group I Storage Vessels (construction, modification or reconstruction commenced after 8/23/2011 and on or before 4/12/2013)	Yes	Production (well sites), gathering, NG processing, and NG transmission sites	Reduce VOC emissions by 95%, or maintain actual VOC emissions at less than 4 tpy without controls	04/15/2015, or within 60 days after startup
Group II Storage Vessels (construction, modification or reconstruction commenced after April 12, 2013)	Yes	Production (well sites), gathering, NG processing, and NG transmission sites	Reduce VOC emissions by 95%, or maintain actual VOC emissions at less than 4 tpy without controls	04/15/2014, or within 60 days after startup
Equipment Leaks (pump, pressure relief device, open-ended valve or line, valve, and flange or other connector in VOC or wet gas service)	No	Onshore NG processing plants	Implement a LDAR program. Leaks > 500 ppm must be repaired.	10/15/2012
Sweetening Units	No	Onshore NG processing plants	Reduce SO_2 as calculated	10/15/2012

5.1 Construction, Modification, Reconstruction, and Affected Facilities

NSPS Subpart OOOO requirements apply only to the types of facilities listed above that are newly constructed, modified, or reconstructed after August 23, 2011. “Construction” is defined as the fabrication, erection, or installation of a new affected “facility.” Relocating an affected facility is not construction, modification, or reconstruction. “Modification” is defined as any physical or operational change to an existing facility which results in an increase in the hourly potential emission rate of any pollutant to which the NSPS standard applies.[60] Changes that do not constitute a modification include: increasing hours of operation, an increase in production rate without a capital expenditure, use of an alternative fuel or material if the source could utilize it prior, addition of an air pollution control device, change in ownership, and routine maintenance, repair, and replacement. “Reconstruction” is defined as replacing components at an existing facility, such that the capital cost of new components exceeds 50% of the capital cost of a comparable new facility, and it is technologically and economically feasible to meet applicable standards.

5.2 Effect of NSPS Subpart OOOO on the TCEQ Oil and Gas Nonpoint Area Source Oil and Gas Emissions Inventory

As shown above in Table 5-1, the following facilities/processes included in the TCEQ nonpoint area source inventory are affected by the rule:

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[60] 40 CFR 60.14. An increase in emissions of a pollutant not regulated by the NSPS Subpart OOOO is not a modification.

- Natural gas wells hydraulically-fractured after 10/15/2012 and prior to 1/1/2015;
- Natural gas wells hydraulically-fractured on or after 1/1/2015;
- Continuous bleed natural-gas driven pneumatic controllers (at well sites);
- Group I Storage Vessels (at well sites); and
- Group II Storage Vessels (at well sites).

Since the NSPS regulations only affect facilities if they are newly constructed, modified, or reconstructed after August 23, 2011, an analysis was conducted to determine how to implement the required controls for each affected facility type in the inventory based on the requirements of the rule. Each of the affected source types is discussed in detail below, indicating how the affected percentage of the equipment population was determined, what the required controls are for each source type, and how these requirements were incorporated into the 2013 TCEQ oil and gas nonpoint area source emissions estimation calculator.

5.3 Natural Gas Well Completions

Under the requirements of NSPS Subpart OOOO, completions at natural gas wells that were hydraulically fractured after October 15, 2012 must be controlled with a flare. Completions at gas wells that are hydraulically fractured after January 1, 2015 must be controlled by capturing the gas for reuse or sale (reduced emissions completions) or flaring for exempted wells. There are currently no requirements in the rule to control emissions from oil well completions.

Information on the number of gas well completions that are hydraulically fractured is not readily available. However, information on the counts of vertical and horizontal gas wells spuds in 2013[61] is available. Therefore, ERG determined the percentage of gas well completions that were hydraulically fractured by assuming that the percentage of horizontal spuds in a county was equivalent to the percentage of horizontal completions, and that all horizontal well completions were hydraulically fractured. Using county-level data on the number of horizontal and vertical gas well spuds, the percent of all new gas wells that were horizontal, and therefore assumed to be hydraulically fractured, at the county level was determined. This data is included Table 5-2.

Table 5-2. Gas Well Completions

County	Vertical Spud Count	Horizontal Spud Count	% Horizontal Spuds
ANDERSON	0	0	0%
ANDREWS	1	0	0%
ANGELINA	0	2	100%
ARANSAS	2	0	0%
ARCHER	0	0	0%

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[61] 2013 annual data was extracted January 2014 by the RRC and provided to TCEQ in March 2014.

Table 5-2. Gas Well Completions

County	Vertical Spud Count	Horizontal Spud Count	% Horizontal Spuds
ARMSTRONG	0	0	0%
ATASCOSA	0	0	0%
AUSTIN	0	1	100%
BAILEY	0	0	0%
BANDERA	0	0	0%
BASTROP	0	0	0%
BAYLOR	0	0	0%
BEE	25	5	17%
BELL	0	0	0%
BEXAR	0	0	0%
BLANCO	0	0	0%
BORDEN	0	0	0%
BOSQUE	0	0	0%
BOWIE	0	0	0%
BRAZORIA	4	8	67%
BRAZOS	0	0	0%
BREWSTER	0	0	0%
BRISCOE	0	0	0%
BROOKS	11	3	21%
BROWN	0	0	0%
BURLESON	0	0	0%
BURNET	0	0	0%
CALDWELL	0	0	0%
CALHOUN	1	0	0%
CALLAHAN	2	0	0%
CAMERON	0	0	0%
CAMP	0	0	0%
CARSON	0	0	0%
CASS	0	0	0%
CASTRO	0	0	0%
CHAMBERS	0	2	100%
CHEROKEE	4	1	20%
CHILDRESS	0	0	0%
CLAY	1	1	50%
COCHRAN	0	0	0%
COKE	0	0	0%
COLEMAN	1	0	0%
COLLIN	0	0	0%
COLLINGSWORTH	0	0	0%
COLORADO	0	2	100%
COMAL	0	0	0%
COMANCHE	1	0	0%
CONCHO	0	0	0%
COOKE	0	9	100%
CORYELL	0	0	0%
COTTLE	1	0	0%
CRANE	0	0	0%

Table 5-2. Gas Well Completions

County	Vertical Spud Count	Horizontal Spud Count	% Horizontal Spuds
CROCKETT	2	0	0%
CROSBY	0	0	0%
CULBERSON	0	0	0%
DALLAM	0	0	0%
DALLAS	0	2	100%
DAWSON	0	0	0%
DE WITT	1	64	98%
DEAF SMITH	0	0	0%
DELTA	0	0	0%
DENTON	0	28	100%
DICKENS	0	0	0%
DIMMIT	1	192	99%
DONLEY	0	0	0%
DUVAL	8	0	0%
EASTLAND	0	0	0%
ECTOR	0	0	0%
EDWARDS	1	0	0%
EL PASO	0	0	0%
ELLIS	0	0	0%
ERATH	0	0	0%
FALLS	0	0	0%
FANNIN	0	0	0%
FAYETTE	0	0	0%
FISHER	0	0	0%
FLOYD	0	0	0%
FOARD	0	0	0%
FORT BEND	3	2	40%
FRANKLIN	0	0	0%
FREESTONE	20	5	20%
FRIO	0	4	100%
GAINES	0	0	0%
GALVESTON	0	2	100%
GARZA	0	0	0%
GILLESPIE	0	0	0%
GLASSCOCK	0	0	0%
GOLIAD	3	0	0%
GONZALES	0	0	0%
GRAY	0	0	0%
GRAYSON	0	1	100%
GREGG	4	3	43%
GRIMES	1	0	0%
GUADALUPE	0	0	0%
HALE	0	0	0%
HALL	0	0	0%
HAMILTON	0	0	0%
HANSFORD	0	0	0%
HARDEMAN	0	0	0%

Table 5-2. Gas Well Completions

County	Vertical Spud Count	Horizontal Spud Count	% Horizontal Spuds
HARDIN	0	1	100%
HARRIS	5	1	17%
HARRISON	28	15	35%
HARTLEY	0	0	0%
HASKELL	0	0	0%
HAYS	0	0	0%
HEMPHILL	36	45	56%
HENDERSON	2	0	0%
HIDALGO	30	12	29%
HILL	0	0	0%
HOCKLEY	0	0	0%
HOOD	0	21	100%
HOPKINS	0	0	0%
HOUSTON	3	0	0%
HOWARD	0	0	0%
HUDSPETH	0	0	0%
HUNT	0	0	0%
HUTCHINSON	0	0	0%
IRION	2	0	0%
JACK	5	0	0%
JACKSON	7	4	36%
JASPER	0	0	0%
JEFF DAVIS	0	0	0%
JEFFERSON	1	7	88%
JIM HOGG	2	2	50%
JIM WELLS	7	0	0%
JOHNSON	0	34	100%
JONES	0	0	0%
KARNES	0	96	100%
KAUFMAN	0	0	0%
KENDALL	0	0	0%
KENEDY	2	1	33%
KENT	0	0	0%
KERR	0	0	0%
KIMBLE	0	0	0%
KING	0	0	0%
KINNEY	0	0	0%
KLEBERG	15	3	17%
KNOX	0	0	0%
LA SALLE	1	81	99%
LAMAR	0	0	0%
LAMB	0	0	0%
LAMPASAS	0	0	0%
LAVACA	10	0	0%
LEE	1	0	0%
LEON	6	4	40%
LIBERTY	3	2	40%

Table 5-2. Gas Well Completions

County	Vertical Spud Count	Horizontal Spud Count	% Horizontal Spuds
LIMESTONE	13	0	0%
LIPSCOMB	0	15	100%
LIVE OAK	7	53	88%
LLANO	0	0	0%
LOVING	0	4	100%
LUBBOCK	0	0	0%
LYNN	0	0	0%
MADISON	3	0	0%
MARION	0	1	100%
MARTIN	0	0	0%
MASON	0	0	0%
MATAGORDA	1	5	83%
MAVERICK	0	0	0%
MCCULLOCH	0	0	0%
MCLENNAN	0	0	0%
MCMULLEN	2	36	95%
MEDINA	0	0	0%
MENARD	0	0	0%
MIDLAND	0	0	0%
MILAM	0	0	0%
MILLS	0	0	0%
MITCHELL	0	0	0%
MONTAGUE	0	81	100%
MONTGOMERY	0	0	0%
MOORE	5	0	0%
MORRIS	0	0	0%
MOTLEY	0	0	0%
NACOGDOCHES	0	2	100%
NAVARRO	0	0	0%
NEWTON	1	2	67%
NOLAN	1	0	0%
NUECES	7	5	42%
OCHILTREE	1	5	83%
OLDHAM	0	0	0%
ORANGE	0	3	100%
PALO PINTO	7	1	13%
PANOLA	51	58	53%
PARKER	0	54	100%
PARMER	0	0	0%
PECOS	0	0	0%
POLK	1	0	0%
POTTER	0	0	0%
PRESIDIO	0	0	0%
RAINS	0	0	0%
RANDALL	0	0	0%
REAGAN	0	0	0%
REAL	0	0	0%

Table 5-2. Gas Well Completions

County	Vertical Spud Count	Horizontal Spud Count	% Horizontal Spuds
RED RIVER	0	0	0%
REEVES	0	12	100%
REFUGIO	11	0	0%
ROBERTS	2	9	82%
ROBERTSON	16	2	11%
ROCKWALL	0	0	0%
RUNNELS	0	0	0%
RUSK	7	22	76%
SABINE	0	0	0%
SAN AUGUSTINE	0	13	100%
SAN JACINTO	2	1	33%
SAN PATRICIO	9	6	40%
SAN SABA	0	0	0%
SCHLEICHER	0	0	0%
SCURRY	0	0	0%
SHACKELFORD	2	0	0%
SHELBY	3	9	75%
SHERMAN	5	0	0%
SMITH	0	0	0%
SOMERVELL	0	0	0%
STARR	42	5	11%
STEPHENS	18	0	0%
STERLING	0	0	0%
STONEWALL	0	0	0%
SUTTON	0	0	0%
SWISHER	0	0	0%
TARRANT	0	218	100%
TAYLOR	0	0	0%
TERRELL	0	0	0%
TERRY	0	0	0%
THROCKMORTON	3	0	0%
TITUS	0	0	0%
TOM GREEN	0	0	0%
TRAVIS	0	0	0%
TRINITY	0	0	0%
TYLER	2	3	60%
UPSHUR	0	0	0%
UPTON	0	0	0%
UVALDE	0	0	0%
VAL VERDE	0	0	0%
VAN ZANDT	0	0	0%
VICTORIA	7	0	0%
WALKER	0	0	0%
WALLER	5	0	0%
WARD	0	0	0%
WASHINGTON	0	0	0%
WEBB	22	201	90%

Table 5-2. Gas Well Completions

County	Vertical Spud Count	Horizontal Spud Count	% Horizontal Spuds
WHARTON	7	0	0%
WHEELER	30	85	74%
WICHITA	0	0	0%
WILBARGER	0	0	0%
WILLACY	4	0	0%
WILLIAMSON	0	0	0%
WILSON	0	0	0%
WINKLER	0	0	0%
WISE	2	119	98%
WOOD	0	1	100%
YOAKUM	0	0	0%
YOUNG	1	0	0%
ZAPATA	3	2	40%
ZAVALA	0	0	0%

To address the changes in the inventory as a result of the requirements of NSPS Subpart OOOO as described above, the following changes have been made to the “Gas Well Completions” tab of TCEQ’s oil and gas nonpoint area source emissions estimation calculator:

- In the Basin-Level Data table: added column for flaring capture/control efficiency. Assumed a value of 95% for all basins;
- In the Basin-Level Data table: added cells for NO_x and CO flaring emission factors. The values are 0.068 and 0.37 lb/MMSCF, respectively, for all basins;
- In the County-level emissions table: added a column to show % of completions controlled (flared);
- In the County-level emissions table: modified the title in column I to read “Uncontrolled VOC Emissions (tons/event)”;
- In the County-level emissions table: modified the formula in column J to reflect controls; and
- In the County-level emissions table: added columns K and L for NO_x and CO emissions.

These changes reflect the impact of the NSPS Subpart OOOO requirements on hydraulically-fractured gas well completions after October 15, 2012, which will affect the 2013 and 2014 emissions inventories as hydraulically-fractured gas wells completed after this date must be controlled with flaring. The additional calculations for NO_x and CO reflect the combustion emissions from the flare. Note that beginning January 1, 2015, hydraulically-fractured gas well completions must be conducted using reduced emissions completions or flaring. This requirement will need to be considered in future inventories.

Attachment D contains the updated TCEQ oil and gas nonpoint area source emissions estimation calculator (“ERG AppendixE_2013 with updates to Basin information.xls”) reflecting the changes to the inventory for natural gas well completions as a result of the requirements of NSPS Subpart OOOO.

5.4 Pneumatic Controllers

Under the requirements of NSPS Subpart OOOO, pneumatic devices at oil and gas wells that were completed after October 15, 2012 must achieve a leak rate of six scf/hr or less. In the current inventory, the leak rate for pneumatic devices at oil wells is estimated to be less than six scf/hr for every basin. Therefore, the calculation for emissions from pneumatic devices at oil wells has not been revised.

To determine the effects on the 2013 emissions inventory of this requirement for gas wells, the percentage of affected gas wells was needed. This was determined by calculating the percent of total gas wells in production in 2013 that were completed after October 15, 2012. ERG used RRC county-level data on well counts and district level data on well completions to estimate the number of wells completed at the county level for the periods October 15, 2012 to December 31, 2012, and January 1, 2013 to December 31, 2013. ERG then calculated the percentage of new wells in each county using the county-level sum of new wells (since October 15, 2012) and the current county-level well count. This data is included in Table 5-3.

Table 5-3. New Gas Wells 10/15/12 – 12/31/13

Basin Name	2012 New Gas Wells (10/15/12 – 12/31/12)	2013 New Gas Wells	Total Gas Wells in 2013	New Wells (10/15/12 – 12/31/13) as Percent of Total
Anadarko Basin	69	526	12,036	4.9%
Bend Arch-Fort Worth Basin	275	1,425	22,388	7.6%
Eagle Ford Shale	86	1,220	11,156	11.7%
East Texas Basin/Haynesville Shale	113	340	19,931	2.3%
Palo Duro Basin	5	37	934	4.5%
Permian Basin	44	317	18,215	2.0%
Western Gulf	81	599	10,598	6.4%

Once the percentage of affected wells was known, an updated basin-weighted average bleed rate could be determined by assuming that all pneumatic devices at new wells would have a bleed rate of six scf/hr, while the bleed rates for pneumatic devices at existing wells (in existence prior to October 15, 2012) would not change. Table 5-4 presents the bleed rates for existing pneumatic devices, for new pneumatic devices (at gas wells brought into production after October 15, 2012), and the updated 2013 basin-weighted average bleed rate of all pneumatic devices within a basin.

Table 5-4. Updated Basin-Weighted Average Bleed Rate (Gas Wells)

Basin Name	Bleed Rate, Pre 10/15/2012 Devices (scf/hr/device)	Bleed Rate, Post 10/15/2012 Devices (scf/hr/device)	2013 Basin Weighted Average Bleed Rate (scf/hr/device)
Anadarko Basin	12.45	6	12.13
Bend Arch-Fort Worth Basin	6.2	6	6.18
Eagle Ford Shale	10.75	6	10.19
East Texas Basin/Haynesville Shale	17.59	6	17.33
Palo Duro Basin	8.58	6	8.46
Permian Basin	8.79	6	8.73
Western Gulf	7.78	6	7.67

As can be seen in the table, for the 2013 inventory, the average bleed rate of pneumatic devices at gas wells has slightly declined in each basin. Over time, as the percentage of wells subject to the six (scf/hr) bleed rate limitation increases, the average bleed rate of pneumatic devices will continue to decline.

In the Gas Well Pneumatic Devices tab of the TCEQ oil and gas nonpoint area source emissions estimation calculator, the column titled "Basin Bleed Rate (scf/hr)" was revised to "Basin Weighted Average Bleed Rate (scf/hr/device)" to reflect the updated bleed rates shown in Table 5-4. These changes reflect the impact of the Subpart OOOO requirements on gas well pneumatic devices at wells completed after October 15, 2012 on the 2013 emissions inventory.

Attachment D contains the updated TCEQ oil and gas nonpoint area source emissions estimation calculator ("ERG AppendixE_2013 with updates to Basin information.xls") reflecting the changes to the inventory for pneumatic controllers as a result of the requirements of NSPS Subpart OOOO.

5.5 Oil and Condensate Storage Vessels

Storage vessels are defined as a single tank or other vessel that contains an accumulation of crude oil, condensate, intermediate hydrocarbon liquids, or produced water. Fuel and chemical injection tanks, skid-mounted/mobile tanks, process vessels, and pressure vessels are excluded. Subpart OOOO applies to storage tanks installed, modified, or reconstructed after August 23, 2011, having a PTE of VOC greater than or equal to six tpy, and located in the: oil and natural gas production, oil and natural gas gathering, natural gas processing, or natural gas transmission and storage segments of the industry.

Under the requirements of the rule, storage vessels are separated into two groups based on date of construction/modification. Group I storage vessels are those vessels constructed, reconstructed, or modified after August 23, 2011, and on or before April 12, 2013. The PTE of Group I storage vessels must be estimated no later than October 15, 2013. Any Group I storage vessel determined to have a PTE greater than six tpy must be in compliance with the emission standards by April 15, 2015. Therefore, for purposes of revising the 2013 inventory, no control is assumed for Group I storage tanks as controls for these tanks are not required until 2015.

Group II storage vessels are those vessels constructed, reconstructed, or modified after April 12, 2013. The PTE of Group II storage vessels must be estimated no later than thirty days after startup. Any Group II storage vessel with PTE greater than six tpy must be in compliance with the emission standards by April 15, 2014 or within 60 days after startup. Pursuant to 40 CFR 60.5365, the PTE from storage vessels can be calculated via testing or by using a generally accepted model or calculation methodology, based on the maximum average daily throughput. Note that the current TCEQ area source emissions inventory accounts for a percentage reduction due to control devices installed on existing equipment at condensate tanks. [62]

A comparison of storage vessel PTE vs. throughput, using current TCEQ area source emissions inventory emission factors for oil storage tanks (1.60 lb VOC released per barrel of oil throughput) and condensate storage tanks (3.15 – 11.02 lb VOC per barrel of throughput), shows that an oil storage tank with throughput of less than 20 bbl per day has a PTE of less than six tpy of VOC, before the effect of any controls.[63] Since the TCEQ air emissions inventory emission factors for condensate storage tanks vary by region,[64] the throughput of condensate that results in a PTE of less than six tpy varies across Texas. For example, condensate production of 2.5 bbl/day in the Western Gulf basin results in PTE of less than six tpy VOC, while condensate production of 10 bbl/day in the Anadarko basin results in PTE of less than six tpy VOC, before the effect of any controls.

Vapors that are collected and re-routed to a process do not count towards PTE. A study conducted by ERG for TCEQ in 2012 on condensate tank emissions[65] showed that many operators were installing multi-stage depressurizing devices and condensers on their wells to capture and sell that portion of their petroleum production that might have previously been lost as emissions. As these devices increase production recovery efficiency, they are not controls, so PTE would be calculated after the effect of these devices.

For any storage tank with a PTE greater than six tpy, VOC emissions must be reduced by 95% (capture + control) using either a closed vent system and a control device or a floating roof. Control devices must undergo a performance test, except for: flares that

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[62] Control factors for VOC emissions from condensate storage tanks are as follows: Anadarko basin-17.1%, Bend Arch-Fort Worth-11.8%, East Texas-10.5%, Eagle Ford Shale-46.0%, Permian-19.5%, and Western Gulf-12.2%.

[63] Based on emissions of 1.6 lb VOC per bbl oil throughput: 1.6 lb/bbl x 365 days/yr x 1 ton/2,000 lb x 20 bbl/day = 5.84 tpy of VOC.

[64] VOC emissions per bbl of condensate throughput: Anadarko basin-3.15, Bend Arch-Fort Worth-9.76, East Texas-4.22, Eagle Ford Shale-10.46, Permian-7.07, and Western Gulf-11.03. Calculation methodology is identical to that for oil.

[65] “Condensate Tank Oil and Gas Activities”, Texas Commission on Environmental Quality, Air Quality Division, October 20, 2012.

are designed and operated in accordance with §60.18(b), large boilers or process heaters (> 44 megawatts), hazardous waste incinerators, or a control device that meets the performance requirements of §60.5412(a). To account for declining production, the control device can be removed from controlled storage vessels whose actual uncontrolled emissions drop to less than four tpy for more than 12 months. Control devices must also meet continuous monitoring requirements.

Since Group I storage vessels have until April 15, 2015 to comply, the effect of Subpart OOOO on emissions from these wells has not been considered for the 2013 inventory. For Group II storage vessels, the set of storage vessels that will need to be considered are those storage vessels that commenced production from April 12, 2013 through December 31, 2013. To determine the number of wells and the liquids production of the storage vessels at oil and gas production sites that were required to control emissions beginning June 11, 2013 (60 days after a date of 1st production of April 12, 2013), ERG used RRC lease-level data on oil and condensate production and TCEQ's basin-specific VOC emission factors for oil and condensate storage tanks[66],[67] to estimate the number, percentage, and liquids production of oil and gas wells completed since August 23, 2011 whose storage vessels have a PTE of VOC greater than six tpy. Although the Subpart OOOO compliance dates are different for isolated new wells and new wells located on a pad with an existing well, in doing these calculations, ERG assumed that all new wells are isolated and that production from a single well goes into a single storage tank. To simplify the determination of when a well begins production, ERG assumed that production begins on the date of completion. To simplify the determination of when a storage tank began complying with Subpart OOOO requirements, ERG assumed that storage tanks were in compliance on the date of completion.

The RRC lease-level data indicate that 2,638 new oil wells and 766 new gas wells were completed after April 12, 2013, and before January 1, 2014. Emissions calculations based on liquids production information and basin-specific emission factors for those wells described above show that 1,557 new oil wells and 356 new gas wells producing liquids are subject to the Subpart OOOO control requirements for the year 2013. The 2013 production represented by these wells (83,932,001 bbl oil and 8,636,341 bbl condensate) was compared with the total production for all new wells completed after April 12, 2013 and before January 1, 2014 (86,451,460 bbl oil and 8,719,058 bbl condensate), indicate that 97.1% of all new oil production and 99.1% of all new condensate production are subject to Subpart OOOO requirements for storage vessels.

When the 2013 oil and condensate production represented by these subject wells is compared with RRC data for 2013 statewide oil and condensate production (687,486,763 bbl oil and 107,651,266 bbl condensate), the data show that 12.2% of total

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[66] "Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide missions", TCEQ, November 24, 2010

[67] "Condensate Tank Oil and Gas Activities", TCEQ, October 10, 2012

statewide 2013 oil production and 8.02% of total statewide 2013 condensate production is subject to Subpart OOOO storage vessel control requirements. The breakdown by basin is shown in Table 5-5.

To account for these controls in the inventory, the Oil Storage Tanks tab of the TCEQ oil and gas nonpoint area source emissions estimation calculator was revised as follows:

- A new table was added with data showing the percentage of basin-level oil production that is subject to Subpart OOOO requirements for 2013;
- A new table was added showing the emission control requirements (95% control) for oil production that is subject to Subpart OOOO requirements;
- A column was added to the County-level emissions table to account for % of 2013 production controlled; and
- In the County-level emissions table, the calculations for VOC, Benzene, Toluene, Ethylbenzene, and Xylene were revised to reflect the changes in emissions due to the Subpart OOOO control requirements for emissions from storage vessels constructed after April 12, 2013.

In the Condensate Storage Tanks tab of the TCEQ oil and gas nonpoint area source emissions estimation calculator, similar changes were made. The calculation for the control percentage for each basin is complicated by the fact that a survey[68] conducted in 2012 showed that a significant percentage of statewide condensate production was already controlled. For 2012, the control factor for storage tanks that already had recovery or control devices installed ranged from 11.8% for condensate-producing gas wells in the Bend Arch-Fort Worth Basin to 46% for gas wells in the Eagle Ford Shale. Since the wells constructed in 2013 that are subject to Subpart OOOO requirements are new wells with the requirement to control emissions from storage vessels, ERG made the simplifying assumption that the percent of regional condensate production represented by these new 2013 wells would be added to the control percentage of the production that was already controlled. As required by the rule, the control percentage applied to the new subject wells is 95%.

Therefore, the Condensate Storage Tank EFs tab of the TCEQ oil and gas nonpoint area source emissions estimation calculator was revised as follows:

- The Control Factors in Table A and Table B were revised to increase the existing regional control factors by the percentages shown above (and reflecting the 95% control requirement for controlled production). These revised control factors are used in the emissions calculations in the Condensate Storage Tanks tab of the spreadsheet;
- Table C was added to show the % of total production within a basin that is subject to the NSPS control requirements; and
- A table was added to show the required NSPS control of 95%.

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[68] "Condensate Tank Oil and Gas Activities", TCEQ, October 10, 2012

No revisions were needed to the Condensate Storage Tanks tab of the TCEQ oil and gas nonpoint area source emissions estimation calculator as the control factors are pulled from the Condensate Storage Tank EFs tab and inherently incorporate the NSPS Subpart OOOO control requirements.

Attachment D contains the updated TCEQ oil and gas nonpoint area source emissions estimation calculator (“ERG AppendixE_2013 with updates to Basin information.xls”) reflecting the changes to the inventory for storage vessels as a result of the requirements of NSPS Subpart OOOO.

Table 5-5. Percentage of 2013 Oil and Condensate Production Subject to Subpart OOOO Requirements

Basin	Oil			Condensate		
	Production Subject to Subpart OOOO (bbl)	Total Production (bbl)	% of Production Subject to Subpart OOOO	Production Subject to Subpart OOOO (bbl)	Total Production (bbl)	% of Production Subject to Subpart OOOO
Anadarko Basin	174,099	10,609,144	1.6%	1,066,246	14,038,374	7.60%
Bend Arch-Fort Worth Basin	787,645	20,391,120	3.9%	328,549	5,147,458	6.38%
Eagle Ford Shale	75,495,269	263,909,215	28.6%	6,493,095	68,335,461	9.50%
East Texas Basin	85,893	7,994,511	1.1%	13,158	624,895	2.11%
East Texas Basin/Haynesville Shale	76,800	6,087,890	1.3%	118,595	4,109,868	2.89%
Marathon Thrust Belt	0	5,668	0.0%	0	54,345	0.00%
Palo Duro Basin	558,642	4,124,773	13.5%	3,644	55,043	6.62%
Permian Basin	5,592,846	344,009,390	1.6%	964	2,472,622	0.04%
Western Gulf	789,990	16,494,090	4.8%	576,967	9,366,101	6.16%
Western Gulf/Beaumont-Port Arthur	13,247	2,512,043	0.5%	355	1,905,094	0.02%
Western Gulf/Houston-Galveston-Brazoria	369,936	11,348,919	3.3%	39,014	1,542,005	2.53%

6. Conclusions

ERG recommends that the TCEQ update the nonpoint area source oil and gas emissions inventory as described in this report for the following source types:

- Condensate storage tanks;
- Gas well completions;
- Gas well pneumatic devices;
- Hydraulic pump engines;
- Mud degassing (oil and gas wells); and
- Oil storage tanks.

Under the requirements of the recently revised NSPS Subpart OOOO (Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution), certain new condensate storage tanks, gas well completions, gas well pneumatic devices, and oil storage tanks require emissions control or emissions reduction strategies. Based on the findings of this study, the rule revisions have had a particularly notable impact on emissions from oil and condensate tanks due to the increase in hydrocarbon liquids production in Texas over the last few years. As new liquids production is brought on-line, particularly in areas such as the Eagle Ford Shale, storage tank control requirements are triggered such that emissions on a per barrel basis are much lower than from older wells.

For mud degassing, limited data was available to improve the current emissions estimate. This source category is not regulated; is not covered under Subpart W of the Greenhouse Gas Reporting Rule; and has not typically been considered a large emitting source. However, Texas-specific gas composition data were used to refine the estimates for mud degassing to reflect basin-specific gas composition in Texas.

Finally, updates to the input variables used to estimate emissions from hydraulic pump engines have resulted in a large increase in emissions for this category. Previously, emissions were based on input variables developed under the CenSARA 2012 emissions inventory project which reflected an average of 3.5 engines rated at 1,258 hp operating for approximately 9 hours to complete well perforation and stimulation. As shown in Table 3 above, well stimulation operations in Texas require significantly more engines, at a higher hp, and increased operational time to complete the process.

Attachment D contains an updated version of TCEQ’s oil and gas nonpoint area source emissions estimation tool reflecting the revisions described above.

Attachment A

Hydraulic Pump Survey Letter

ERG
EASTERN RESEARCH GROUP, INC.

Dear [Insert Operator_Contact_Name], [Insert Operator_Contact_Title]

[Insert Operator_Company_Name] [Date]

Eastern Research Group (ERG), an independent research organization, is conducting a study on emissions from pump engines used in hydraulic stimulation and perforation activities for the Texas Commission on Environmental Quality (TCEQ). The purpose of this study is to develop equipment inventories and usage data for estimating emissions from hydraulic pump engines for each of the oil and gas producing regions in Texas. The study results will assist the TCEQ in refining the Texas air emissions inventory.

Hydraulic pump engine emissions are currently estimated by TCEQ using activity data from a 2012 Central States Air Resources Agencies (CenSARA) study. The purpose of this survey is to gather Texas-specific data on hydraulic pump engine activities so that TCEQ can refine its emissions estimates. To support this effort, the TCEQ is seeking information from Texas oil and gas drilling/hydraulic stimulation companies to assist in development of refined, county-specific equipment and usage data.

We are asking for your participation in this voluntary survey that will involve sharing information regarding the number and horsepower of engines used, and the amount of time they are used. ***Individual wells and rigs do not need to be identified.*** The information your company provides will be used for statistical purposes only in order to develop county-level and basin-level estimates and will not be republished or disseminated for other purposes. **The information you provide will be held confidential.**

ERG will contact your company via phone to discuss this effort and collect any information you are willing to share. We are seeking basin-specific hydraulic pump engine usage information for oil and gas well sites hydraulically stimulated in the [Insert Basin_name] [Insert counties_text] The specific information we are requesting for each well hydraulically stimulated in 2013:

- County
- Well type (oil or gas)
- Percent full load for engines
- Number of engines
- Horsepower of engines
- Number of fracturing stages
- Duration of each fracturing stage (hours)

A table on the reverse side of this letter shows the type of data we wish to collect.

We appreciate your assistance in this study. If you have any questions on the technical aspects of the study, please contact me at (919) 468-7902, or via email at stephen.treimel@erg.com. Completed surveys should be sent to my attention. Questions concerning the scope of this study or ERG's relationship with TCEQ may be directed to the TCEQ Project Manager, Michael Ege, at (512) 239-5706, or via email at Michael.Ege@tceq.texas.gov.

Sincerely,

Stephen Treimel, Environmental Scientist
Eastern Research Group, Inc.

Operator Name: [Insert Operator_Company_Name]
Basin and Counties: [Insert Basin_name] basin: [Insert counties_text]
Instructions: Provide the data listed below for up to ten separate well sites located in the counties listed above. To avoid biasing the survey results, we ask that you please select the well sites at random from all of the wells you worked on in this region in 2013.

Site #	County	Well type (oil or gas) [a]	Number of Engines	Horsepower of Engines	Percent Full Load for Engines (when active)	Number of Fracturing Stages	Duration of Each Fracturing Stage (hours)

[a] Does the Texas Railroad Commission consider this well a gas well (G) or an oil well (O)?

Completed surveys can be emailed to me at stephen.treimel@erg.com or printed and mailed to my attention at: Eastern Research Group, 1600 Perimeter Park Drive, Morrisville, NC 27560.

Attachment B
Mud Degassing Survey Letter

ERG
EASTERN RESEARCH GROUP, INC.

Dear [Insert Operator_Contact_Name], [Insert Operator_Contact_Title]

[Insert Operator_Company_Name] [Date]

Eastern Research Group (ERG), an independent research organization, is conducting a study on emissions from drilling mud degassing for the Texas Commission on Environmental Quality (TCEQ). The purpose of this study is to develop activity estimates for estimating emissions from mud degassing activities during well drilling for each of the oil and gas producing regions in Texas. The study results will assist the TCEQ in refining the Texas air emissions inventory.

Emissions from mud degassing are currently estimated by TCEQ using EPA default water-based mud emission factors from the Climate Registry Reporting Protocol and activity data from a 2012 Central States Air Resource Agencies (CenSARA) study. The purpose of this survey is to gather Texas-specific data on drilling mud usage, characteristics, and mud degassing activities so that TCEQ can refine its emissions estimates. To support this effort, the TCEQ is seeking information from Texas oil and gas drilling companies to assist in development of refined, county-specific equipment and usage data.

We are asking for your participation in this voluntary survey that will involve sharing information regarding the location, the type of well, the type of drilling mud used, the number of drilling days per well, and any control equipment used. ***Individual wells and rigs do not need to be identified.*** The information your company provides will be used for statistical purposes only in order to develop county-level and basin-level estimates and will not be republished or disseminated for other purposes. **The information you provide will be held confidential.**

ERG will contact your company via phone to discuss this effort and collect any information you are willing to share. We are seeking basin-specific mud degassing emissions information for oil and gas wells drilled/recompleted in the [Insert Basin_name] [Insert counties_text] The specific information we are requesting for each well drilled or recompleted in 2013:

- County
- Well type (oil or gas)
- New well or recompletion
- Type of mud used (water- or oil-based)
- Number of drilling days per well
- Are emissions from degassing equipment controlled?

A table on the reverse side of this letter shows the type of data we wish to collect.

We appreciate your assistance in this study. If you have any questions on the technical aspects of the study, please contact me at (919) 468-7902, or via email at stephen.treimel@erg.com. Completed surveys should be sent to my attention. Questions concerning the scope of this study or ERG's relationship with TCEQ may be directed to the TCEQ Project Manager, Michael Ege, at (512) 239-5706, or via email at Michael.Ege@tceq.texas.gov.

Sincerely,

Stephen Treimel, Environmental Scientist
Eastern Research Group, Inc.

Operator Name: [Insert Operator_Company_Name]

Basin and Counties: [Insert Basin_name] [Insert counties_text]

Instructions: Provide the data listed below for up to ten separate well sites located in the basin/counties listed above. To avoid biasing the survey results, we ask that you please select the well sites at random from the wells drilled in this region in 2013.

Site #	**County**	**Well type (oil or gas)** [a]	**New well or Recompletion**	**Type of mud used (water-based, oil-based, synthetic)**	**Number of drilling days**	**Are emissions from degassing equipment controlled? (Y/N)**	**Percent Control (%)**

[a] Does the Texas Railroad Commission consider this well a gas well (G) or an oil well (O)?

Completed surveys can be emailed to me at stephen.treimel@erg.com or printed and mailed to my attention at: Eastern Research Group, 1600 Perimeter Park Drive, Morrisville, NC 27560.

Attachment C
Survey Results
(TCEQ Hydraulic Pump Engine Study Findings.xlsx)

Attachment D
Updated Oil and Gas Nonpoint Area Source Emissions Estimation Tool
(ERG Appendix E_2013 with updates to Basin information.xlsx)

APPENDIX 8

2014 STATEWIDE DRILLING RIG EMISSIONS INVENTORY WITH UPDATED TRENDS INVENTORIES

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Eastern Research Group, Inc.

2014 STATEWIDE DRILLING RIG EMISSIONS INVENTORY WITH UPDATED TRENDS INVENTORIES

FINAL REPORT

TCEQ Contract No. 582-15-50416
Work Order No. 582-15-52832-05

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

July 31, 2015

ERG NO. 0345.00.005.002

2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories

Final Report

TCEQ Contract No. 582-15-50416
Work Order No. 582-15-52832-05

Prepared for:

Mr. Michael Ege
Texas Commission on Environmental Quality
Air Quality Division
Building E, Room 245S
Austin, Texas 78711-3087

Prepared by:

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July 31, 2015

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List of Acronyms

Acronym	**Definition**
AACOG	Alamo Area Council of Governments
API	American Petroleum Institute
CERS	Consolidated Emissions Reporting Schema
CO	Carbon Monoxide
DOE	U.S. Department of Energy
EIA	Energy Information Administration
ERG	Eastern Research Group
HAP	Hazardous Air Pollutant
HSE	Health, Safety and Environment
hp	Horsepower
MMBBL	Million Barrels
NEI	National Emissions Inventory
NO_x	Nitrogen Oxides
OSD	Ozone Season Daily
PM_{10}	Particulate Matter with particle diameter less than 10 micrometers
$PM_{2.5}$	Particulate Matter with particle diameter less than 2.5 micrometers
QAPP	Quality Assurance Project Plan
SCC	Source Classification Code
SCR	Silicon Controlled Rectifier
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
TCAT	Texas Center for Applied Technology
TCEQ	Texas Commission on Environmental Quality
TexAER	Texas Air Emissions Repository
TOG	Total Organic Gases
RRC	Railroad Commission of Texas
TxLED	Texas Low Emission Diesel
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
XML	Extensible Markup Language

1.0 Executive Summary

The purpose of this study was to develop updated, comprehensive statewide controlled and uncontrolled emissions inventories for drilling rig engines associated with onshore oil and gas exploration activities occurring in Texas. Oil and gas exploration and production facilities are some of the largest contributors to area source emissions in certain geographical areas, dictating the need for continuing studies and surveys to more accurately depict these activities. The current inventory effort builds off of two previous studies prepared for the Texas Commission on Environmental Quality (TCEQ). In 2009, Eastern Research Group (ERG) prepared a 2008 Drilling Rig Emission Inventory for the State of Texas (TCEQ, 2009), which focused exclusively on drilling activities. This effort was expanded upon in 2011 by improving the drilling activity data (including well counts, types, and depths) used to estimate emissions through acquisition of the “Drilling Permit Master and Trailer” database from the Railroad Commission of Texas (RRC) (TCEQ, 2011).

The drilling rig profiles developed in the 2009 study provided:

- The average number of engines on a rig
- Average engine model year and size in horsepower (hp)
- Average load for each engine
- Engine function (draw works, mud pumps, power)
- Average engine hour data for each well (total hours)
- Average well drilling time (actual number of drilling days)
- Average well depth

As part of this current study, a data collection effort was implemented to obtain updated drilling rig profile data focusing on a 2014 base year. In addition to development of a 2014 base year emissions inventory, trends inventories were developed to reflect emissions associated with actual annual drilling activity in Texas each year from 2012 through 2014, and for projected annual drilling activity in Texas for each year 2015 through 2040. This was accomplished by:

- conducting a review of available literature about drilling operations;
- conducting a mail, phone, and email survey of Texas oil and gas well drilling companies to obtain information on drilling rig engines used in the field in 2014;
- researching oil and gas drilling company websites to characterize the types of rigs used in the field in 2014;
- obtaining actual drilling activity data for the years 2012, 2013, and 2014;
- developing projected drilling activity for Texas for the years 2015 through 2040; and,

- developing updated drilling rig emissions profiles based on survey data obtained on the age, size, type, and operating practices of the engines used in the drilling process.

To develop updated emissions and activity data, ERG first conducted a review of available literature, looking for data on emissions from drilling rig engines that would help inform the analysis. Academic and technical literature on equipment characterization and available state and federal research on drilling rig emissions were evaluated. Additionally, ERG conducted a mail, email, and phone survey of Texas oil and gas drilling companies, requesting information on the use and type of engines used to drill oil and gas wells in Texas. Several companies were interviewed at length, to gather information on current practices and trends in the industry that are specific to Texas. This industry survey and study sought to obtain updated information to be used in conjunction with data and methodologies developed under the previous drilling rig emission inventory efforts to determine:

- equipment characteristics such as the number and type of engines used to drill wells in Texas;
- operational characteristics such as the total operating hours and load factors of the engines used to drill wells in Texas;
- updated year-specific emission factors to use for estimating emissions from drilling rig engines used in Texas;
- base year 2014 drilling activity in Texas by well type;
- historical drilling activity in Texas for the years 2012 and 2013; and
- projected drilling activity in Texas for the years 2015 through 2040.

These data were used to develop well drilling rig emissions profiles using the United States Environmental Protection Agency (US EPA)'s NONROAD emissions model.[1] ERG also gathered information from company websites and from the RigData® database to characterize the drilling rig fleet.

Target pollutants for this study include nitrogen oxides (NO_x), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and hazardous air pollutants (HAP). Emissions were calculated for each county in Texas where drilling occurred and are provided in annual tons per year and by typical ozone season day. Emission estimates for 2012, 2013, and 2014 were based on RRC records of oil and gas well completions during those years, and U.S Department of

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[1] While the NONROAD model was used to calculate drilling activity emissions (in order to more accurately capture emission standard phase in impacts), these emissions are actually classified as area sources emissions and reported as such to the TCEQ.

Energy (DOE), Energy Information Administration (EIA) oil and gas production growth estimates were used to develop the projections for the years 2015 through 2040.

The final emissions inventory estimates are provided in Consolidated Emissions Reporting System (CERS) Extensible Markup Language (XML) to facilitate entry of the data into the state's TexAER (Texas Air Emissions Repository) database, and for the purposes of submittal to US EPA. For purposes of XML preparation, Source Classification Code (SCC) 23-10-000-220 (Industrial Processes - Oil and Gas Exploration and Production - All Processes - Drill Rigs) was used, consistent with the 2009 and 2011 studies.

Table 1-1 summarizes the statewide annual criteria pollutant emission estimates for 2012 through 2040. Figures 1-1 and 1-2 present this same information in chart form for NO_x, CO, VOC, and PM_{10}. As seen in Table 1-1, $PM_{2.5}$ emissions are comparable to PM_{10} emissions, and SO_2 emissions are less than 25 tons per year for all study years. Appendix A provides a complete summary of emissions of all pollutants (including HAPs) for all years.

Table 1-1. Statewide Drilling Rig Estimates (Tons/Year)

Year	CO	NO_x	$PM_{2.5}$	PM_{10}	SO_2	VOC
2012	8,566	41,724	1,221	1,259	16	2,068
2013	7,826	38,167	1,115	1,149	15	1,890
2014	11,278	36,488	1,176	1,213	20	3,249
2015	12,173	38,629	1,269	1,308	22	3,524
2016	12,110	38,934	1,191	1,228	22	3,501
2017	12,423	38,842	1,229	1,267	23	3,528
2018	7,598	39,456	951	980	23	2,419
2019	4,098	31,423	477	492	20	2,479
2020	3,709	31,090	448	462	20	2,466
2021	3,681	30,855	445	459	20	2,448
2022	3,661	27,011	443	456	20	2,434
2023	1,940	26,492	339	349	20	2,026
2024	1,481	25,645	309	318	19	1,938
2025	1,469	25,448	306	316	19	1,923
2026	1,434	24,944	301	310	19	1,886
2027	1,419	24,683	298	307	19	1,867
2028	1,408	24,499	295	305	19	1,853
2029	1,398	24,042	290	299	18	1,838
2030	1,368	23,611	285	294	18	1,809
2031	1,332	22,758	271	279	18	1,761
2032	1,299	22,192	264	272	17	1,717
2033	1,272	21,709	258	266	17	1,682

Table 1-1. Statewide Drilling Rig Estimates (Tons/Year)

Year	CO	NO_X	$PM_{2.5}$	PM_{10}	SO_2	VOC
2034	1,138	20,924	237	244	17	1,623
2035	1,119	20,587	233	240	16	1,597
2036	1,110	20,415	231	238	16	1,583
2037	1,101	20,042	228	235	16	1,568
2038	1,098	19,989	227	234	16	1,564
2039	987	19,802	212	218	16	1,554
2040	984	19,755	211	218	16	1,550

Figure 1-1. Statewide Drilling Rig Estimates (NO_X and CO Tons/Year)

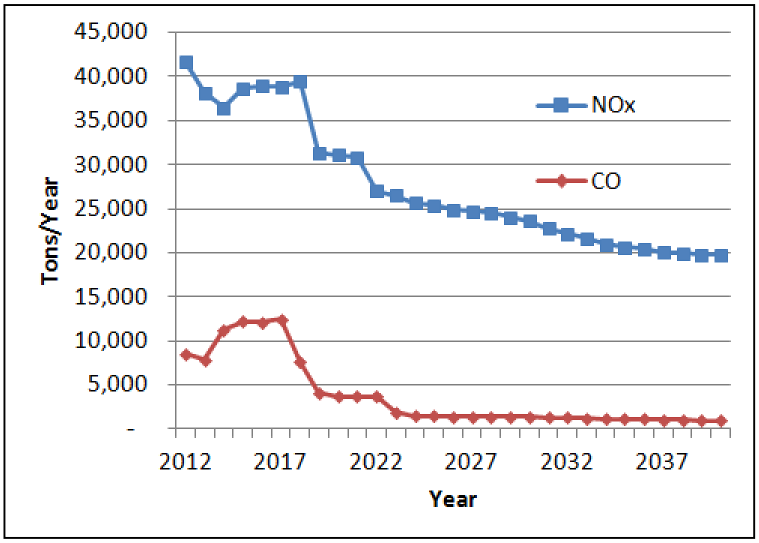
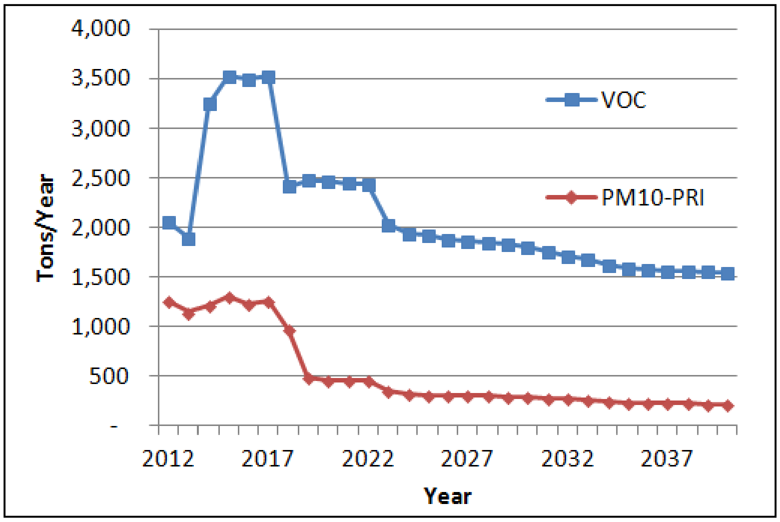


Figure 1-2. Statewide Drilling Rig Estimates (VOC and PM_{10} Tons/Year)



The study results expand upon the 2009 and 2011 efforts by updating the emission factors using equipment profile data representative of field operations in 2014. The result is an updated, temporally resolved profile of county-level drilling activity emissions.

Based on the projected oil and gas production levels in Texas from the EIA, drilling activity is estimated to generally increase across the state through the next 15 to 20 years before returning to 2014 levels. However, the continued phase-in of more stringent Non-Road diesel engine emission standards as older engines are replaced with new engines should cause a steady decrease in drilling-related emissions per unit of activity (feet drilled) over time. SO_2 emissions levels in particular are estimated to have fallen substantially due to the introduction of the ultra-low sulfur standards for diesel fuel in effect since 2010, and should remain low for the foreseeable future.

An analysis of county-level data found that the vast majority of Texas counties produced some level of emissions associated with drilling activities (180 of 254 counties) in the 2014 base year. However, the county-level distribution of NO_x emissions is highly skewed, with 10 counties being responsible for 50 percent of total statewide drilling rig NO_x emissions in 2014. The preponderance of the high NO_x emitting counties are located in West and South-Central Texas. These areas correspond to the high level of oil and gas exploration activities in the Permian Basin and the Eagle Ford Shale areas, respectively.

While the emissions inventory results provide an excellent basis for assessing historical emissions levels, projections of future activity are highly uncertain, and subject to significant fluctuations in activity depending upon economic factors and associated oil and gas prices. Accordingly, periodic refinement of the drilling activity data used for projected years 2015 through 2040 is strongly recommended to account for such factors.

2.0 Introduction

The purpose of this study was to develop updated, comprehensive, statewide controlled and uncontrolled emissions inventories for drilling rig engines associated with onshore oil and gas exploration activities occurring in Texas. Oil and gas exploration and production facilities are among the largest contributors to area source emissions in certain geographical areas, warranting continuing studies and surveys to more accurately depict these activities. While drilling activities are generally short-term in duration, typically spanning a few weeks to a few months, the associated diesel engines are usually very large in size. As such, drilling activities can generate substantial amounts of NO_x emissions.

The current inventory effort builds off of two previous studies prepared for the TCEQ. In 2009, ERG prepared a 2008 Drilling Rig Emission Inventory for the State of Texas (TCEQ, 2009), which focused exclusively on drilling activities. This effort was expanded upon in 2011 by improving the drilling activity data (including well counts, types, and depths) used to estimate emissions through acquisition of the “Drilling Permit Master and Trailer” database from the RRC (TCEQ, 2011).

To develop updated emissions and activity data, ERG first conducted a review of available academic and technical literature on equipment characterization and available state and federal research on emissions from drilling rig engines that would help form the analysis. Additionally, ERG conducted a mail, email, and phone survey of Texas oil and gas drilling companies, requesting information on the use and type of engines used to drill oil and gas wells in Texas. Several companies were interviewed at length, to gather information on current practices and trends in the industry that are specific to Texas. This information was then used to develop updated emission factors for each rig and well type. Finally, emissions were calculated on a county-level basis and provided in annual tons per year and by typical ozone season day.

Section 3.0 of this report provides an overview of the drilling process and identifies the types of activities and equipment that are commonly associated with drilling activity. Section 4.0 presents a summary of the literature and database review that was conducted to identify current studies and data that may be useful in the compilation of the Texas drilling rig emissions inventory. Section 5.0 describes the industry survey that was implemented to obtain updated drilling rig activity and equipment characterization data representative of operations in Texas in 2014, and Section 6.0 describes how that data was used to develop updated emission factors for drilling rig engines for the years 2012 through 2040. Section 7.0 describes the development of the emissions inventory including how the activity data was compiled, how the model drilling rig emission profiles were developed, and how these model drilling rig emission profiles were combined with the activity data to develop the emission inventories, along with quality assurance measures applied. Section 8.0 summarizes the study conclusions and offers recommendations for future studies.

3.0 Drilling Rig Overview

Air pollutant emissions from oil and gas drilling operations originate from the combustion of diesel fuel in the drilling rig engines. The main functions of the engines on an oil and gas well drilling rig are to provide power for hoisting pipe, circulating drilling fluid, and rotating the drill pipe. Of these operations, hoisting and drilling fluid circulation require the most power.

There are two common types of drilling rigs currently in use – mechanical and electrical. In general, mechanical rigs have three independent sets of engines. The first set of engines (draw works engines) are used to provide power to the hoisting and rotating equipment, a second set of engines (mud pump engines) are dedicated to circulating the drilling fluid which is commonly referred to as “mud”, and a third set of engines (generator engines) are used to provide power to auxiliary equipment found on the drill site such as lighting, heating, and air conditioning for crew quarters and office space. There may be one, two, or more draw works engines, depending on the input power required. There are typically two mud pumps for land rigs, with each mud pump independently powered by a separate engine. The mud pump engines are typically the largest engines used on a mechanical rig. Finally, there are typically two electric generator engines per mechanical rig, with one running continuously and the second serving as a stand by unit.

Electrical rigs are typically comprised of three large, identical diesel-fired engine-generator sets that provide electricity to a control house called a silicon controlled rectifier (SCR) house. Electricity from the SCR house is then used to provide power to separate motors on the rig. In this configuration, there are dedicated electric motors used for the draw works/hoisting operations, the mud pumps, and other ancillary power needs (such as lighting). The generator engines are loaded as required to meet fluctuating power demands, with one unit typically designated for standby capacity. The trend in new rig design is almost exclusively towards electric rigs. This is probably due to the relative expense of engines versus motors, both in terms of initial cost and maintenance. Today, electrical rigs are common, especially for larger rigs (Bommer, 2008).

Oil and gas wells are commonly classified as vertical, directional, or horizontal wells, depending on the direction of the well bore. Vertical wells are historically the most common, and are wells that are drilled straight down from the location of the drill rig on the surface. Directional wells are wells where the well bore has not been drilled straight down, but has been made to deviate from the vertical. Directional wells are drilled through the use of special tools or techniques to ensure that the well bore path hits a particular subsurface target, typically located away from (as opposed to directly under) the surface location of the well. Horizontal wells are a subset of directional wells, but are distinguished from directional wells in that they typically have well bores that are initially vertical, but at some depth begin to deviate from vertical by 80 - 90 degrees. Horizontal wells are commonly drilled in shale formations. Once the desired depth has been reached (the well bore has penetrated the target formation), lateral legs are drilled to provide a greater length of well bore in the reservoir.

4.0 Literature and Database Review

At the start of this study ERG conducted a review of relevant literature, current studies, and available data that could be used in the development of an updated drilling rig engine emissions inventory for Texas. The results of this research are discussed below.

4.1 RigData® Database

In order to survey drilling rig contractors and oil and gas operators across the state, ERG purchased a commercial database that contained contact information for companies that were active in well drilling activities occurring in Texas in 2014 (RigData®). This database contained contact information including name, address, and phone number for over 150 drilling companies that drilled over 20,000 wells in 2014. This database provided the necessary data to implement the survey mail out.

In addition to the drilling company contact information, the RigData® database also contained information on the type of well drilled (vertical, directional, or horizontal), the well depth, the spud date (date drilling commenced), and the rig release date (when the rig was released from the well). This information was useful to supplement the information obtained during the survey effort. In particular, the well depth and temporal data allowed an independent estimation of the hours needed to drill a well, in terms of hour per 1,000 feet drilled. This is discussed below.

4.2 Drilling Company Websites

Many of the larger drilling contractors provide detailed information about their drilling rig fleets on-line. Examples of these websites were provided in the approved Data Collection Plan. ERG reviewed this on-line information in an effort to gain a better understanding of typical drilling rig engine profiles, including the size, number, and type of engines used on typical rigs. Additional information provided included the type of rig (mechanical or electric).

When combined with data from RigData®, an estimate of the breakdown of rig type by well category (horizontal wells; deep vertical wells greater than 7,000 feet deep; and shallow vertical wells less than 7,000 feet deep) was possible. This analysis showed that 96% of shallow vertical wells (< 7,000 feet) are drilled by mechanical rigs, while 86% of horizontal wells are drilled by electrical rigs. 80% of deep vertical wells (> 7,000 feet) are drilled by mechanical rigs. These breakdowns were used to develop composite emission factor profiles for each well type as discussed in Section 6.1.3.

4.3 EPA Nonpoint Oil and Gas Emission Estimation Tool

EPA recently developed a Nonpoint Oil and Gas Emission Estimation Tool (EPA Tool) used to supplement the 2011 National Emissions Inventory (NEI)[2] by providing area source emissions estimates for upstream oil and gas processes where such data is not provide by the states. The EPA Tool covers a variety of upstream emissions processes, including drilling rig engines.

Data contained within the EPA Tool that is used to estimate emissions from drilling rig engines was evaluated for comparison to data collected during the survey process. This data includes the number and size of drilling rig engines, and the load at which these engines were operated during the drilling process. The results of this comparison are discussed in more detail below.

4.4 Oil and Gas Emission Inventory, Eagle Ford Shale

The Alamo Area Council of Governments (AACOG), published a study in April, 2014 entitled "Oil and Gas Emission Inventory, Eagle Ford Shale" (AACOG, 2014). This study focused exclusively on the oil and gas operations in the Eagle Ford Shale formation in south Texas. The study examined the unique characteristics of the geology, hydrocarbon production, and production equipment used in the Eagle Ford Shale, and developed an air emissions inventory for oil and gas operations located in that region. The study gathered activity data on production, drill rig counts, well counts, well characteristics, and nonroad equipment from the Railroad Commission of Texas, Schlumberger, Baker-Hughes, TCEQ, oil and gas companies, and previous studies to get a comprehensive view of the type and amount of equipment used in the area. The study then combined this activity data with emissions factors from a variety of sources, including TCEQ's 2011 Drilling Rigs Emission Inventory study (TCEQ, 2011), equipment manufacturers, and the results of Texas Center for Applied Technology (TCAT) surveys to develop an air emissions inventory for oil and gas operations in the Eagle Ford Shale region. The study also examined development trends in the region, and, based on predicted regional production increases in the future, developed estimates of air emissions for the years 2015 and 2018 under three different development scenarios[3].

Relevant information from the AACOG study has been evaluated for use and compared to information obtained from other sources to assist in development of the state-wide

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[2] Information on the 2011 National Emissions Inventory, including EPA's Nonpoint Oil and Gas Emission Estimation Tool, is available online at: http://www.epa.gov/ttnchie1/net/2011inventory.html

[3] The study predicted air emissions under low, medium and high development scenarios. These development scenarios were based on estimates of ultimate recoverable reserves from the region, the number of drill rigs available, interviews with industry representatives about their plans for future development, production decline curves for wells in the region, and the prices for natural gas and petroleum liquids.

2014 drilling rig inventory. In particular, the AACOG study has data on the number and size of engines used in each rig type, as well as the typical drilling rate (feet/hour). The information from the AACOG study is compared to the data obtained during the drilling rig engine survey in more detail below. It should be noted that as of July, 2015, an updated version of this report is pending and should be considered in any future inventory efforts.

4.5 EIA Annual Energy Report

The US Department of Energy (DOE) Energy Information Administration (EIA) has published projections of oil and gas production for the Southwest and Gulf Coast regions in their Annual Energy Outlook 2015, with projections to 2040 report (EIA, 2015). The EIA data was used to estimate oil and gas well drilling activity for the years 2015 through 2040.

5.0 Drilling Rig Engine Survey

5.1 Survey Implementation

In order to survey drilling rig contractors and oil and gas operators across the state, the drilling rig engines survey targeted oil and gas well drilling companies and attempted to obtain information on the size, number, and type of drilling rig engines used on their drilling rigs, as well as standard operating practices. The companies targeted had significant activity drilling oil and gas wells in Texas in 2014. Contact information for each company was obtained through purchase of the RigData® dataset. The survey effort itself focused on collecting the following information from each respondent:

- The number of engines on a rig;
- Engine make, model, model year, and size (hp);
- Average load for each engine;
- Engine function (draw works, mud pumps, generators);
- Actual fuel use data for each well (total fuel use);
- Total well drilling time (actual number of drilling days);
- Well depth; and
- Number of wells represented by the survey.

Using the contact information, ERG began implementing the Data Collection Plan on March 19, 2015 and collected data through June 5, 2015. ERG initiated the survey by mailing survey letters to the drilling companies on a staggered four week timeline, beginning with the larger drillers. Appendix B contains a copy of the survey letter and form used to solicit drilling rig information from the target respondents.

The largest companies were contacted first to allow for the time necessary in these larger organizations for the survey to work its way through their organizational structure. This initial mail out was followed up with subsequent mailings on a weekly basis to the medium and small drillers in weeks two through five.

Within one week of the first mail out, the target respondents were contacted by phone, asked if they had received the survey, and given a summary of the project and were asked if they were willing to participate. The same procedure was followed in consecutive weeks until all the target respondents had been contacted. As a result of this strategy, by the end of week five almost all the respondents had been contacted by mail, phone and email at least once each.

In order to make the survey as user-friendly as possible, it was submitted to each target respondent using three different formats: a self-addressed stamped envelope, a customized spreadsheet attached with the cover letter in an email, and through a link to an electronic survey that could be filled out online using Google Forms.

Typically, when calling the company and asking for the original contact, the office manager or secretary would ask the purpose of the call, a short summary of the project would be given, and a contact would be assigned based on the conversation. If the contact was different than the one listed in the original dataset, an email address was requested and a letter modified to fit the new contact was emailed to the new recipient. This was typically done after either a direct phone contact or a voice mail was left with the updated contact.

Frequently the person (or multiple persons in the case of the larger drillers) on the contact list was not the individual authorized to complete a survey. Because the lists are public information and the drillers are frequently contacted for commercial sales purposes, the initial contact was often only able to provide direction as to where in their company the phone call should be directed.

In the case of the larger companies, the contact listed in the RigData® dataset was typically a drilling superintendent or an area manager who was not authorized to give out the requested data. In those cases we were directed to the appropriate corporate contact for this survey. Usually that person was an executive of some sort in the company's Health, Safety and Environment (HSE) department. The corporate process usually consisted of the HSE contact asking the Operations department for the data and waiting for the decision to participate in the survey to come down the corporate chain of command.

The process worked similarly for smaller companies, however the chain of command tended to be shorter and usually the correct contact was identified much faster. For the smallest companies, the contact in the RigData® dataset was often determined to be the correct contact with authority to complete the survey.

Since the original mail-out was staggered along a four week timeline, the contact strategy came from the timing of the mail-out and the nature of the corporate bureaucracy of the target company. After initial contact, follow up communication was made with each company on a rolling basis for the rest of the survey period.

The voluntary nature of the survey dictated that we attempt to contact the respondents in a way designed to remind them of the survey, but without antagonizing them to the point of non-participation. In order to do this efficiently, an email tracking software was used to determine when and if the emails were being opened.

The level of contact with each company was dictated based on the response of the contacts. If the contacts were opening the email on a regular basis a note was made of that and an appropriate calendar date was set to check back with them by phone. If they were not opening the email, a response date was setup to automatically return the email sooner and trigger a phone call in order to leave a message or a voice mail.

After the original mail-outs had been distributed, it was decided to expand the contact list in an attempt to collect more data. As a result, a supplemental distribution list was developed that included additional small and medium drilling companies. The supplement survey was distributed to the target respondents, and then each target respondent was called and emailed in much the same fashion as the original contact list.

Each driller was contacted at least five times by mail, phone and email, and the larger drillers were contacted 10-15 times over the eight week collection period.

During the last two weeks of the survey, any driller who had previously not responded was sent an email in the morning and called that day to reinforce the contact and remind them of the due date and ask for their participation.

Ultimately, over 200 individuals at 139 different companies were contacted. Upon follow-up to the survey mail out, it was determined that several of these companies were no longer in business, and several others drilled water wells and were not involved in the drilling of oil or gas wells. Table 5-1 presents the final disposition of response to the survey for each of these companies.

Table 5-1. Survey Statistics

Survey Activity/Results	Number of Respondents
Attempted Company Contacts	139
Refusal to Participate	27
Soft Refusal (did not return attempted contacts via phone calls or email)	102
Respondent Interviewed and provided sufficient data for inclusion in inventory dataset	10

5.2 Survey Response Summary

The surveys that were received were generally complete and deemed to be representative of oil and gas well drilling operations in Texas in 2014. The surveys deemed complete for inclusion in the inventory were from 9 different companies that drilled over 1,000 wells in Texas in 2014. These wells were located in all of the major oil and gas regions in the state (East Texas, Ft. Worth/Bend Arch, Permian, Eagle Ford, and the Western Gulf). One additional survey was received that did not contain sufficient information to be included in the analysis. Updated 2014 drilling rig profiles for three different well categories were developed based on the survey data received, and

Table 5-2 presents the final drilling rig profiles that will be used in this inventory project. Appendix C contains the survey results by well category.

Table 5-2. 2014 Final Drilling Rig Profiles Obtained From Current Survey

Well Category	Rig Type	Engine Type	# of Engines	Average Age (yrs)	Engine Size (hp)	Hours per 1,000 feet	Average Load (%)
Horizontal	Electric	All [a]	3.00	2.50	1,338.00	33.93	60.00
Vert > 7,000	Mechanical	Drawworks	2.00	8.00	597.79	28.85	70.00
Vert > 7,000	Mechanical	Mud Pump	2.00	7.74	1,093.51	24.39	63.33
Vert > 7,000	Mechanical	Generator	2.00	8.10	655.57	18.86	86.67
Vert < 7,000	Mechanical	Drawworks	1.70	23.10	430.18	26.13	43.49
Vert < 7,000	Mechanical	Mud Pump	2.68	9.11	614.61	22.16	42.21
Vert < 7,000	Mechanical	Generator	1.96	27.86	279.69	21.41	80.38

[a] Electric rigs use a single bank of engines to power all equipment on the rig.

5.3 Survey Comparison to Other Available Data

Tables 5-3 through 5-5 present a comparison of the updated 2014 drilling rig profiles with other available data for the three well categories: horizontal wells, vertical wells deeper than 7,000 feet, and vertical wells shallower than 7,000 feet, respectively. The comparison data was obtained from the references discussed above, including the 2009 TCEQ survey (TCEQ, 2009), data contained within the RigData® data set, the 2014 AACOG study (AACOG, 2014), and the EPA Tool.

Table 5-3 below compares the drilling rig profiles for horizontal wells obtained from the current survey with the same data obtained from the 2009 TCEQ drilling rig survey, the AACOG Study, and the EPA Tool.

Table 5-3. Data Comparison: Horizontal Wells

Study Reference	Rig Type	Engine Type	# of Engines	Average Age (yrs)	Engine Size (hp)	Hours per 1,000 feet	Average Load (%)
Current Survey [a]	*Electric*	*All [b]*	*3.00*	*2.50*	*1,338*	*33.93*	*60.0*
2009 TCEQ Survey	Electric	All [b]	2.03	2.00	1,346	47.30	52.5
EPA Tool	Electric	All [b]	3.00	NA[c]	1,500	NA[c]	NA[c]
2014 AACOG Study	Electric	All [b]	3.17	NA[c]	1,429	20.40	NA[c]
RigData® Dataset	Electric	All [b]	NA[c]	NA[c]	NA[c]	45.39	NA[c]

[a] This is the data obtained from the current (2015) survey.

[b] Electric rigs use a single bank of engines to power all equipment on the rig.

[c] Not Available.

Of note in Table 5-3 is the reduction in the estimate of the time required to drill a well per unit depth (as reflected in the “Hours per 1,000 feet” column) from the 2009 TCEQ survey. The AACOG study was conducted in 2013, and it notes that “New drill rigs and improved technology reduces the time it take to drill 1,000 feet compared to what was report in ERG’s (2009) drill rig emission inventory.” The current survey data results shown in Table 5-3 (33.93 hours per 1,000 feet drilled) appear to confirm this observation, which could be attributable in part to the increased load factors.

Table 5-4 below compares the drilling rig profiles for deep vertical wells obtained from the current survey with the same data obtained from the 2009 TCEQ drilling rig survey, the AACOG Study, and the EPA Tool.

Table 5-4. Data Comparison: Vertical Wells Deeper than 7,000 Feet

Study Reference	Rig Type	Engine Type	# of Engines	Average Age (yrs)	Engine Size (hp)	Hours per 1,000 feet	Average Load (%)
Current Survey	*Mechanical*	*Drawworks*	*2.00*	*8.00*	*597.79*	*28.85*	*70.00*
		Mud Pump	*2.00*	*7.74*	*1093.51*	*24.39*	*63.33*
		Generator	*2.00*	*8.10*	*655.57*	*18.86*	*86.67*
2009 TCEQ Survey	Mechanical	Drawworks	2.01	25.00	455.00	35.90	47.40
		Mud Pump	1.62	18.00	761.00	33.20	46.00
		Generator	2.00	10.00	407.00	19.30	78.70
EPA Tool	Mechanical	Drawworks	1.25	NA[a]	647.00	NA[a]	54.00
		Mud Pump	1.75	NA[a]	601.00	NA[a]	59.00
		Generator	1.33	NA[a]	402.00	NA[a]	68.00
RigData® Dataset	Mechanical	(All)	NA[a]	NA[a]	NA[a]	40.03	NA[a]
AACOG Study	Mechanical	(All)	5.88	NA[a]	702.00	20.40	NA[a]

[a] Not available.

Based on the data shown in Table 5-4, the cumulative horsepower employed by drilling rigs used to drill a deep, vertical well is 4,694 based on the current survey data as compared to 2,961 cumulative horsepower in the 2009 study. The current survey data compares favorably with the data from the AACOG study, which shows a cumulative horsepower requirement of 4,128 for wells drilled using mechanical rigs. The data in the EPA Tool is lower (at 2,395 cumulative horsepower), but the EPA Tool does not distinguish drilling rig engine requirements by well depth. As with the updated data for Horizontal wells, the current survey data for the deeper vertical wells shows a reduction in the estimate of the time required to drill a well per unit depth (as reflected in the “Hours per 1,000 feet” column) from the 2009 TCEQ survey. For these types of wells, it appears that the newer rigs utilize both more horsepower, and higher load factors to improve efficiency.

Table 5-5 below compares the drilling rig profiles for shallow vertical wells obtained from the current survey with the same data obtained from the 2009 TCEQ drilling rig survey, the AACOG Study, and the EPA Tool.

Table 5-5. Data Comparison: Vertical Wells Shallower than 7,000 Feet

Study Reference	**Rig Type**	**Engine Type**	**# of Engines**	**Average Age (yrs)**	**Engine Size (hp)**	**Hours per 1,000 feet**	**Average Load (%)**
Current Survey	*Mechanical*	*Drawworks*	*1.70*	*23.10*	*430.18*	*26.13*	*43.49*
		Mud Pump	*2.68*	*9.11*	*614.61*	*22.16*	*42.21*
		Generator	*1.96*	*27.86*	*279.69*	*21.41*	*80.38*
2009 TCEQ Survey	Mechanical	Drawworks	1.6	7	442	30.8	51.8
		Mud Pump	1.69	6	428	29.4	45.9
		Generator	0.97	4	330	28.3	70.4
EPA Tool	Mechanical	Drawworks	1.25	NA[a]	647.00	NA[a]	54.00
		Mud Pump	1.75	NA[a]	601.00	NA[a]	59.00
		Generator	1.33	NA[a]	402.00	NA[a]	68.00
RigData®	Mechanical	(All)	NA[a]	NA[a]	NA[a]	36.64	NA[a]
AACOG Study	Mechanical	(All)	5.88	NA[a]	702.00	20.40	NA[a]

[a] Not available.

As shown in Table 5-5, the cumulative horsepower employed at a shallow, vertical well is 2,928 based on the current survey data as compared to 1,751 cumulative horsepower in the 2009 study. Neither the AACOG study nor the EPA Tool distinguish drilling rig engine requirements by well depth, so the values used in those studies (4,128 and 2,395 cumulative horsepower, respectively) are the same in Tables 5-4 and 5-5. As would be expected, the current survey data shows a lower power requirement for drilling shallow wells than is needed for the deeper wells. As with the updated data for Horizontal and deep Vertical wells, the current survey data for the shallow vertical wells shows a reduction in the estimate of the time required to drill a well per unit depth (as reflected in the “Hours per 1,000 feet” column) from the 2009 TCEQ survey.

6.0 Emissions Factor Development

The survey data described in the previous section were used to develop “Model Rig” engine profiles. These profiles were in turn used to provide inputs for emission factor modeling using EPA’s NONROAD model. The resulting NONROAD model outputs provide emission factors specific to each model rig profile of interest, expressed in terms of tons of pollutant per 1,000 feet drilled. The process used to develop the emission factors is described in detail below.

6.1 Model Rig Engine Profiles

As described above, updated drilling rig engine profiles for three distinct model rig categories were developed for the following well types and depths based on the results of the data collection survey:

- Mechanical Rigs drilling Vertical wells less than or equal to 7,000 feet;
- Mechanical Rigs drilling Vertical wells greater than 7,000 feet; and
- Electric Rigs.

For each of these categories, an updated model rig engine profile was developed. In order for the model rig engine profile data to be applied consistently to the RRC activity data, the survey results were normalized to a 1,000 foot drilling depth. This was accomplished by dividing the total drilling hours for each engine included in each survey by the well depth for that survey to obtain the hours of operation per engine per 1,000 feet of drilling depth.

The following average engine parameters were calculated for each model rig well type category using a weighted average for each parameter based on the number of wells associated with each survey:

- Number of engines by rig type (i.e., mechanical draw works, mud pumps, and generators; and electrical rig engines)
- Engine age
- Engine size (hp)
- Engine on-time (hours/1,000 feet drilled)
- Overall average load (%)

The updated weighted average engine parameters developed for each model rig category by rig type are summarized in Table 6-1.

Table 6-1. Model Rig Engine Parameters

Well Category	Rig Type	Engine Type	# of Engines	Average Age (yrs)	Engine Size (hp)	Hours per 1,000 feet	Average Load (%)
Horizontal	Electric	All [a]	3.00	2.50	1,338.00	33.93	60.00
Vert > 7,000	Mechanical	Drawworks	2.00	8.00	597.79	28.85	70.00
Vert > 7,000	Mechanical	Mud Pump	2.00	7.74	1,093.51	24.39	63.33
Vert > 7,000	Mechanical	Generator	2.00	8.10	655.57	18.86	86.67
Vert < 7,000	Mechanical	Drawworks	1.70	23.10	430.18	26.13	43.49
Vert < 7,000	Mechanical	Mud Pump	2.68	9.11	614.61	22.16	42.21
Vert < 7,000	Mechanical	Generator	1.96	27.86	279.69	21.41	80.38

[a] Electric rigs use a single bank of engines to power all equipment on the rig.

6.2 Model Rig Emission Factors

Using the model rig engine parameters presented in Table 6-1, EPA's NONROAD2008a model was run to develop criteria pollutant emission factors for each of the three model rig types, for each year (2012 through 2040). Note the NONROAD model accounts for expected emission reductions over time due to the phasing in of EPA's emissions standards for nonroad diesel engines.[4] An additional set of emission factors were also developed for an "uncontrolled" scenario representing emissions from equipment prior to any EPA nonroad diesel engine standards (discussed below).

EPA's NONROAD emission factor model estimates emissions for "Other Oil Field Equipment" which includes fracturing rigs, mechanical drilling engines, oil field pumps, pump jacks, and seismograph rigs (PSR 1998). Of these subcategories, only the first three are involved in drilling activities. The survey results successfully profiled activity and population levels for drilling engines and pumps, as well as electrical generators used to power auxiliary equipment.

Following the same methodology used in the 2011 emission inventory study, ERG modified the ACTIVITY.DAT file within NONROAD to reflect the appropriate hours per thousand feet of drilling, and engine load factors, for the required engine types (mechanical and electrical engines) for each of the rig types as appropriate. Modifications were made for SCC 2270010010 (Diesel Other Oil Field Equipment) resulting in seven unique ACTIVITY.DAT files.

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[4] While the NONROAD model was used to calculate drilling activity emissions (in order to more accurately capture emission standard phase in impacts), these emissions are actually classified as area sources emissions and reported as such to the TCEQ.

ERG also modified NONROAD's TX.POP file to reflect the appropriate average hp for the engine type in question, and set the equipment population count to one for the corresponding hp bin, and zero for all other hp bins, in order to facilitate post-processing calculations.

Next, default NONROAD OPT files (input files containing basic model run information) were modified to reflect the statewide diesel fuel sulfur levels (see Table 6-4 below) for each scenario year of interest. Accordingly, sets of OPT, activity, and population files were developed to model each well type/engine type/scenario year combination for this analysis.

HAP emission factors were developed by speciating the NONROAD criteria emission outputs based on HAP emissions profiles obtained from the EPA National Mobile Inventory Model (EPA, 2015) and the California Air Resource Board's Speciation Profile Database (ARB, 2001). The specific ARB speciation profile used for Manganese, Mercury, and Nickel is Profile #425 for PM. This methodology is consistent with the prior 2011 emission inventory study approach. The specific HAP speciation factors used are presented in Table 6-2 and Table 6-3.

Table 6-2. PM_{10} Speciation Factors

HAP	HAP CAS #	Weight Fraction of PM_{10}
Acenaphthene	83329	0.0001
Acenaphthylene	208968	0.000084
Anthracene	120127	0.00000043
Arsenic & compounds	7440382	0.000038866
Benz(a)anthracene	56553	0.00000071
Benzo(a)pyrene	50328	0.00000035
Benzo(b)fluoranthene	205992	0.00000049
Benzo(g,h,i)perylene	191242	0.00000019
Benzo(k)fluoranthene	207089	0.00000035
Chrysene	218019	0.0000019
Dibenzo(a,h)anthracene	53703	2.9E-09
Fluoranthene	206440	0.000017
Fluorene	86737	0.0001
Indeno(1,2,3,c,d)pyrene	193395	0.000000079
Naphthalene	91203	0.00046
Phenanthrene	85018	0.00026
Pyrene	129000	0.0000029
Manganese [a]	7439965	0.00004
Mercury [a]	7439976	0.00003
Nickel [a]	7440020	0.000019

[a] Based on ARB Profile #425.

Table 6-3. VOC Speciation Factors

HAP	HAP CAS #	Weight Fraction of VOC
1,3-Butadiene	106990	0.0018616
2,2,4-Trimethylpentane	540841	0.000719235
Acetaldehyde	75070	0.05308
Acrolein	107028	0.00303165
Benzene	71432	0.020344
Ethyl Benzene	100414	0.0031001
Formaldehyde	50000	0.118155
Hexane	110543	0.0015913
Propionaldehyde	123386	0.0118
Styrene	100425	0.00059448
Toluene	108883	0.014967
Xylene	1330207	0.010582

SO_2 emissions are based on the diesel fuel sulfur content, provided in weight percent in the NONROAD input files. Diesel sulfur values were calculated on a statewide basis for all scenario years. Statewide averages were calculated by weighting the county-specific sulfur weight percent values in TCEQ's TexN model by the total drilling depth for each county for the same year. Table 6-4 summarizes the resulting diesel fuel sulfur levels for each scenario year. Note that 1990 corresponds to the uncontrolled scenario noted above.

Table 6-4. Diesel Fuel Sulfur Content (% wt), Statewide Weighted Average

Year	Sulfur Content (% wt)
1990	0.30407
2012	0.00052
2013	0.00052
2014+	0.00055

The NONROAD model outputs provide mass emissions for each engine and rig type, for each calendar year of interest. The activity levels entered into NONROAD corresponded to the hours required to drill 1,000 feet, so the associated mass emission outputs are uniformly expressed in terms of thousand feet drilled. Total emissions for each engine/drill rig category combination were then calculated by dividing the mass emissions outputs by the fractional engine population for the appropriate engine model year (using NONROAD's by-model-year output option), and then multiplying by the average number of engines for each drill rig type. The resulting value for a given pollutant represents an emission factor expressed in mass per 1,000 feet drilled.[5]

To illustrate the emission factor calculation process, consider shallow well mechanical draw works engines. The average age for these engines is 23 years. Therefore, for the 2014 calendar year, emissions for a 23 year old (1991 model year) engine are first identified in the NONROAD by-model-year output. Since the NONROAD population file was set to equal one unit (the sum across all engine model years), NONROAD calculates the “population” of 23 year old engines to be 0.0279 (i.e., 2.79% of all engines operating in 2014).[6] In order to calculate total emissions per 1,000 feet of drilling activity for this engine, the mass emissions associated with this model year are first divided by the population value to obtain the mass emissions rate per year for one engine (e.g., 0.00434 tons per year CO per 0.0279 engines = 0.156 tons per year per unit). Finally, this value is multiplied by the average number of engines of this type for the given well type (e.g., 1.7 mechanical draw works engines per shallow well drill rig) to obtain the emission factor expressed as mass emissions for each engine category/well type combination per 1,000 feet of drilling activity.

Total hydrocarbon (THC) exhaust emissions outputs from the NONROAD model required an additional calculation step, and were converted to VOC and TOG using ratios of 1.053 and 1.070, respectively (U.S. EPA, 2005a). Crankcase THC emissions were assumed to be equivalent to both VOC and TOG (U.S. EPA, 2005b). For diesel nonroad engines, PM_{10} is equivalent to PM, while the $PM_{2.5}$ fraction of PM_{10} is estimated to be 0.97 (U.S. EPA, 2005a).

The above process was followed to develop emission factors for each of the three model rig types, for both uncontrolled and controlled scenarios. The uncontrolled scenario was developed by running the NONROAD model for the 1990 calendar year. Diesel engines

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[5] The NONROAD model itself employs emission factors expressed in grams per brake-hp-hr of engine use. The ERG methodology avoids use of g/bhp-hr factors; factors expressed in terms of mass emissions per 1,000 feet drilled can be combined directly with the available activity data for each county (expressed as total depth drilled per year).

[6] This methodology relies on a single model year to represent average engine age, rather than a distribution across model years (which is expected in actual use). This approach will likely bias the emission estimates high to some degree. This simplification was made for a number of reasons. First, the rig survey data was not robust enough to develop new model year distributions for the different equipment/rig profiles. Nevertheless, ERG could have modified the default scrappage curve and growth factors used by the NONROAD model to develop in-use model year distributions, with average ages set to the survey values. However, the required calculation is under-specified since both the engine population growth rates and the scrappage rates for the different equipment/rig type populations is unknown. In addition, the exceedingly rapid expansion of the industry in the past few years has likely skewed the in-use age distribution in ways not modeled well by the NONROAD model’s logit curve. For example, a highly accelerated turnover rate for older, less reliable engines was anticipated for the deep well category – indirectly confirmed by the new survey data. For these reasons ERG selected the simplified approach to engine age characterization, providing conservative (i.e., “high end”) emission estimates.

operating in 1990 were not subject to emission controls and therefore represent uncontrolled conditions. The controlled scenario (used for calendar years 2012 – 2040) reflects the emission controls in place for any given year, and are accounted for in the NONROAD model emission factors output for each analysis year. Depending upon the analysis year in question, one or more of the following emission controls are reflected in the controlled scenario:

- Federal Emission Standards for Heavy-Duty and Non-Road Engines – “1998 HD and Non-Road Rule”;
- Tier 1, Tier 2, and Tier 3 Emission Standards: Control of Emissions of Air Pollution from Non-Road Diesel Engines – “Tier 1, 2 and 3 Rule”; and
- Clean Air Non-Road Diesel – Tier 4 Final Rule – “Tier 4 Rule”, including ultra-low sulfur requirements for Non-Road diesel fuel.

None of these rules are accounted for in the uncontrolled scenario.

6.3 Well Type Emission Factors

Once the final emission factors by rig type for each well category were developed, the distribution of rig types for each well category (derived as discussed in Section 4.2) were used to develop a composite set of emission factors for each well type. The composite well type emissions profile was developed by aggregating the mechanical and electrical rig types together based upon the percentage of wells associated with each rig type. For example, for the horizontal well type, approximately 86% of the wells were drilled by electrical rigs, so the resultant emission factors are weighted 86% by the NONROAD electrical rig emission factors, and 14% by the mechanical rig (for wells > 7,000 feet) emission factors. For wells > 7,000 feet, 20% of the wells are estimated to be drilled using electric rigs, and a similar weighting scheme was used to develop the composite emission factors

For wells < 7,000 feet, less than 5% are estimated to be drilled using electric rigs. For this study, it was assumed that all wells < 7,000 feet were drilled by mechanical rigs. In addition to no data being obtained through the survey showing the use of electric rigs on these shallow wells, this assumption is also supported by the data obtained during the 2009 study, which also showed no electric rig use on shallow wells

Table 6-5, Table 6-6 and Table 6-7 contain the resultant criteria pollutant emission factors developed for each well type category for the emission inventory target years. Note that emission factors for uncontrolled emission inventory estimates were set equal to the 1990 factors below, as these pre-date the introduction of diesel engine controls.

Table 6-5. Emission Factors for Vertical Wells <= 7,000 feet (tons/1,000 feet)

Year	NO_X	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
1990	0.29092	0.03518	0.04687	0.18318	0.03683	0.03573
2012	0.23420	0.00006	0.02304	0.09997	0.01500	0.01455
2013	0.23129	0.00006	0.02308	0.09997	0.01498	0.01453
2014	0.23129	0.00007	0.02308	0.09997	0.01498	0.01453
2015	0.20694	0.00007	0.02308	0.09998	0.01463	0.01419
2016	0.21089	0.00007	0.01727	0.07568	0.00810	0.00785
2017	0.20527	0.00007	0.01730	0.07568	0.00804	0.00779
2018	0.20527	0.00007	0.01730	0.07568	0.00804	0.00779
2019	0.18388	0.00007	0.01263	0.06297	0.00619	0.00601
2020	0.16511	0.00006	0.01186	0.04264	0.00463	0.00449
2021	0.16511	0.00006	0.01186	0.04264	0.00463	0.00449
2022	0.16511	0.00006	0.01186	0.04264	0.00463	0.00449
2023	0.14634	0.00006	0.01186	0.04264	0.00463	0.00449
2024	0.10506	0.00006	0.00749	0.01855	0.00304	0.00295
2025	0.10506	0.00006	0.00749	0.01855	0.00304	0.00295
2026	0.10353	0.00006	0.00746	0.01812	0.00304	0.00295
2027	0.10353	0.00006	0.00746	0.01812	0.00304	0.00295
2028	0.10353	0.00006	0.00746	0.01812	0.00304	0.00295
2029	0.08853	0.00006	0.00746	0.01813	0.00286	0.00277
2030	0.08534	0.00006	0.00743	0.01771	0.00284	0.00276
2031	0.07216	0.00006	0.00743	0.01771	0.00244	0.00236
2032	0.07216	0.00006	0.00743	0.01771	0.00244	0.00236
2033	0.07051	0.00006	0.00743	0.01771	0.00239	0.00231
2034	0.04645	0.00006	0.00571	0.01082	0.00132	0.00128
2035	0.04645	0.00006	0.00571	0.01082	0.00132	0.00128
2036	0.04645	0.00006	0.00571	0.01082	0.00132	0.00128
2037	0.03320	0.00006	0.00556	0.01083	0.00125	0.00121
2038	0.03320	0.00006	0.00556	0.01083	0.00125	0.00121
2039	0.02169	0.00005	0.00498	0.00367	0.00023	0.00022
2040	0.02169	0.00005	0.00498	0.00367	0.00023	0.00022

Table 6-6. Emission Factors for Vertical Wells > 7,000 feet (tons/1,000 feet)

Year	NO_X	SO_2	VOC	CO	PM_{10}	PM2.5
1990	0.70222	0.08497	0.11307	0.44028	0.08786	0.08523
2012	0.43234	0.00015	0.01985	0.08020	0.01024	0.00993
2013	0.43234	0.00015	0.01985	0.08020	0.01024	0.00993
2014	0.29658	0.00016	0.01923	0.08026	0.00875	0.00849
2015	0.28910	0.00016	0.01917	0.07926	0.00871	0.00845
2016	0.27681	0.00016	0.01882	0.07926	0.00869	0.00843

Table 6-6. Emission Factors for Vertical Wells > 7,000 feet (tons/1,000 feet)

Year	NO_X	SO_2	VOC	CO	PM_{10}	PM2.5
2017	0.26468	0.00016	0.01806	0.07926	0.00879	0.00853
2018	0.26468	0.00016	0.01518	0.06685	0.00803	0.00779
2019	0.16976	0.00012	0.01669	0.02814	0.00266	0.00258
2020	0.16976	0.00012	0.01669	0.02814	0.00266	0.00258
2021	0.16976	0.00012	0.01669	0.02814	0.00266	0.00258
2022	0.12541	0.00012	0.01669	0.02814	0.00266	0.00258
2023	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2024	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2025	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2026	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2027	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2028	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2029	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2030	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2031	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2032	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2033	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2034	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2035	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2036	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2037	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2038	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2039	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138
2040	0.12541	0.00012	0.01202	0.00798	0.00142	0.00138

Table 6-7. Emission Factors for Directional/Horizontal Wells (tons/1,000 feet)

Year	NO_X	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
1990	0.71765	0.08686	0.11554	0.44947	0.08952	0.08684
2012	0.38008	0.00015	0.01702	0.07053	0.01084	0.01051
2013	0.38008	0.00015	0.01702	0.07053	0.01084	0.01051
2014	0.22914	0.00013	0.02532	0.07057	0.00644	0.00625
2015	0.22787	0.00013	0.02531	0.07040	0.00643	0.00624
2016	0.22578	0.00013	0.02525	0.07040	0.00643	0.00624
2017	0.22371	0.00013	0.02512	0.07040	0.00645	0.00625
2018	0.22371	0.00013	0.01282	0.01737	0.00321	0.00311
2019	0.20755	0.00013	0.01308	0.01078	0.00229	0.00222
2020	0.20755	0.00013	0.01308	0.01078	0.00229	0.00222
2021	0.20755	0.00013	0.01308	0.01078	0.00229	0.00222
2022	0.20000	0.00013	0.01308	0.01078	0.00229	0.00222

Table 6-7. Emission Factors for Directional/Horizontal Wells (tons/1,000 feet)

Year	NO_X	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
2023	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2024	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2025	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2026	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2027	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2028	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2029	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2030	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2031	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2032	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2033	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2034	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2035	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2036	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2037	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2038	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2039	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202
2040	0.20000	0.00013	0.01228	0.00735	0.00208	0.00202

A clear pattern is apparent from the above tables. For example, in Tables 6-6 and 6-7 the emission factors decrease steadily up to 2022, after which time they are constant. This reflects the impact of the relatively low average engine age for deep vertical and directional wells – by 2022 all pre-Tier 4 engines have been replaced with Tier 4 models (fully phased in by 2014).

Table 6-7 also shows a short-lived increase in VOC emission factors from 2014 to 2017. This increase is a byproduct of the way the Tier 4 engine standards are phased in. Specifically, since the Tier 4 standards focus on NO_X and PM reductions, engine manufacturers were allowed to have a slight increase in VOC emissions during the phase in period from 2011 to 2014.[7] Starting with model year 2015, the final Tier 4 standards cut the VOC[8] limits approximately in half, reflected in the substantial decrease in the VOC factor from 2017 to 2018.

Appendix D contains the final emission factors for all pollutants for all years.

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[7] Given the very low average age of the engines used on electric rigs (2.5 years), the emission factors from 2014 through 2017 reflect engine model years between 2011 and 2014.

[8] Tier 4 standards are actually expressed in terms of NMHC rather than VOC, but the relative impact is very similar for both pollutants.

7.0 Emissions Inventory Development and Results

Historical activity data from the RRC, projected 2015 through 2040 activity data derived from DOE EIA data, and the updated emissions profiles developed for each well type category as described above were utilized to develop emissions estimates for selected target years, as described in the following sections. Note that small engines – e.g., 25 hp and less – were excluded from the survey effort due to their anticipated low levels of emissions. In addition, the survey results did not find any engines powered by gasoline or natural gas, so emission inventory estimates were limited to diesel engines.

7.1 Activity Data

7.1.1 2012, 2013, and 2014 Historical Activity

The RRC maintains oil and natural gas drilling permits for the state of Texas. In addition to descriptive information about each permit record (i.e., permit number, American Petroleum Institute (API) number, Well ID, etc.), the RRC data file contains information for when drilling began (Spud Date), when drilling was completed (Drilling Completion Date), wellbore profile type (vertical or horizontal), and permitted well depth.

Historical drilling activity data for the years 2012, 2013, and 2014 were based on the "TCEQ Air Quality Data Set" obtained by the TCEQ from the RRC through an open records request. [9] Figure 7-1 shows the level of activity in each county in Texas during 2014. The counties with the highest level of activity correspond to the liquid-rich plays being developed in the Permian Basin in west Texas and the Eagle Ford Shale in the south-central part of the state. Other areas of elevated activity in 2014 include the Barnett Shale in north Texas, and the Haynesville Shale in east Texas. According to the RRC [10], 2014 saw the highest level of drilling activity in Texas since 1984.

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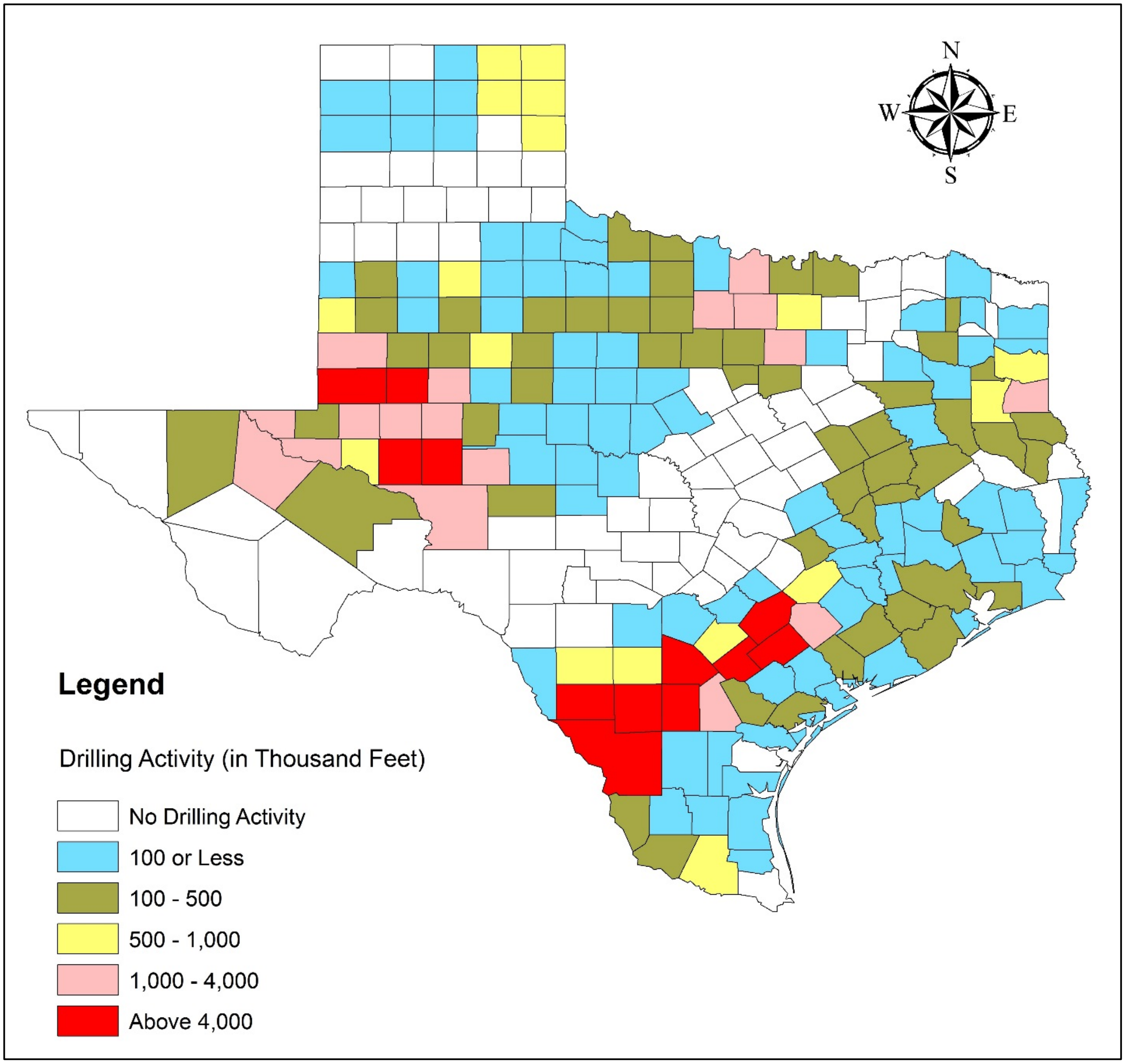
[9] Historical drilling activity data provided to the TCEQ by the RRC through Work Order 33408 on February 2, 2015.

[10] Annual and Monthly Drilling, Completion, and Plugging Summaries are available on-line at http://www.rrc.state.tx.us/oil-gas/research-and-statistics/well-information/monthly-drilling-completion-and-plugging-summaries/.

Figure 7-1. 2014 Texas Drilling Activity

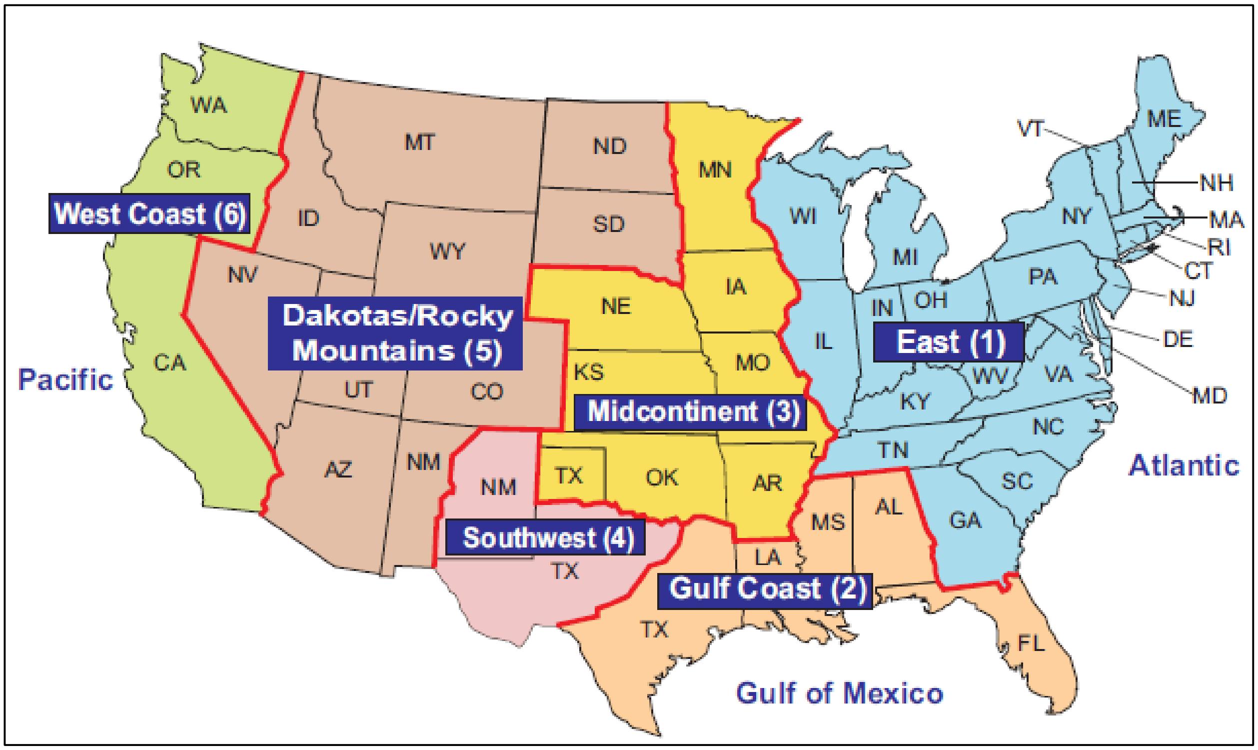


7.1.2 2015 through 2040 Projected Activity

2015 through 2040 projected drilling activity data were developed using the 2014 base year drilling activity data from the RRC and forecasting future activity based on US DOE EIA projections of oil and gas production for the Southwest and Gulf Coast regions from the *Annual Energy Outlook 2015, with projections to 2040* report. The EIA data tables present estimated crude oil and natural gas production estimates for the years 2014 through 2040. The geographic level of the projected data is by EIA Region.

Portions of Texas fall into three EIA Regions: Gulf Coast (Region 2); Southwest (Region 4); and Midcontinent (Region 3). The majority of the State is in the Gulf Coast and Southwest EIA Regions. These two regions include the Permian Basin and the Eagle Ford Shale, the primary areas of drilling activity in Texas in 2014. Only a small portion of Texas (the Texas panhandle area to the west of Oklahoma) is in the Midcontinent Region. It was assumed that the Southwest and Gulf Coast EIA Regions are equally representative of current Texas oil and gas activity, and each region was weighted equally to determine the statewide projections of future drilling activity. Figure 7-2 shows the EIA regions and their coverage in Texas.

Figure 7-2. EIA Regions



Tables 7-1 and 7-2 show projected crude oil and natural gas production for the Gulf Coast and Southwest EIA Regions, as well as the combined total for both regions, from 2015 through 2040. The total percentage change of crude oil and natural gas production for each year from 2015 through 2040 is presented relative to the base year of 2014.

This data was then used to calculate a total projected growth factor (%) for each year from 2015 through 2040 by weighing the oil and gas percentage growth figures relative to the number of oil and gas wells completed in Texas in 2014. For example, the projected growth factor for 2015 is calculated as follows:

2015 growth factor = ((% change from 2014 to 2015 in Crude Oil Production x number of oil well completions in 2014) + (% change from 2014 to 2015 in Natural Gas Production x number of gas well completions in 2014)) / (total number of oil and gas well completions in 2014)

Therefore, the projected growth factor for 2015 is:

2015 growth factor = ((10.27% x 23,521) + (-3.47% x 3,186)) / (23,521 + 3,186) = 8.63%

Table 7-3 shows the resultant total projected growth factors that were developed for each projected year as a result of this analysis. These factors were then applied to the 2014 base year well depth totals by county for each of the three well categories to determine activity data (total feet drilled) for 2015 through 2040.

As noted above, 2014 saw the highest level of drilling activity in Texas since 1984. This was due to relatively high crude oil prices from 2011 through mid-2014, with the price of crude averaging at or near $100/barrel over this time frame. By the end of 2014, crude oil commodity prices were severely depressed from these highs with crude oil reaching $50/barrel by year's end. Not surprisingly, drilling activity began to decline towards the end of the year, a trend that has carried forward into 2015.

It should be noted that the projected production data in the DOE EIA report does not reflect a reduction in activity in 2015 as the EIA projections are more reflective of a long-term outlook and show macro-trends in production (increased domestic energy production due to shale oil and gas resource). Price fluctuations may have a more prominent impact year-to-year, as reflected in the 2014 to early 2015 downward trend in drilling activity.

Projected drilling activity for the years 2015 through 2040 estimated as described above may be found in Appendix E (TCEQ 2015_2040 Projected Drilling Activity.xlsx).

Table 7-1. Projected Crude Oil Production 2015-2040

Year	Gulf Coast EIA Region (MMBBL/day)	Southwest EIA Region (MMBBL/day)	Total (MMBBL/day)	% change from 2014
2014	1.98	1.72	3.7	NA
2015	2.23	1.85	4.08	10.27
2016	2.23	1.98	4.21	13.78
2017	2.28	2.05	4.33	17.03
2018	2.26	2.13	4.39	18.65
2019	2.24	2.17	4.41	19.19
2020	2.18	2.21	4.39	18.65
2021	2.07	2.26	4.33	17.03

Table 7-1. Projected Crude Oil Production 2015-2040

Year	Gulf Coast EIA Region (MMBBL/day)	Southwest EIA Region (MMBBL/day)	Total (MMBBL/day)	% change from 2014
2022	1.99	2.29	4.28	15.68
2023	1.91	2.32	4.23	14.32
2024	1.85	2.35	4.2	13.51
2025	1.78	2.37	4.15	12.16
2026	1.68	2.37	4.05	9.46
2027	1.61	2.38	3.99	7.84
2028	1.57	2.38	3.95	6.76
2029	1.55	2.36	3.91	5.68
2030	1.51	2.33	3.84	3.78
2031	1.48	2.24	3.72	0.54
2032	1.45	2.16	3.61	-2.43
2033	1.43	2.09	3.52	-4.86
2034	1.41	2.03	3.44	-7.03
2035	1.39	1.98	3.37	-8.92
2036	1.38	1.95	3.33	-10
2037	1.37	1.92	3.29	-11.08
2038	1.37	1.9	3.27	-11.62
2039	1.37	1.89	3.26	-11.89
2040	1.37	1.88	3.25	-12.16

Table 7-2. Projected Natural Gas Production 2015-2040

Year	Gulf Coast EIA Region (trillion cubic feet)	Southwest EIA Region (trillion cubic feet)	Total (trillion cubic feet)	% change from 2014
2014	5.05	3.89	8.94	NA
2015	4.93	3.7	8.63	-3.47
2016	5.1	3.77	8.87	-0.78
2017	5.14	3.76	8.9	-0.45
2018	5.29	3.9	9.19	2.8
2019	5.56	4.03	9.59	7.27
2020	5.91	4.11	10.02	12.08
2021	6.29	4.13	10.42	16.55
2022	6.68	4.16	10.84	21.25
2023	6.98	4.21	11.19	25.17
2024	7.25	4.23	11.48	28.41
2025	7.47	4.24	11.71	30.98
2026	7.65	4.24	11.89	33
2027	7.84	4.24	12.08	35.12
2028	7.94	4.23	12.17	36.13
2029	8.05	4.19	12.24	36.91
2030	8.09	4.12	12.21	36.58

Table 7-2. Projected Natural Gas Production 2015-2040

Year	Gulf Coast EIA Region (trillion cubic feet)	Southwest EIA Region (trillion cubic feet)	Total (trillion cubic feet)	% change from 2014
2031	8.21	3.99	12.2	36.47
2032	8.34	3.87	12.21	36.58
2033	8.46	3.78	12.24	36.91
2034	8.58	3.7	12.28	37.36
2035	8.7	3.64	12.34	38.03
2036	8.85	3.6	12.45	39.26
2037	9	3.57	12.57	40.6
2038	9.19	3.55	12.74	42.51
2039	9.34	3.54	12.88	44.07
2040	9.42	3.47	12.89	44.18

Table 7-3. Projected Growth Factors 2015-2040

Year	Oil Production (% change from 2014)	Natural Gas Production (% change from 2014)	Projected Growth Factor (%)[a]
2015	10.27	-3.47	8.63
2016	13.78	-0.78	12.05
2017	17.03	-0.45	14.94
2018	18.65	2.8	16.76
2019	19.19	7.27	17.77
2020	18.65	12.08	17.87
2021	17.03	16.55	16.97
2022	15.68	21.25	16.34
2023	14.32	25.17	15.62
2024	13.51	28.41	15.29
2025	12.16	30.98	14.41
2026	9.46	33	12.27
2027	7.84	35.12	11.09
2028	6.76	36.13	10.26
2029	5.68	36.91	9.4
2030	3.78	36.58	7.7
2031	0.54	36.47	4.83
2032	-2.43	36.58	2.22
2033	-4.86	36.91	0.12
2034	-7.03	37.36	-1.73
2035	-8.92	38.03	-3.32
2036	-10	39.26	-4.12
2037	-11.08	40.6	-4.92
2038	-11.62	42.51	-5.16
2039	-11.89	44.07	-5.22
2040	-12.16	44.18	-5.44

[a] Based on 23,521 oil well and 3,186 gas well completions in 2014.

7.2 Emission Estimation Methodology

Once the total depth drilled per year was aggregated by well type category, and the emission factor profile for each well type category was developed, county level emissions for each well type category were estimated by multiplying the total depth drilled by county by the emission factors developed using the NONROAD model, as follows:

$$\text{Epoll/type} = (\text{Depth (1,000 feet/yr)}) \times (\text{EFpoll (tons/1,000 feet)})$$

Where:

Epoll/type = Emission of pollutant for each county by well type category (tons/yr)

Depth = Total depth drilled in well type category by county (1,000 feet/yr)

EFpoll = Pollutant emission factor (tons/1,000 feet)

This process is repeated for each pollutant for each year for each well type category – for example, 2014 NO_x emissions for shallow vertical wells (< 7,000 feet).

For 2006 onward, NO_x emission estimates for the 110 counties in the eastern half of Texas subject to the Texas Low Emission Diesel (TxLED) program were adjusted downward by 6.2% to account for the effect of the rule. Table 7-4 identifies the counties where this adjustment was made.

Table 7-4. TxLED Counties

Anderson	Denton	Johnson	Robertson
Angelina	Ellis	Karnes	Rockwall
Aransas	Falls	Kaufman	Rusk
Atascosa	Fannin	Lamar	Sabine
Austin	Fayette	Lavaca	San Jacinto
Bastrop	Franklin	Lee	San Patricio
Bee	Freestone	Leon	San Augustine
Bell	Fort Bend	Liberty	Shelby
Bexar	Galveston	Limestone	Smith
Bosque	Goliad	Live Oak	Somervell
Bowie	Gonzales	Madison	Tarrant
Brazoria	Grayson	Marion	Titus
Brazos	Gregg	Matagorda	Travis
Burleson	Grimes	McLennan	Trinity
Caldwell	Guadalupe	Milam	Tyler
Calhoun	Hardin	Montgomery	Upshur

Table 7-4. TxLED Counties

Camp	Harris	Morris	Van Zandt
Cass	Harrison	Nacogdoches	Victoria
Chambers	Hays	Navarro	Walker
Cherokee	Henderson	Newton	Waller
Collin	Hill	Nueces	Washington
Colorado	Hood	Orange	Wharton
Comal	Hopkins	Panola	Williamson
Cooke	Houston	Parker	Wilson
Coryell	Hunt	Polk	Wise
Dallas	Jackson	Rains	
De Witt	Jasper	Red River	
Delta	Jefferson	Refugio	

For counties subject to TxLED requirements, NO_x emissions were estimated as follows:

$$ENO_x\text{-type} = (\text{Depth } (1{,}000 \text{ feet/yr})) \times (EFNO_x \text{ (tons/1,000 feet)}) \times (0.938)$$

Where:

ENO_x-type = Emission of NO_x for each county by well type category (tons/yr)

Depth = Total depth drilled in well type category by county (1,000 feet/yr)

$EFNO_x$ = NO_x emission factor (tons/1,000 feet)

(0.938) = Adjustment factor to account for 6.2% TxLED reduction

Total county level emissions were then determined by summing emissions for each of the three model rig categories for a particular county for a given year.

7.2.1 Example Emission Calculations

Using the data above, CO emissions in 2014 for Anderson County from vertical wells > 7,000 feet are estimated as follows:

ECO = (Depth (1,000 feet/yr)) x (EFpoll (tons/1,000 feet)), or
ECO = (33.72 (1,000 feet/yr)) x (0.080 (tons/1,000 feet))
ECO = 2.7 (tons/yr)

As Anderson County is subject to the TxLED requirements, NO_x emissions in 2014 for Anderson County from vertical wells > 7,000 feet are estimated as follows:

ENO_x = (Depth (1,000 feet/yr)) x (EFpoll (tons/1,000 feet)) x (0.938), or
ENO_x = (33.72 (1,000 feet/yr)) x (0.297 (tons/1,000 feet)) x (0.938)
ENO_x = 9.4 (tons/yr)

7.3 Results

7.3.1 Emission Summary

Tables 7-5 through 7-8, as well as Figures 7-3 through 7-7 summarize the statewide annual and ozone-season daily criteria emissions totals for diesel engine drill rigs, for both controlled and uncontrolled scenarios. Note that the impact of the state TxLED rule (discussed above) is also included in all controlled scenario estimates.

HAP emissions estimates and by-county breakouts were provided in the electronic XML files submitted to the TCEQ. Appendix A also provides the statewide emission estimates for HAPs.

Table 7-5. Statewide Annual Emissions Totals (Tons/Year), Controlled Scenario

Year	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
2012	41,724	16	2,068	8,566	1,259	1,221
2013	38,167	15	1,890	7,826	1,149	1,115
2014	36,488	20	3,249	11,278	1,213	1,176
2015	38,629	22	3,524	12,173	1,308	1,269
2016	38,934	22	3,501	12,110	1,228	1,191
2017	38,842	23	3,528	12,423	1,267	1,229
2018	39,456	23	2,419	7,598	980	951
2019	31,423	20	2,479	4,098	492	477
2020	31,090	20	2,466	3,709	462	448
2021	30,855	20	2,448	3,681	459	445
2022	27,011	20	2,434	3,661	456	443
2023	26,492	20	2,026	1,940	349	339
2024	25,645	19	1,938	1,481	318	309
2025	25,448	19	1,923	1,469	316	306
2026	24,944	19	1,886	1,434	310	301
2027	24,683	19	1,867	1,419	307	298
2028	24,499	19	1,853	1,408	305	295
2029	24,042	18	1,838	1,398	299	290
2030	23,611	18	1,809	1,368	294	285
2031	22,758	18	1,761	1,332	279	271
2032	22,192	17	1,717	1,299	272	264
2033	21,709	17	1,682	1,272	266	258
2034	20,924	17	1,623	1,138	244	237
2035	20,587	16	1,597	1,119	240	233
2036	20,415	16	1,583	1,110	238	231
2037	20,042	16	1,568	1,101	235	228
2038	19,989	16	1,564	1,098	234	227

Table 7-5. Statewide Annual Emissions Totals (Tons/Year), Controlled Scenario

Year	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
2039	19,802	16	1,554	987	218	212
2040	19,755	16	1,550	984	218	211

Figure 7-3. Statewide Drilling Rig Emissions – Controlled (NO_x and CO Tons/Year)

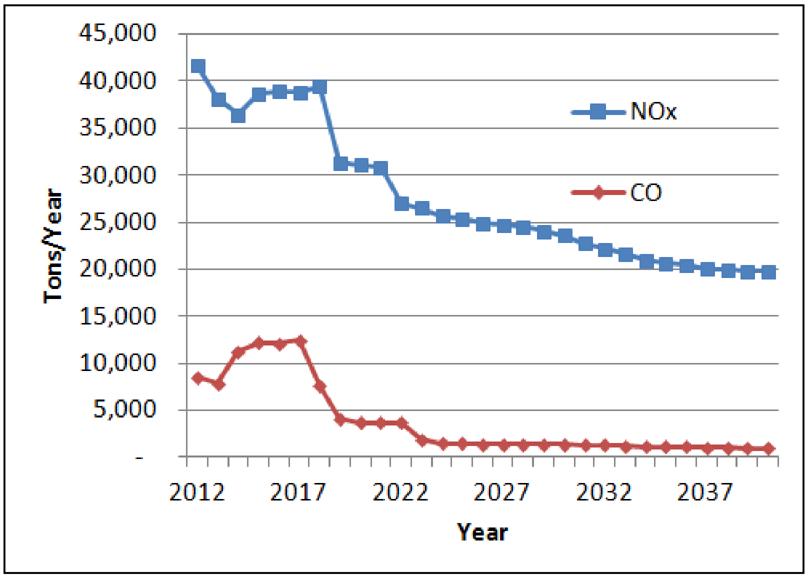
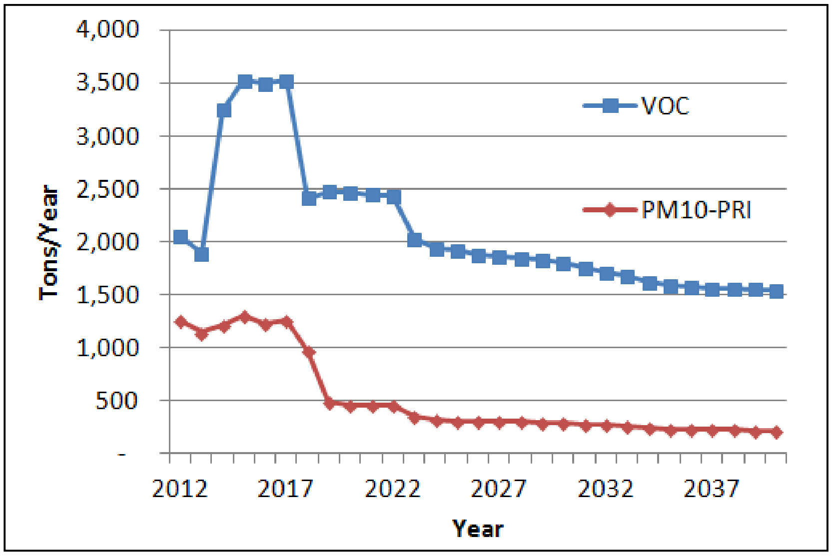


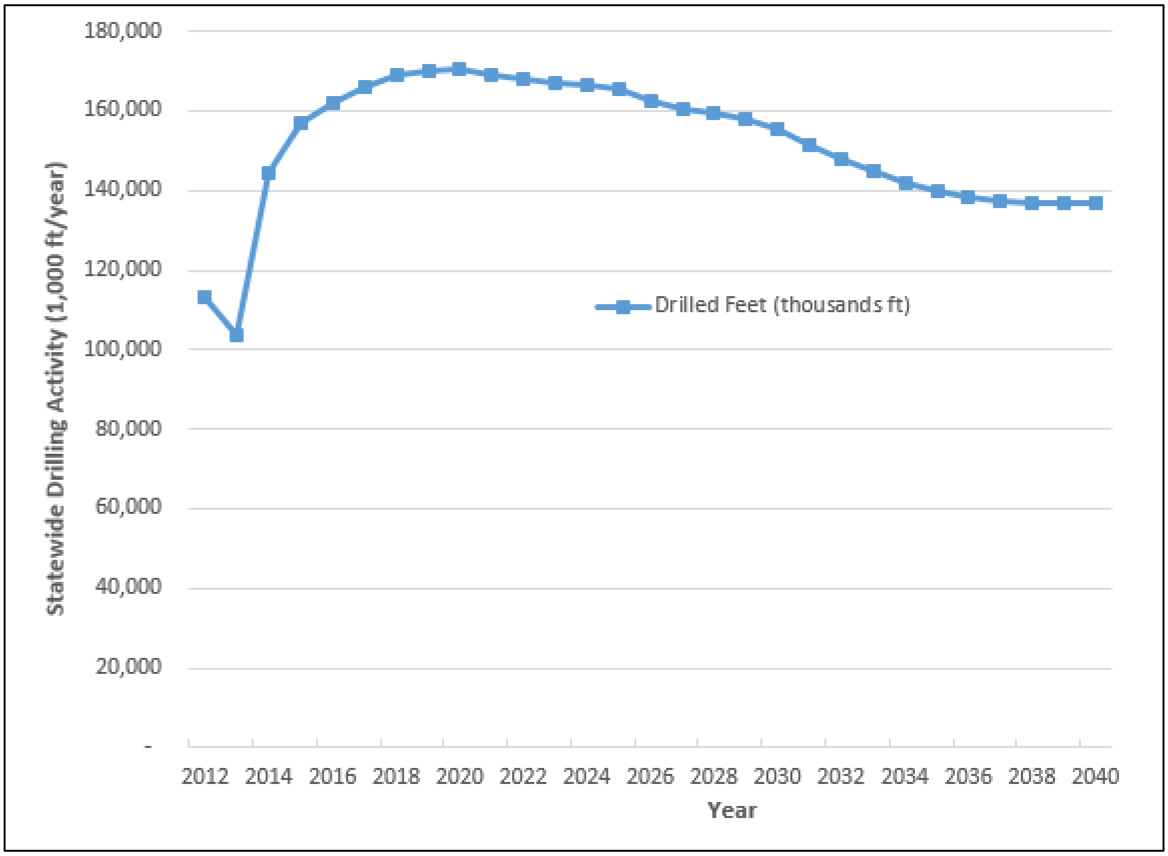
Figure 7-4. Statewide Drilling Rig Emissions – Controlled (VOC and PM_{10} Tons/Year)



Figures 7-3 and 7-4 show a general increase in most pollutants through 2017, after which time emissions drop off dramatically due to decreased drilling activity as well as continued turnover of the drilling rig fleet to newer engines subject to Tier 2, 3, and 4 non-road diesel engine standards. Figure 7-5 presents the corresponding statewide drilling activity for comparison.

The pronounced drop in emissions between 2017 and 2018 reflects the complete replacement of older electric rig engines with Tier 4 engines. A less dramatic drop-off occurs again with a similar replacement of pre-Tier 4 engines with Tier 4 units for deep vertical rigs. Emission reductions resulting from Tier 4 introduction are significant for all four pollutants shown above, although a temporary increase in VOC is seen through 2017 (discussed in more detail in Section 6.3).

Figure 7-5. Statewide Annual Drilling Rig Activity (1,000 feet)



Ozone season day (OSD) emissions were calculated by dividing annual emissions estimates by 365. These values are presented in the tables below. Note that trend charts are not presented for OSD totals, since the relative emissions over time are the same as the annual emissions cases above.

Table 7-6. Statewide OSD Emissions Totals (Tons/Day), Controlled Scenario

Year	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
2012	114.31	0.044	5.67	23.47	3.45	3.34
2013	104.57	0.040	5.18	21.44	3.15	3.05
2014	99.97	0.054	8.90	30.90	3.32	3.22
2015	105.83	0.059	9.66	33.35	3.58	3.48
2016	106.67	0.061	9.59	33.18	3.36	3.26
2017	106.42	0.062	9.67	34.04	3.47	3.37
2018	108.10	0.064	6.63	20.82	2.69	2.60
2019	86.09	0.055	6.79	11.23	1.35	1.31
2020	85.18	0.055	6.76	10.16	1.27	1.23
2021	84.53	0.054	6.71	10.09	1.26	1.22
2022	74.00	0.054	6.67	10.03	1.25	1.21
2023	72.58	0.054	5.55	5.32	0.96	0.93
2024	70.26	0.053	5.31	4.06	0.87	0.85
2025	69.72	0.053	5.27	4.03	0.87	0.84
2026	68.34	0.052	5.17	3.93	0.85	0.82
2027	67.63	0.051	5.11	3.89	0.84	0.82
2028	67.12	0.051	5.08	3.86	0.83	0.81
2029	65.87	0.051	5.04	3.83	0.82	0.79
2030	64.69	0.050	4.96	3.75	0.81	0.78
2031	62.35	0.049	4.82	3.65	0.76	0.74
2032	60.80	0.047	4.70	3.56	0.75	0.72
2033	59.48	0.046	4.61	3.48	0.73	0.71
2034	57.33	0.045	4.45	3.12	0.67	0.65
2035	56.40	0.045	4.37	3.07	0.66	0.64
2036	55.93	0.044	4.34	3.04	0.65	0.63
2037	54.91	0.044	4.30	3.02	0.64	0.62
2038	54.77	0.044	4.28	3.01	0.64	0.62
2039	54.25	0.043	4.26	2.70	0.60	0.58
2040	54.12	0.043	4.25	2.70	0.60	0.58

Table 7-7. Statewide Annual Emissions Totals (Tons/Year), Uncontrolled Scenario

Year	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
2012	76,260	9,229	12,279	47,785	9,526	9,240
2013	69,773	8,444	11,234	43,720	8,715	8,454
2014	95,816	11,595	15,428	60,056	11,978	11,618
2015	104,086	12,596	16,760	65,239	13,011	12,621
2016	107,358	12,992	17,286	67,290	13,420	13,018
2017	110,133	13,328	17,733	69,029	13,767	13,354
2018	111,872	13,538	18,013	70,120	13,985	13,565
2019	112,840	13,655	18,169	70,726	14,106	13,682
2020	112,934	13,667	18,184	70,785	14,117	13,694

Table 7-7. Statewide Annual Emissions Totals (Tons/Year), Uncontrolled Scenario

Year	NO$_x$	SO$_2$	VOC	CO	PM$_{10}$	PM$_{2.5}$
2021	112,077	13,563	18,046	70,248	14,010	13,590
2022	111,473	13,490	17,949	69,869	13,935	13,517
2023	110,780	13,406	17,837	69,435	13,848	13,433
2024	110,467	13,368	17,787	69,239	13,809	13,395
2025	109,621	13,266	17,651	68,708	13,703	13,292
2026	107,570	13,018	17,320	67,423	13,447	13,043
2027	106,445	12,881	17,139	66,718	13,306	12,907
2028	105,647	12,785	17,011	66,218	13,207	12,810
2029	104,825	12,685	16,878	65,702	13,104	12,711
2030	103,190	12,488	16,615	64,677	12,899	12,512
2031	100,440	12,155	16,172	62,954	12,556	12,179
2032	97,944	11,853	15,771	61,390	12,244	11,876
2033	95,930	11,609	15,446	60,127	11,992	11,632
2034	94,157	11,394	15,161	59,016	11,770	11,417
2035	92,637	11,210	14,916	58,063	11,580	11,233
2036	91,865	11,117	14,792	57,579	11,484	11,139
2037	91,106	11,025	14,670	57,104	11,389	11,047
2038	90,868	10,996	14,631	56,954	11,359	11,018
2039	90,818	10,990	14,623	56,923	11,353	11,012
2040	90,603	10,964	14,589	56,788	11,326	10,986

Figure 7-6. Statewide Drilling Rig Emissions – Uncontrolled (NO$_x$ and CO Tons/Year)

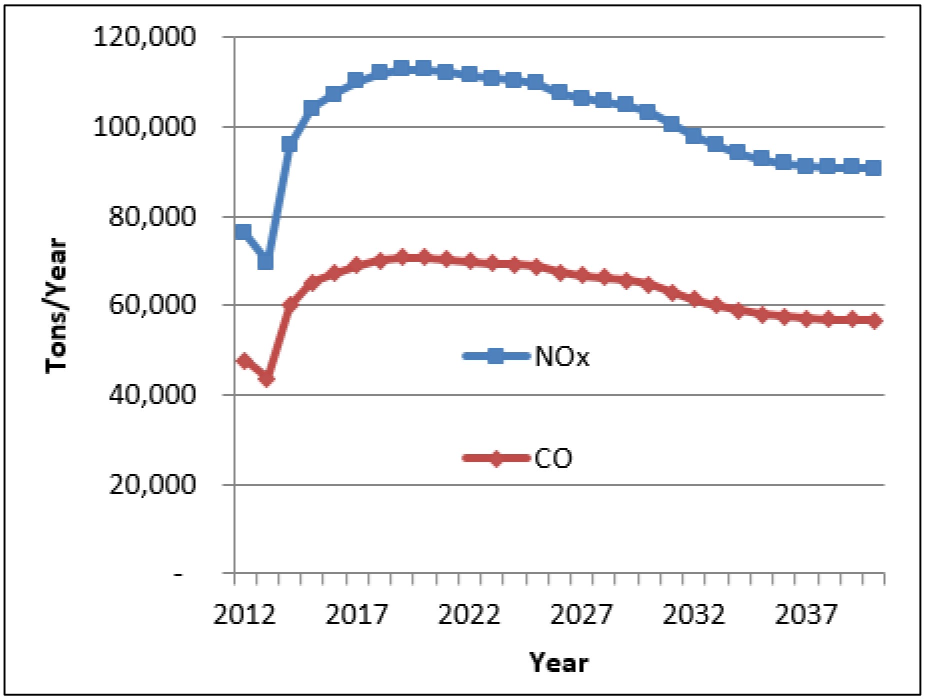
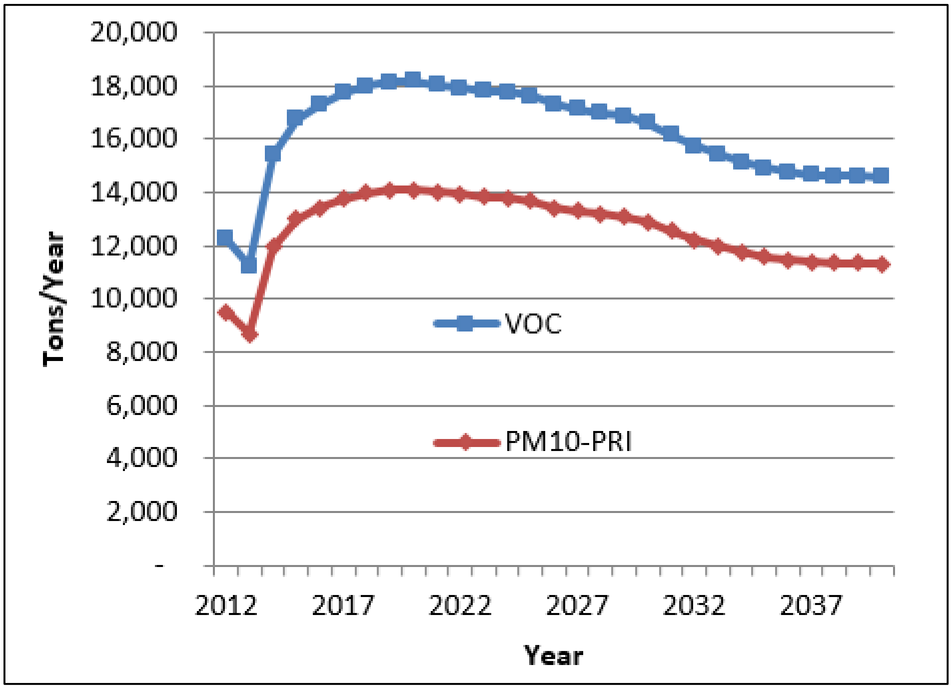


Figure 7-7. Statewide Drilling Rig Emissions – Uncontrolled (VOC and PM$_{10}$ Tons/Year)



The emissions trends presented in Figures 7-6 and 7-7 above clearly show how emissions for all pollutants would be substantially higher without the benefit of the engine and fuel controls implemented since 1990. To illustrate this point trend graphs were also generated to compare the difference between the controlled and uncontrolled emissions scenarios directly (see Figures 7-8 through 7-11).

Figure 7-8. Controlled and Uncontrolled Emissions Projections (NO_x Tons/Year)

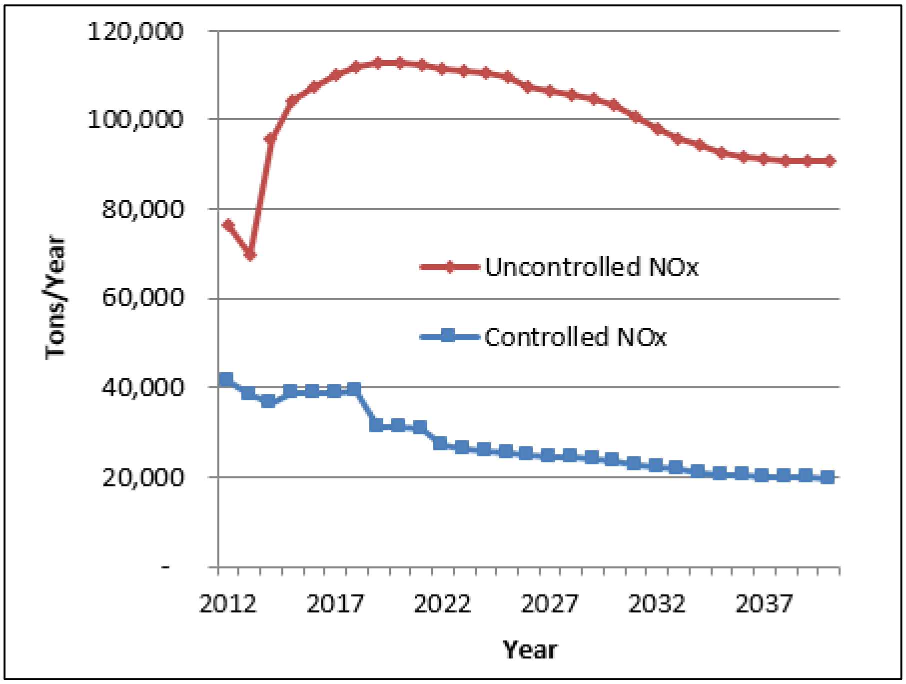


Figure 7-9. Controlled and Uncontrolled Emissions Projections (CO Tons/Year)

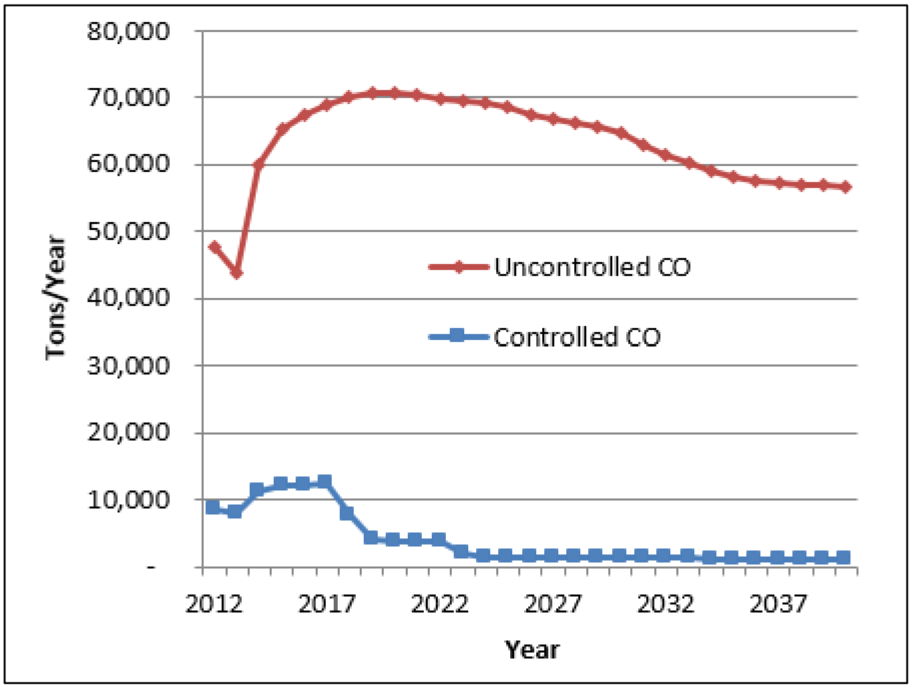


Figure 7-10. Controlled and Uncontrolled Emissions Projections (VOC Tons/Year)

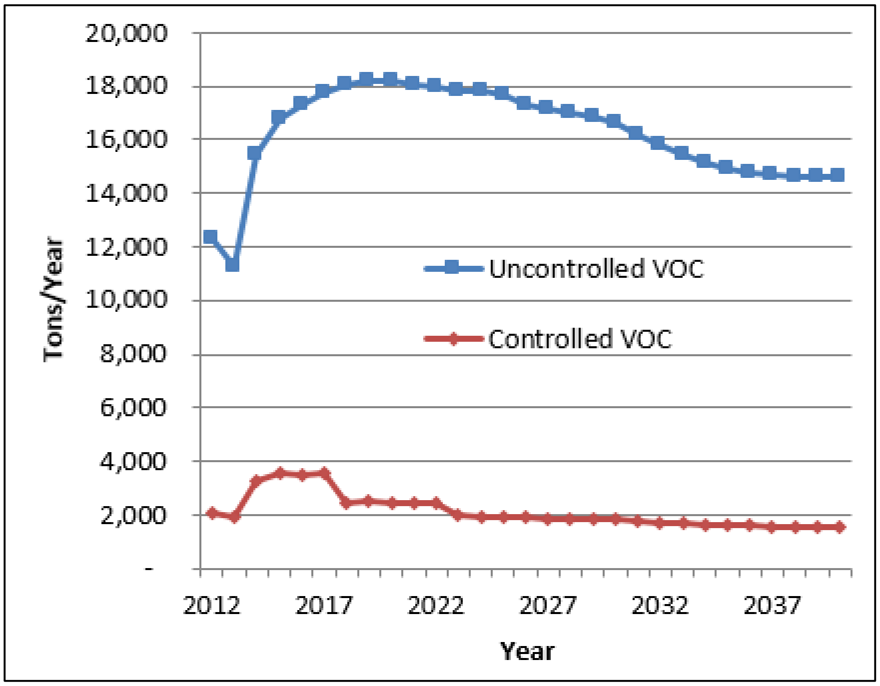
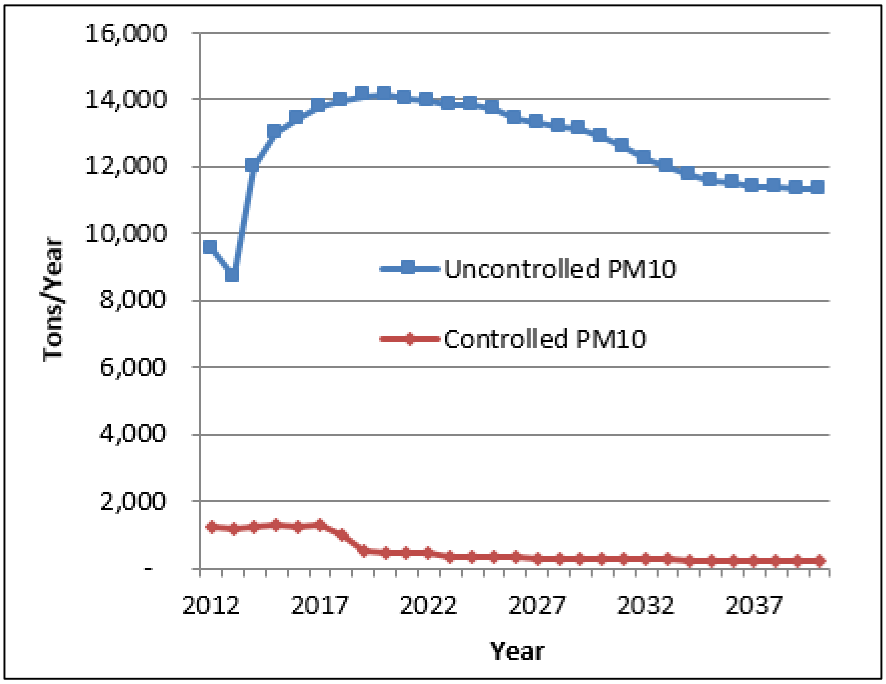


Figure 7-11. Controlled and Uncontrolled Emissions Projections (PM_{10} Tons/Year)



In addition, since the emission factors are held constant for uncontrolled estimates, the year-to-year changes shown above for the uncontrolled scenarios are exclusively due to changes in historical and projected drilling activity (see Figure 7-5).

Table 7-8. Statewide OSD Emissions Totals (Tons/Day), Uncontrolled Scenario

Year	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
2012	208.93	25.28	33.64	130.92	26.10	25.31
2013	191.16	23.13	30.78	119.78	23.88	23.16
2014	262.51	31.77	42.27	164.54	32.82	31.83
2015	285.17	34.51	45.92	178.74	35.65	34.58
2016	294.13	35.59	47.36	184.36	36.77	35.67
2017	301.73	36.51	48.58	189.12	37.72	36.59
2018	306.50	37.09	49.35	192.11	38.31	37.16
2019	309.15	37.41	49.78	193.77	38.65	37.49
2020	309.41	37.44	49.82	193.93	38.68	37.52
2021	307.06	37.16	49.44	192.46	38.38	37.23
2022	305.41	36.96	49.18	191.42	38.18	37.03
2023	303.51	36.73	48.87	190.23	37.94	36.80
2024	302.65	36.63	48.73	189.69	37.83	36.70
2025	300.33	36.34	48.36	188.24	37.54	36.42
2026	294.71	35.66	47.45	184.72	36.84	35.74

Table 7-8. Statewide OSD Emissions Totals (Tons/Day), Uncontrolled Scenario

Year	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
2027	291.63	35.29	46.96	182.79	36.46	35.36
2028	289.45	35.03	46.61	181.42	36.18	35.10
2029	287.19	34.75	46.24	180.01	35.90	34.82
2030	282.71	34.21	45.52	177.20	35.34	34.28
2031	275.18	33.30	44.31	172.48	34.40	33.37
2032	268.34	32.47	43.21	168.19	33.54	32.54
2033	262.82	31.81	42.32	164.73	32.85	31.87
2034	257.96	31.22	41.54	161.69	32.25	31.28
2035	253.80	30.71	40.87	159.08	31.73	30.77
2036	251.69	30.46	40.53	157.75	31.46	30.52
2037	249.61	30.21	40.19	156.45	31.20	30.27
2038	248.95	30.13	40.09	156.04	31.12	30.19
2039	248.82	30.11	40.06	155.95	31.10	30.17
2040	248.23	30.04	39.97	155.58	31.03	30.10

Annual county-level NO_x emissions were also investigated for the controlled scenario for the 2014 base year, in order to help identify the areas of the state with the greatest level of drilling rig emissions. Table 7-9 presents these emissions, with counties ranked from highest to lowest. Of the 180 counties with non-zero emissions in 2014, only a small fraction were responsible for a preponderance of total statewide emissions. For example, the top 10 counties were responsible for nearly 50 percent of total NO_x emissions. In addition, the top six counties (and seven of the top ten) are located in South-Central Texas (Eagle Ford Shale), with the others being Upton, Andrews, and Martin counties in West Texas (Permian Basin).

Table 7-9. County NO_x Emissions Estimates, 2014 Controlled Scenario

County	Tons/Year	Cumulative %
Karnes	2,679.01	7%
Dimmit	2,316.37	14%
La Salle	2,311.68	20%
De Witt	2,128.48	26%
Webb	1,927.57	31%
McMullen	1,814.81	36%
Upton	1,282.37	40%
Andrews	1,206.71	43%
Martin	1,170.47	46%
Atascosa	1,082.97	49%

Table 7-9. County NO_x Emissions Estimates, 2014 Controlled Scenario

County	Tons/Year	Cumulative %
Reagan	1,058.20	52%
Gonzales	1,020.66	55%
Midland	999.00	58%
Irion	821.60	60%
Live Oak	816.79	62%
Glasscock	801.74	64%
Ector	730.24	66%
Crockett	667.06	68%
Panola	587.96	70%
Howard	579.15	71%
Reeves	504.90	73%
Tarrant	485.92	74%
Gaines	424.82	75%
Montague	405.06	76%
Ward	391.82	77%
Wise	386.35	78%
Lavaca	310.63	79%
Loving	287.51	80%
Jack	270.03	81%
Ochiltree	246.95	81%
Harrison	239.67	82%
Denton	227.47	83%
Crane	217.28	83%
Roberts	189.92	84%
Wheeler	185.23	84%
Yoakum	184.17	85%
Zavala	169.47	85%
Frio	167.06	86%
Hidalgo	160.93	86%
Crosby	157.40	87%
Hemphill	154.73	87%
Lipscomb	154.34	87%
Rusk	148.59	88%
Scurry	142.35	88%
Dawson	139.23	89%
Wilson	137.87	89%
Freestone	132.39	89%
Fayette	123.94	90%

Table 7-9. County NO_x Emissions Estimates, 2014 Controlled Scenario

County	Tons/Year	Cumulative %
Starr	111.40	90%
Hockley	96.23	90%
Pecos	94.52	91%
Wichita	94.42	91%
Grayson	89.90	91%
Leon	83.58	91%
Cherokee	83.26	92%
San Augustine	80.68	92%
Culberson	79.88	92%
Stephens	76.39	92%
Wood	76.24	92%
Borden	74.06	93%
Madison	71.47	93%
Brazos	68.39	93%
Throckmorton	68.05	93%
Palo Pinto	64.91	93%
Sterling	64.57	94%
Shelby	62.07	94%
Refugio	61.40	94%
Terry	60.69	94%
Fort Bend	58.40	94%
Parker	56.95	94%
Nolan	56.21	95%
Chambers	53.70	95%
San Jacinto	52.88	95%
Stonewall	52.70	95%
Robertson	52.50	95%
Fisher	50.59	95%
Limestone	50.48	95%
Winkler	50.12	95%
Gregg	49.46	96%
Bee	46.87	96%
Johnson	45.99	96%
Young	45.00	96%
Garza	44.47	96%
Schleicher	42.99	96%
Nacogdoches	42.92	96%
Zapata	42.34	96%

Table 7-9. County NO_x Emissions Estimates, 2014 Controlled Scenario

County	Tons/Year	Cumulative %
Wharton	40.91	97%
Wilbarger	40.16	97%
Houston	39.40	97%
Archer	39.31	97%
Cooke	38.15	97%
Hood	37.13	97%
Haskell	33.88	97%
Brazoria	31.24	97%
Henderson	29.02	97%
Jackson	28.78	97%
Franklin	28.43	98%
Harris	28.09	98%
Brooks	27.58	98%
Lee	24.46	98%
Kleberg	22.64	98%
Dallas	22.51	98%
Mitchell	22.16	98%
Lubbock	22.07	98%
Newton	21.99	98%
Hardeman	21.90	98%
Kent	21.86	98%
Willacy	21.52	98%
Carson	20.32	98%
King	20.10	98%
Titus	19.29	98%
Burleson	18.98	98%
Kenedy	18.59	99%
Taylor	17.54	99%
Jones	17.46	99%
Walker	17.45	99%
Oldham	17.09	99%
San Patricio	16.80	99%
Duval	16.79	99%
Galveston	16.22	99%
Victoria	15.85	99%
Jim Hogg	14.65	99%
Smith	14.58	99%
Upshur	14.19	99%

Table 7-9. County NO_x Emissions Estimates, 2014 Controlled Scenario

County	Tons/Year	Cumulative %
Matagorda	14.01	99%
Baylor	13.88	99%
Orange	13.68	99%
Grimes	13.54	99%
Anderson	12.94	99%
Aransas	12.93	99%
Hansford	12.85	99%
Milam	12.72	99%
Marion	12.38	99%
Montgomery	12.14	99%
Shackelford	11.94	99%
Tom Green	11.62	99%
Runnels	11.16	99%
Maverick	11.02	99%
Jefferson	10.54	100%
Coke	10.39	100%
Liberty	9.55	100%
Lynn	8.98	100%
Tyler	8.77	100%
Hopkins	8.68	100%
Clay	8.67	100%
Caldwell	8.32	100%
Polk	7.10	100%
Cottle	7.02	100%
Coleman	7.01	100%
Cochran	6.92	100%
Hardin	6.15	100%
Dickens	6.02	100%
Hartley	5.89	100%
Austin	5.16	100%
Colorado	4.44	100%
Waller	4.23	100%
Cass	4.19	100%
Jim Wells	3.90	100%
Van Zandt	3.69	100%
Knox	3.62	100%
Concho	3.59	100%
Brown	3.45	100%

Table 7-9. County NO_x Emissions Estimates, 2014 Controlled Scenario

County	Tons/Year	Cumulative %
Medina	3.38	100%
Calhoun	2.98	100%
Goliad	2.97	100%
Comanche	2.82	100%
Hutchinson	2.73	100%
Guadalupe	2.61	100%
Callahan	2.59	100%
Bexar	2.04	100%
Menard	1.68	100%
Foard	1.43	100%
Red River	1.23	100%
Motley	1.19	100%
Eastland	1.03	100%
Potter	0.55	100%
Moore	0.55	100%
Washington	0.32	100%
McCulloch	0.25	100%
Edwards	0.06	100%

While there is some relative variation in historical estimates, most county trends follow the general pattern seen in the statewide totals (see Figure 7-3). Figures 7-12, 7-13, and 7-14 display the county-level distribution of annual NO_x, VOC, and $PM_{2.5}$ emissions for the 2014 base year.

Figure 7-12. 2014 Annual NO_x Emissions by County (Tons/Year)

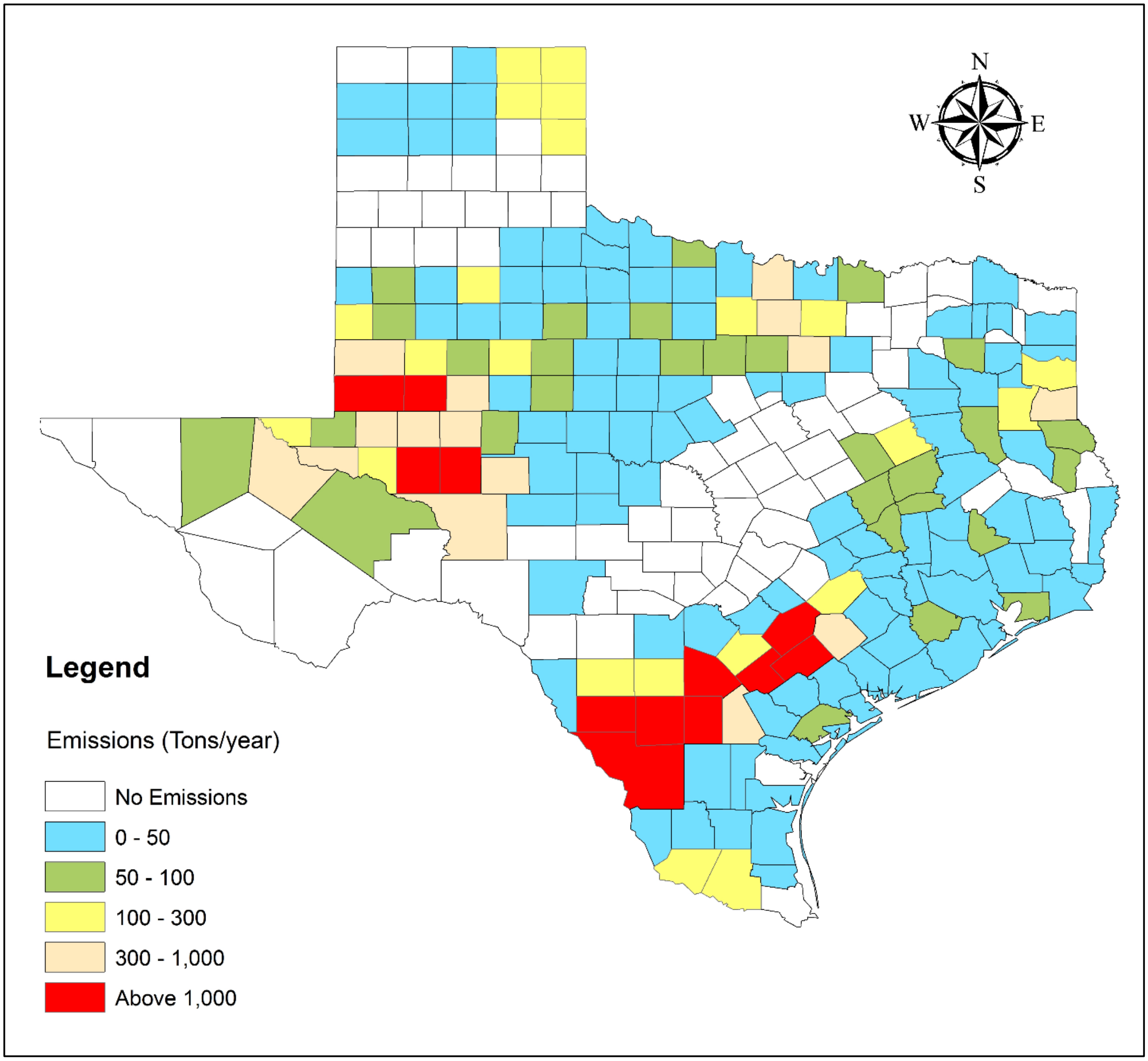


Figure 7-13. 2014 Annual VOC Emissions by County (Tons/Year)

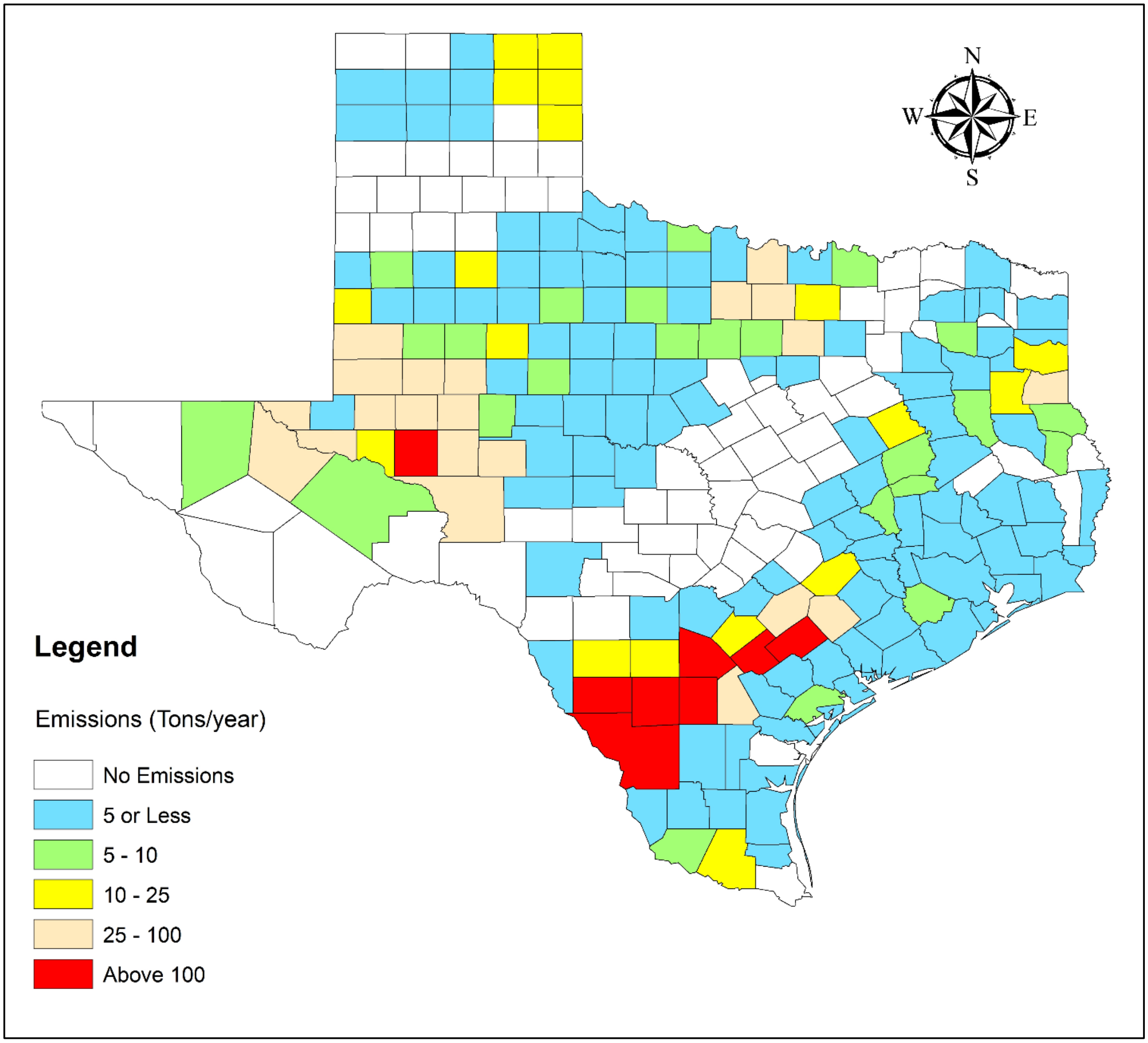
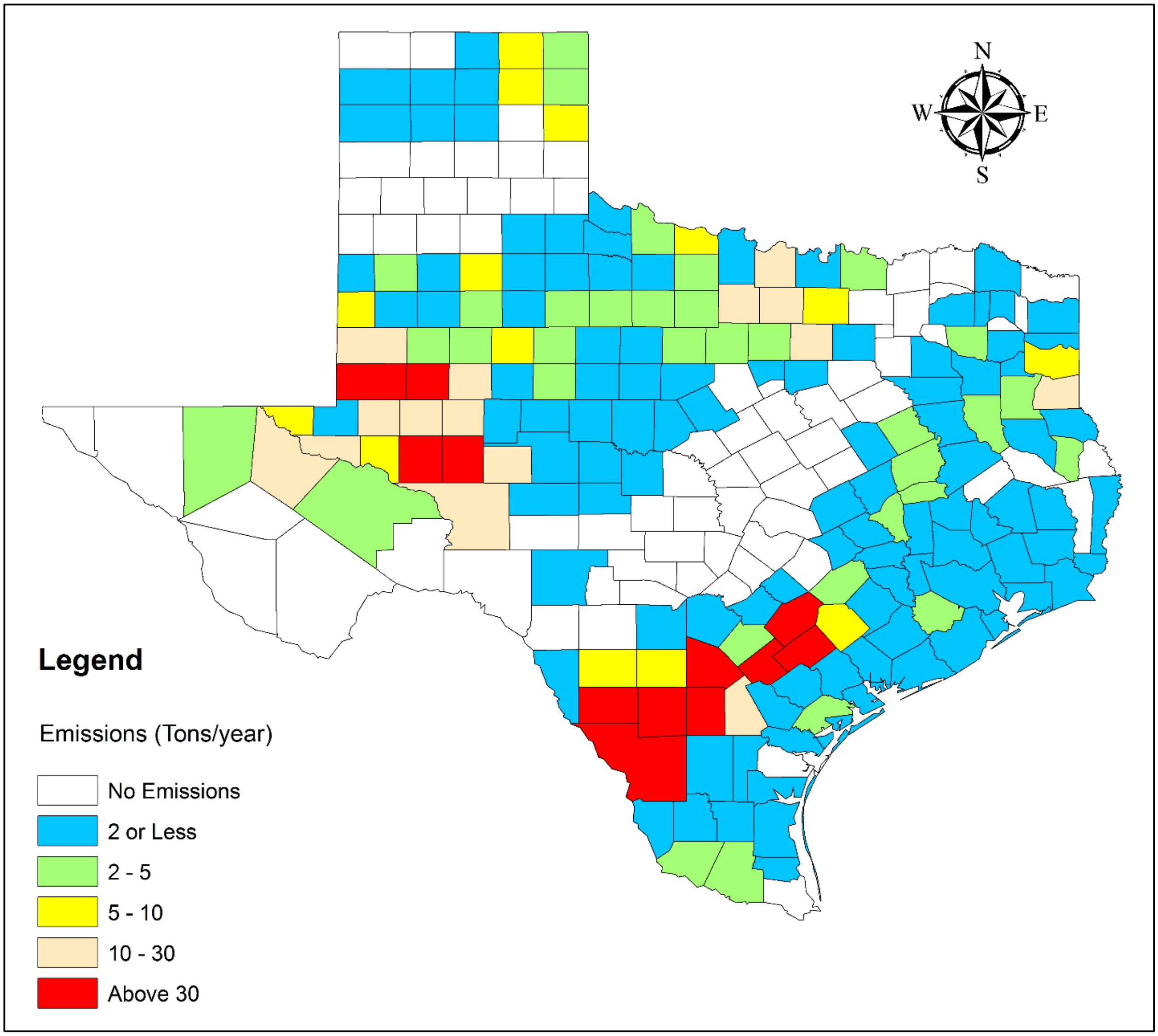


Figure 7-14. 2014 Annual $PM_{2.5}$ Emissions by County (Tons/Year)



7.3.2 CERS XML Files

Once the emissions inventories were completed, CERS XML-formatted input files were prepared. For purposes of XML preparation, SCC 23-10-000-220 (Industrial Processes - Oil and Gas Exploration and Production - All Processes - Drill Rigs) was used, consistent with the 2009 and 2011 studies. ERG uploaded the CERS XML files to the TexAER test server to ensure the files were complete and accurate and in a format consistent with the TexAER area source file data requirements.

7.4 Quality Assurance

ERG conducted a variety of quality assurance checks consistent with the requirements of the Quality Assurance Project Plan (QAPP) submitted to the TCEQ for this project. Key spreadsheet inputs and calculations used to estimate emissions were checked to ensure accuracy, and final emission estimates were evaluated for internal and external consistency. Errors identified during the QA were resolved and emissions estimates were subsequently revised prior to generation of the final XML files developed for TexAER.

QA activities were comprised of two main components – evaluation of the survey data used to generate the updated inventories with respect to reasonableness, and evaluation of the calculation methodologies to ensure the calculations were performed correctly.

First, due to the low response rate to the survey efforts, all external available information that was identified that would help inform the reasonableness of the received data was evaluated. This step is discussed in detail in Section 5.3. This analysis showed that the data obtained through the survey appeared reasonable and was consistent with data developed for other inventory efforts, both within Texas as well as nationally.

Due to the large number of records generated by compiling a 2012 through 2040 inventory for all counties in Texas for over 35 pollutants under both a controlled and uncontrolled scenario, the inventory used to prepare the XML files for TexAER upload was generated using Microsoft Access®. As Task 3.1 of this Work Assignment required updating the Excel-based emissions calculator for the 2014 base year inventory, two independent inventories were generated which allowed for comparison to ensure the emissions were calculated accurately. The Excel-based emissions calculator has been used previously for the 2011 emissions inventory, and was evaluated once the updated emission factors were input and was found to be working correctly. Emission estimates from the Excel-based calculator were then compared to the emissions generated from the Microsoft Access® database and were found to be in agreement. This analysis was done for both the controlled and uncontrolled scenarios and no discrepancies were observed.

Key findings from the evaluation of final emission estimates include the following. First, the time series charts generated for the pollutants appear to follow a reasonable trend for future year projections, with significant activity and emissions drop offs occurring after 2020. The differences in trends across pollutants appear to be explained by the differential impact of emission control phase-in schedules, as discussed in Section 7.3.1 above.

8.0 Conclusions and Recommendations

This study presents updated statewide drilling rig engine emissions inventories for Texas. These inventories were prepared using well drilling activity data obtained through the RRC, combined with updated emissions factors derived through detailed drilling rig engine data collected through a bottom-up survey effort. This study improves upon the 2009 and 2011 inventory efforts by updating drilling rig engine profiles from a 2008 base year to a 2014 base year. In addition, the updated data was evaluated using contemporary information from other similar studies being conducted in Texas as well as nationally. This information was not readily available at the time the 2009 and 2011 studies were prepared.

The ultimate result of this study is a reliable, temporally and spatially resolved profile of county-level drilling activity emissions for the 29 year period from 2012 through 2040. The successful update of the TexAER system with this data will allow for improved SIP and trend analysis for all regions of the state.

Based on the projected oil and gas production levels in Texas from the EIA, drilling activity is estimated to gradually increase across the state through 2020, at which time activity is projected to decline. As shown in the tables and figures presented in this report, the Non-Road diesel engine emission standards have resulted in a steady decrease in drilling-related emissions over time. SO_2 emissions levels in particular are estimated to have fallen precipitously due to the introduction of the ultra-low sulfur standards for diesel fuel in 2010, and should remain extremely low for the foreseeable future.

An analysis of county-level data found that over two-thirds of Texas counties produced some level of emissions associated with drilling activities (180 of 254 counties) in the 2014 base year. However, the county-level distribution of NO_x emissions is highly skewed, with 10 counties being responsible for approximately 50 percent of total statewide NO_x in 2014. In addition, the preponderance of the high NO_x emitting counties were predominantly in West and South-Central Texas where intense drilling activity is occurring in the Permian Basin and the Eagle Ford Shale areas, respectively.

While the emissions inventory results provide an excellent basis for assessing historical emissions levels, projections of future activity are highly uncertain, subject to significant rises and falls depending upon economic factors and associated oil and gas prices. Accordingly, periodic refinement of the activity data used for projected years 2015 through 2040 is strongly recommended to account for such factors.

Finally, while high quality survey data was obtained from several drilling companies in this project, the low number of survey responses could potentially introduce additional uncertainty into the analysis. Fortunately, there are now several other studies with relevant information available that were used to provide data range checks on the resultant drilling rig profiles. The data obtained during the survey were found to agree well with other publically available data and are deemed to be representative of oil and gas well drilling operations in Texas in 2014.

9.0 References

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Appendix A. Drill Rig Emissions (Tons/year)

(see file “Drill Rig Emissions.xlsx”)

Appendix B. Survey Letter

ERG

Dear Owner/Operator:

Eastern Research Group (ERG), an independent research organization, is conducting a study on **drilling rig engine** emissions for wells drilled in Texas in 2014 for the Texas Commission on Environmental Quality (TCEQ). Information currently used by TCEQ to develop emission estimates for drilling rig engines is based on older data collected in 2009. Since that time, it is expected that newer, more efficient engines have been brought on-line and emissions associated with well drilling have decreased. Therefore, the goal of this study is to obtain more current information reflecting operating practices (such as the hours of operation) and drilling rig configuration (such as the age, number, and size of engines) used during well drilling.

Your participation is voluntary and completely confidential, individual wells do not need to be identified. The information your company provides will be used for statistical purposes only in order to develop basin-level estimates and will not be republished or disseminated for other purposes. Responses will not be disclosed in identifiable form to anyone other than ERG employees or agents.

ERG will contact your company via phone to discuss this effort and collect any information you are willing to share. We are seeking basin-specific drilling rig engine usage information for oil and gas wells your company drilled in the [Insert Basin_name] basin located in [Insert counties_text]. The specific information we are requesting for each basin is provided on the reverse side of this letter. Your expertise is valued; please contact us with any comments or clarifications!

Your response is requested by **May 29, 2015**. Completed forms may be submitted via email to **Len Boatman** at 2014drillingsurvey@gmail.com, or via fax to **(512) 419-0089**. For further information or assistance in completing this form, please call Len Boatman at (346) 444-5097.

We appreciate your assistance in this important study. Questions concerning the scope of this study or ERG's relationship with TCEQ may be directed to the TCEQ Project Manager, Michael Ege, at (512) 239-5706, or via email at Michael.Ege@tceq.texas.gov. If you have any specific questions on the technical aspects of this study, please feel free to contact me at (919) 468-7840, or via email at mike.pring@erg.com.

Sincerely,

Mike Pring
Senior Environmental Engineer
Eastern Research Group, Inc.

DRILL RIG SURVEY QUESTIONS

Part 1. General Information

Owner/Operator	
Owner/Operator Contact Name	
Owner/Operator Contact Phone	

Please use **county or basin** averages for each question.

1. Well Locations (county or basin)	
2. Well Type (vertical, horizontal, directional) [a]	
3. Well Measurement Depth (feet)	
4. Well Horizontal/Lateral Length (feet) [b]	
5. Well Drilling Duration (days)	
6. Rig Type (Mechanical or Electric/SCR)	
7. Number of engines on site	
8. Rig Fuel Use (gallons diesel/day)	

[a] Use a separate form for each well type.
[b] Include lateral length for horizontal wells.

Part 2. Drill Rig Engine-Specific Information (for each engine to complete a typical well).

Engine Function (Draw works, Mud Pump, Generator)	Engine ID	Make and Model	Model Year	Engine Size (HP)	Engine On-time (hr/day)	Engine time under load (hr/day)	Engine Load (%)

Comments:

Appendix C. Drill Rig Survey Results

(see file “Drill Rig Survey Results.xlsx”)

Appendix D. Drill Rig Emission Factors

(see file “Drill Rig Emission Factors.xlsx”)

Appendix E. 2015 – 2040 Projected Drilling Activity

(see file “2015_2040 Projected Drilling Activity.xlsx”)

APPENDIX 9

2014 TEXAS STATEWIDE COMMERCIAL MARINE VESSEL EMISSIONS INVENTORY AND 2008 THROUGH 2040 TREND INVENTORIES

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Eastern Research Group, Inc.

2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories

FINAL

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:
Eastern Research Group, Inc.

August 26, 2015

ERG No. 0345.00.001.002

2014 Texas Statewide Commercial Marine Vessel Emissions Inventory and 2008 through 2040 Trend Inventories

TCEQ Contract No. 582-15-50416
Work Order No. 582-15-51493-01 FY: 2015-10

Prepared for:

Cody McLain
Texas Commission on Environmental Quality
Emissions Assessment Section
P.O. Box 13087
Bldg. E, Room 335
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Prepared by:

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Morrisville, NC 27560

August 26, 2015

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1.0 Introduction

The objective of this Texas Commission on Environmental Quality (TCEQ) project is to develop the 2014 Air Emissions Reporting Requirements (AERR) commercial marine vessel (CMV) emissions inventory (EI) for actual annual and average summer weekday emissions as well as 2008 through 2040 CMV statewide actual annual and average summer weekday trend emission inventories. Data developed was for all criteria pollutants, ozone precursors, and hazardous air pollutants (HAPs). During project development, activity data for 2014 were not available. Therefore, Eastern Research Group, Inc. (ERG) obtained activity data from 2013 as this represented the most recent available data at the time the project began. ERG collected activity data for calendar year 2013 and used the data to develop actual and ozone season weekday emission inventories for CMVs using updated emissions and activity-based projection factors all coastal counties in Texas. ERG developed trend emissions inventory data for both controlled and uncontrolled criteria emissions for years 2008 to 2040.

The Texas CMV Emissions Inventory includes Category 1, 2, and 3 vessel activity and emissions by waterway for the entire state. Texas state waters extend 9 nautical miles (nm) from the coast into the Gulf of Mexico and include all waterways that extend inland, such as the upper reaches of the Houston Ship Channel. As such, this inventory examined activities in the following counties: Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Hardin, Harris, Jackson, Jasper, Jefferson, Kenedy, Kleberg, Liberty, Matagorda, Newton, Nueces, Orange, Refugio, San Patricio, Victoria, and Willacy.

The EPA marine category is divided into three groups based on engine cylinder displacement; Category 1 engines have a per cylinder displacement less than 5 liters, Category 2 engines have a per cylinder displacement greater than or equal to 5 liters and less than 30 liters, and Category 3 vessels have a per cylinder displacement greater than or equal to 30 liters. Category 1 and Category 2 marine diesel engines typically range in size from about 500 to 8,000 kW (700 to 11,000 hp). These engines are used to provide propulsion power on many kinds of vessels including tugboats, pushboats, supply vessels, fishing vessels, and other commercial vessels in and around ports. They are also used as stand-alone generators for auxiliary electrical power on many larger vessels. Category 3 marine diesel engines typically range in size from 2,500 to 70,000 kW (3,000 to 100,000 hp). These are very large marine diesel engines that run on residual fuel blends and are used for propulsion power on large ocean-going vessels such as container ships, oil tankers, bulk carriers, and cruise ships. The following sections describe the inventory approach, including initial collection of local data, emission calculations, and spatial allocations used to develop the CMV emissions inventory.

2.0 Data Collection

2.1 PortVision Automatic Identification System (AIS) Data

As a first step in data collection, ERG obtained Automatic Identification System (AIS) activity data for commercial marine vessels from PortVision. PortVision, a service of AIRSIS, Inc., is one of the largest international providers of satellite and terrestrial AIS data. AIS transponders serve as GPS units that report vessel location, speed, and other information every 2 seconds to nearby receivers and are available on most marine vessels due to increasing regulations and decreasing cost. AIS signals cover activities both in port as well as in state, federal, and international waters, providing a more complete picture of each vessel's activity. While there are a number of vessel activity data sources available, many publicly available datasets are highly aggregated and include only vessel origins and destinations (or entrances and clearances) with no indication of how the distance was traversed. Hours of operation using these datasets can only be crudely estimated based on an estimate of vessel speed and the length of the shortest route between the origin and destination.

In contrast, AIS data provide individual vessel identification information along with both geographic location and time stamps, allowing for spatially and temporally accurate vessel routes. Using these data enables one to map individual trips for each vessel to calculate actual hours of operation resulting in a more refined estimate of CMV activity.

As AIS data is primarily geared toward traffic control and accident avoidance, it is not ideally formatted for use in inventory efforts. The dataset ERG obtained from PortVision for this effort includes observations every 15 minutes for every vessel in the area of interest during 2013 (31,841,919 unique observations associated with 9,584 vessels) to provide a comprehensive picture of vessel movement and to reduce potential data gaps.

2.2 Other Vessel Activity Data

AIS data, while far more comprehensive than in the past, may not capture all CMVs within the study area. In particular, smaller vessels that are not required to carry AIS transponders may not be well represented in the dataset. ERG identified three categories of vessels which may not be accurately represented in AIS: military, dredging, and commercial fishing vessels. The following sections describe the additional data sources that ERG used to complement, gap-fill, or replace AIS data where needed.

2.2.1 Government Vessels

The Department of Homeland Security limits the ability to collect activity data and estimate emissions. In the Gulf of Mexico, military vessel activity is implemented by the

U.S. Navy and the U.S. Coast Guard. ERG assumed that Navy vessel activities in Texas state waters were relatively few, since the last Navy base located in Texas was closed in 2006 and most military vessel exercises occur in federal waters.

ERG obtained information about Coast Guard vessels operating in Texas waters using fleet profiles obtained from their websites (USCG, 2014).

2.2.2 Dredging Activity

ERG obtained information concerning dredging operations occurring in Texas state waters from the U.S. Army Corps of Engineers Dredging Activity Database (USACE, 2014).

2.2.3 Commercial Fishing Activity

Commercial fishing activities can be difficult to estimate since fishing vessels tend to consider the locations of their fishing spots confidential business information. ERG estimated commercial fishing activity based on the following data sources. ERG obtained: fish landings from the National Marine Fisheries Service (NMFS, 2015), fishing vessel counts from the National Transportation Safety Board (NTSB, 2010), fishing vessel activity assumptions (Wells 2012) and values of fish landing from the Texas Parks and Wildlife (TPW, 2014). Using these four datasets, ERG estimated and spatially allocated commercial fishing activity.

2.3 Vessel Characteristics Data

In addition to activity data, emission calculations require information about the vessels themselves, particularly the engine category (derived from the cylinder displacement) and its kilowatt (kW) rating to determine which subset of emission factors to use. The kilowatt rating is multiplied by the hours of operation to estimate the kilowatt-hours (kWh), which can then be multiplied by the kWh-based emission factors. These data elements are available in the Information Handling Services (IHS) Vessel Database, which were purchased for use in this project.

3.0 Local Activity Data Processing

3.1 PortVision AIS

The AIS data file received from PortVision included 31,841,919 unique observations, in 15 minute intervals, associated with 9,584 vessels, provided in monthly files. Data were examined in their raw monthly format as both a QA check as well as to determine if there was significant seasonality between months. In terms of vessel observations, each month represented between 7.7 % to 8.8% of the total annual activity. The average was 8.3% with a standard deviation of 0.36%. The average summer month activity was 8.6%. This analysis indicated that the data files were complete and that commercial marine vessel traffic within the Gulf does not have a significant seasonal variation.

To obtain activity data that could be used for annual and daily estimates, data processing steps included consolidating monthly data files into a single dataset in Structured Query Language (SQL) Server and organizing the dataset by vessel and time stamp. ERG performed a quality assurance review of the records and removed records that could not be used, including the following:

- 12 records with no date;
- 11 records with an invalid Maritime Mobile Service Identity (MMSI); and
- 2,564 vessels had a single observation in the year, which is insufficient for routing.

ERG mapped the points in a geographic information system (GIS) and removed 2,523,130 records that plotted more than one nautical mile outside of Texas state waters. ERG selected a buffer distance of one nautical mile to ensure all vessel movements near the edge of the nine-mile state waters area were included. This method aimed to capture data points just outside of the area of interest in order to represent the movements as vessels enter and exit state waters.

Summary statistics performed on the AIS data in SQL server indicated that 72.8 percent of the records were associated with vessel speeds less than 0.2 knots. Discussions with PortVision clarified that speeds of 0.2 knots or less could indicate vessels maintaining position or otherwise not moving. As a result, ERG consolidated consecutive records with vessel speeds of less than or equal to 0.2 knots by averaging the coordinates and speeds to reduce the record count. These processing steps reduced the size of the dataset to 5,667,338 records.

3.1.1 Vessel Characteristics

The AIS data contain identifying information including International Maritime Organization (IMO) number, Maritime Mobile Service Identity (MMSI), vessel name, and vessel type. ERG used these identifiers to match individual vessels to their characteristics in the IHS Vessel Database (IHS 2014). The best method to match vessels is by matching IMO numbers between the two datasets; however, the IMO number is not fully populated in AIS data. As a result, ERG conducted additional rounds of matching using vessel names, call signs, and vessel type to match as many vessels as possible to their detailed vessel characteristics and to validate matches made by IMO number.

Ultimately, ERG successfully matched 4,152 vessels of the 6,301 vessels (66% matched) to the IHS database to obtain kW ratings and maximum speeds. IHS data, while comprehensive, may not have fully populated engine characteristics. For vessels that matched to IHS but did not have kilowatt rating or maximum speed data, ERG calculated average values (excluding zeros) by vessel type and category. For vessels that lacked a category, ERG used the vessel type to assign a category, and average kW rating and maximum speeds were gap-filled based on the type and category.

Vessels that could still not be matched, for example, because they were lacking IMO number, vessel type, and vessel category, were considered most likely to be Category 2 vessels that do not travel internationally and do not require IMO identification, but have invested in AIS technology. Note that vessels equipped with Category 3 engines have a very high match rate as they tend to include IMO or MMSI codes and smaller Category 1 vessels are less likely to participate in the AIS. Therefore vessels that could not be matched, because they were lacking both vessel type and category, were considered to be Category 2 vessels. This assumption may potentially result in an overestimation of emissions as there are a few Category 1 vessels in the AIS dataset. ERG developed average values for Category 2 vessels to gap-fill engine data for the 2,155 vessels that could not be matched to detailed vessel characteristics or were missing data by averaging the kW and maximum speed data values for the 253 Category 2 vessels present in the Texas IHS data. Outliers were accounted for and removed before averaging. The resulting average values were 3,201 for engine kW rating and 12.68478 knots for maximum speed.

3.1.2 Load Factors

Previous inventories, including the 2011 TCEQ CMV inventory, used default load factors in estimating emissions. This is a common practice and has been the established practice for the TCEQ and the EPA for previous CMV emissions inventories.

Vessels tend to operate at an optimal and consistent load while cruising, but their engine loads can vary significantly while they are transiting reduced speed zones or shifting in a port area. AIS data include actual vessel speed, which ERG used in conjunction with the maximum vessel speed as provided in the IHS data to accurately calculate engine load using the Propeller law:

$$LF = (AS/MS)^3$$

Where:

LF = Load factor
AS = Actual vessel speed
MS = Maximum vessel speed

After linking the vessels to the IHS database, ERG calculated load factors using the maximum vessel speed and the observed (actual) vessel speed for individual route segments. In some cases, however, the actual speed reported in AIS data exceeded the maximum speed reported in IHS data. In these cases, the actual speed was set equal to the maximum speed and their load factors, which exceeded 1.0, were replaced by averages derived from IHS data by vessel type. Load factors under 20% were rounded to the nearest percent for later processing as described in Section 6 to account for low load emissions.

3.1.3 Auxiliary Engines

Data on auxiliary engines were obtained for all Category 3 vessels from the IHS data. Category 1 and 2 vessels are smaller and as such tend not to have auxiliary engines or turn their engines off while dockside, so no gap-filling of Category 2 and 3 auxiliary engines was necessary.

3.1.4 Kilowatt-hour Calculations and Data Quality Checks

With kW ratings, maximum speeds, and loading factors fully populated, the kilowatt hours (kWh) were calculated as follows:

$$A = MCR \times LF \times H$$

Where:

A = Vessel activity in kWh
MCR = Maximum continuous rated engine power, kW
LF = Load factor
H = Hours of operation

Activity for propulsion engines were calculated using the kW rating of the main engines for all records with an AIS-reported speed over ground greater than 0.2 knots. For Category 3 vessels, all records indicating movement were considered underway activities. For Category 1 and 2 vessels, the activity associated with speeds over 0.2 knots was split between port and underway Source Category Code (SCCs) to account for hoteling (operations while stationary at dock). 11.75% of the activity was considered hoteling while the remaining 88.25% was considered underway as identified in a previous Category 2 Census Report from the EPA (U.S. EPA, 2007). Activity in the reduced speed zone (RSZ) was calculated using the kW rating of the auxiliary engines for all Category 3 vessels with a recorded speed greater than 0.2 knots. Hoteling activity was calculated using the kW rating of the auxiliary engines for all Category 3 AIS observations where the speed was less than or equal to 0.2 knots.

3.2 Government Vessels

Table 3-1 shows information ERG obtained about Coast Guard vessels operating in Texas waters using fleet profiles obtained from their websites and from direct communication with Coast Guard staff in 2011 (USCG, 2014). ERG obtained the list of vessels in 2015 from the Coast Guard, but was not able to contact anyone at the Coast Guard to obtain or confirm activity information at this time. Therefore, ERG used the original assumptions which are listed in Table 3-1 from the 2011 inventory as surrogates. For the eight new vessels that were not included in the 2011 inventory, ERG assigned activity hours to these vessels to be consistent with other similar Coast Guard Classes. For example navigational aid boats were assumed to have annual operating hours less than larger vessels involved in inland construction and lighter faster medium response boats were assumed to be used slightly more often than larger coastal patrol boats.

The Coast Guard’s Eighth District is responsible for safety and security of the full length of the Mississippi River, as well as the Gulf of Mexico (Peschke, 2015). In Texas, the District operates 21 vessels, as listed in Table 3.1.

Table 3-1. Coast Guard Vessel Characteristics and Associated Ports

Port	Vessel ID	Class	Vessel Name	Vessel Type	Horsepower (hp)	State Water Hours	Source of Hours
Corpus Christi	BUSL 49426	BUSL-49	Stern-Loading Buoy	Aids to Navigation Boat	350	1,000	Assumption from similar vessels
Corpus Christi	WLIC 75304	WLIC-75	Mallet	Inland Construction Tenders	1,320	1,700	2011 TX Inventory
Corpus Christi	WPB 87348	WPB-87	Brant	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory
Corpus Christi	WPB 87363	WPB-87	Manatee	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory
Freeport	WPB 87320	WPB-87	Manta	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory
Galveston	WPB 87330	WPB-87	Man-O-War	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory
Galveston	45630	RB-M	Response Boat-Medium	Response Boat-Medium	825	640	Assumption from similar vessels
Galveston	ANB 55103	ANB-55	55-foot Aids to Navigation Boat	Aids to Navigation Boat	1,080	500	Assumption from similar vessels
Galveston	WMEC 624	WMEC 210	Dauntless	Medium Endurance Cutter	5,000	240	2011 TX Inventory
Galveston	WLIC 75309	WLIC-75	Hatchet	Inland Construction Tenders	1,320	1,700	2011 TX Inventory
Galveston	WLIC 75306	WLIC-75	Clamp	Inland Construction Tenders	1,320	1,700	2011 TX Inventory
Galveston	WLM 561	WLM-175	Harry Claiborne	Coastal Buoy Tender - Keeper Class	3,400	240	2011 TX Inventory
Galveston	45618	RB-M	Response Boat-Medium	Response Boat - Medium	825	640	Assumption from similar vessels
Galveston	WPB 87353	WPB-87	Skipjack	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory
Port Aransas	WPB 87324	WPB-87	Steelhead	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory
Port Aransas	45606	RB-M	Response Boat-Medium	Response Boat - Medium	825	640	Assumption from similar vessels
Port Aransas	45611	RB-M	Response Boat-Medium	Response Boat - Medium	825	640	Assumption from similar vessels
Port Isabel	WPB 87315	WPB-87	Amberjack	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory

Table 3-1. Coast Guard Vessel Characteristics and Associated Ports

Port	Vessel ID	Class	Vessel Name	Vessel Type	Horsepower (hp)	State Water Hours	Source of Hours
Sabine	WPB 87344	WPB-87	Heron	Coastal Patrol Boat - Marine Protector Class	3,000	360	2011 TX Inventory
Sabine Pass	ANB 55110	ANB-55	55-foot Aids to Navigation Boat	Aids to Navigation Boat	1,080	500	Assumption from similar vessels
South Padre Island	33107	Unknown	Full Cabin SAFE Response Boat	Full Cabin SAFE Response Boat	500	500	Assumption from similar vessels

Table 3-1 notes for each Coast Guard vessel the home port, vessel ID number, name, type, horsepower rating of the propulsion engines, and an estimate of the number of hours these vessels operate in state waters. The Coast Guard provided a past estimate of the annual hours of operation and the percentage of time the vessels operated within state waters for 2011. ERG was not able to obtain 2013 data for the Coast Guard. ERG used these 2011 data to estimate the horsepower hours (hp hr) of operation within state waters using the following equation:

$$\text{hp hr} = \text{Vn} \times \text{hp} \times \text{Ao}$$

Where:

hp hr = horsepower hours
Vn = Number of vessels
hp = Total horsepower rating of the Coast Guard vessel's propulsion engines
Ao = Annual operating hours in Texas state waters

Example: Military Vessel Activity Calculation

The 87-foot coastal patrol boat, Steelhead, operates out of Corpus Christi; it is equipped with two 1,475 horsepower (hp) engines. The vessel operates 1,800 hours per year; 20 percent of operations are in Texas state waters. Using the equation above, ERG calculated the horsepower hours for this vessel:

$$\text{hp hr} = \text{Vn} \times \text{hp} \times \text{Ao}$$
$$\text{hp hr} = 1 \times 2950 \text{ hp} \times 360 \text{ hrs}$$
$$\text{hp hr} = 1{,}062{,}000$$

ERG developed emission estimates for criteria pollutants using the following equation:

$$DE = AH \times CF_1 \times LF \times EF \times CF_2 \times D$$

Where:

DE = Daily emissions (tons per day)
AH = Annual activity (hp hr)
CF_1 = Conversion factor (0.7455 kW/hp)
LF = Engine load factor
EF = Emission factor (g/kWh)
CF_2 = Conversion factor (1.10231 E-6 ton/g)
D = Conversion of Annual hours to summer season daily hours (1 year/365 days)

Example: Military Vessel Emission Calculation

The Steelhead has annual hp hrs of 1,062,000, which it operates at a load factor of 0.80. Using the equation directly above, ERG estimated the NO_X emissions using a NO_X emission factor of 13.2 g/kWh:

$$DE = AH \times CF_1 \times LF \times EF \times CF_2 \times D$$

$$DE = 1{,}062{,}000 \text{ hp hrs per year} \times 0.745 \text{ kW/hp} \times 0.80 \times 13.2 \text{ g/kWh} \times 1.10231 \text{ E-6 ton/g} \times 1/365$$

$$DE = 0.025 \text{ tons per day}$$

ERG assumed that the underway load factor for propulsion engines of Coast Guard vessels was 80 percent. To estimate emissions, ERG used emission factors that the EPA developed in support of recent marine vessel rule making (EPA 2010). ERG spatially allocated Coast Guard activity and emissions based on the district associated with each base and assigned them to appropriate counties based on the geographic information system (GIS) shapefiles. Similar to the data processing for the AIS Category 1 and 2 vessels, total activity was split between port and underway SCCs to account for hoteling. 11.75% of the activity was considered hoteling while the remaining 88.25% was considered underway as identified in a previous Category 2 Census Report from the EPA (U.S. EPA, 2007).

3.3 Dredging Operations

ERG obtained information concerning dredging operations occurring in Texas state waters for 2012 through 2014 from the U.S. Army Corps of Engineers Dredging Activity Database (USACE, 2015). The 14 dredging projects that ERG identified were implemented by both the Army Corps as well as private contractors. The Army Corps of Engineers private company data set included the following information:

- The name of the dredging site;
- The type of dredging equipment used;
- The dates on which dredging was planned to be initiated and completed;
- The dates when dredging was actually initiated and completed;
- The amount of material dredged and the disposal method; and
- Information about the private company (including address) that was awarded the work.

ERG used the actual dredging start and completion dates to estimate the total hours of operation for the dredging equipment. In some cases, the completion dates were not documented in the database, in which case ERG assumed the project was ongoing and would continue until December 31, 2014.

Though this equipment operates 24 hours per day seven days per week, ERG assumed that dredging engines operate 90 percent of the time to account for the fact that 10 percent of the time the engines are not operating for minor maintenance and refueling activities.

Three different dredging types are used in state waters: cutter suction (pipeline), hopper, and cutter and hopper combination vessels. Cutter suction dredges use a rotating drill to bring sediment up. Hopper vessels use a vacuum device that transports sediments from the ocean floor into the vessel’s hold. ERG obtained limited information concerning the dredging vessels from websites of the companies implementing the dredging contracts, requiring the use of assumed average values. Cutter suction dredges are equipped with engines rated from 5,000 to 15,000 horsepower, so for this project ERG assumed a value of 9,600 horsepower (7,161 kW). Hopper dredges are equipped with engines rated from 7,500 to 12,000 horsepower, so an average value of 9,814 horsepower (7,272 kW) was assumed (TCEQ 2011). ERG found only one example of a combination dredger at the Marine Aggregate Levy Sustainability Fund (MALSF) website, which had a horsepower rating of 5,476 (4,080 kW) (MALSF, 2015).

The U.S. Army Corps of Engineers’ Dredging Activity Database included project arrival and departure dates which were used to estimate hours of operation.

ERG estimated total kilowatt hours using the following equation:

$$TKW = THP \times 0.745\ KW/hp \times (DP\text{-}AR) \times 24\ hrs/day \times 0.90$$

Where:

TKW = Total kilowatt hours (kWh)
THP = Total maximum horsepower rating of the engine (hp)
0.745 = Conversion of hp to kW
DP = Departure date
AR = Arrival date
24 = Hours per day
0.90 = Total fraction of time operating (considering ongoing maintenance activities and refueling)

Example: Dredging Activity Calculation

A hopper vessel equipped with a 9,814 hp engine arrived at the site on January 1, 2014, and departed on January 11, 2014. Using the equation above, ERG calculated the operating kilowatt hours for this vessel:

$$\text{kWh} = \text{THP} \times 0.745\text{KW/hp} \times (\text{DP-AR}) \times 24\ \text{hrs/day} \times 0.90$$
$$\text{kWh} = 9{,}814\ \text{hp} \times 0.745\ \text{KW/hp} \times (1/1/14 - 1/11/14) \times 24 \times 0.90$$
$$\text{kWh} = 1{,}570{,}790\ \text{kWh}$$

ERG calculated the total operating kilowatt hours based on the hours of operation applied to the vessel and horse power rating. Though there are large dredging ships equipped with Category 3 engines, most dredging vessels that operate along inland waterways are likely to be large Category 2 vessels with cylinder displacements up to 30 liters. For future years, ERG used the 2013 data as the base year for the growth factors. Similar to the data processing for the AIS Category 1 and 2 vessels, total activity was split between port and underway SCCs to account for hoteling. 11.75% of the activity was considered hoteling while the remaining 88.25% was considered underway as identified in a previous Category 2 Census Report from the EPA (U.S. EPA, 2007).

ERG developed emissions estimates for criteria pollutants using the following equation:

$$DE = AH \times EF \times CF \times D$$

Where:

DE = Annual emissions (tons per day)
AH = Annual activity (kWh)
EF = Emission factor (g/kWh)
CF = Conversion factor (1.10231 E-6 ton/g)
D = Conversion of annual emissions to summer season daily emissions (1 year / 365 days)

Example: Dredging Emission Calculation

Using the equation directly above, ERG estimated the NO_X emissions of a dredging vessel with annual operations of 829,487 kWh. The NO_X emission factor is 19.54 g/kWh.

$$DE = AH \times LF \times EF \times CF \times D$$

$$DE = 829{,}487\ \text{kWhs} \times 0.80 \times 19.54\ \text{g/kWh} \times 1.10231 \times 10^{-6}\ \text{ton/g} \times 1/365$$

$$DE = 0.039\ \text{tons of}\ NO_X\ \text{per day}$$

There is little data currently available to quantify engine operating loads for dredging propulsion engines. ERG assumed that vessel operators would attempt to optimize fuel consumption rates for diesel engines, which would be operating loads around approximately 80 percent, based off EPA's Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (April 2009).

3.4 Commercial Fishing

ERG based commercial fishing activity on a variety of data sources for commercial fishing in Texas. ERG estimated fishing vessel ship calls as a function of vessel purpose and its type of fishery operations. Table 3-2 summarizes vessel operating characteristics for the four main types of fishing operations, specifically the number of vessel port calls per year, distance traveled in state waters per call, vessel speed, kilowatt rating of the engine, calculated hours of operation in state waters, and calculated kilowatt hours.

Table 3-2. Vessel Operating Characteristics by Fishing Operation Type

Fishery Operation	Vessels	Calls/Yr	Distance	Speed	Hours	kW	kW/ Vessel - Yr
Snapper	84	40	20	7.5	2.7	224	16,247
Shrimp	1,086	20	20	7.5	2.7	522	18,931
Oyster	252	100	40	7.5	5.3	224	81,133
Other	195	50	30	7.5	4.0	186	25,354
Total	1,617						141,646

Wells 2012

ERG obtained the number of vessels from information from the Texas Parks and Wildlife Commercial Fishing License Buyback Programs (TPWD, 2015). To estimate annual kilowatt-hours of operation per vessel, ERG multiplied the number of calls by the vessel's kilowatt rating, the hours per call, and a load factor of 68 percent. Most fishing vessels have a governor and "trolling gear" to lower engine loads to 68 percent, optimizing diesel fuel consumption. For this component of the TCEQ emission inventory, ERG assumed the propulsion engine load factor to be 68 percent. ERG calculated fishing vessel kilowatt hours using the following equation:

$$Actf = Kw \times Dt / Sp \times Cf \times Lf$$

Where:

Actf = Annual activity per vessel in terms of adjusted kilowatt hours
Kw = Typical kilowatt rating of fishing boats' propulsion engines by type of fishing vessel operation
Dt = Distance traveled in state waters per trip (nautical miles)
Sp = Vessel speed (nautical miles per hour)
Cf = Number of calls per year
Lf = Load factor (percent)

Example: Fishing Vessel Activity Calculation

A vessel involved in fishing operations for snappers is equipped with a single 224 kW propulsion engine, has 40 calls per year where they transit 20 nautical miles per call and operate at a speed of 7.5 nautical miles per hour. ERG used the equation directly above to calculate the total horsepower hours of operation:

$$\text{Actf} = \text{Kw} \times \text{Dt} / \text{Sp} \times \text{Cf} \times \text{Lf}$$

$$\text{Actf} = 224 \text{ kw} \times 20 \text{ NM}/7.5 \text{ NM/hr} \times 40 \times 68/100$$

$$\text{kWh} = 16{,}247$$

The fleet of Gulf of Mexico fishing vessels involved in pelagic fishing (e.g., red snapper and other ground fish), long-line tuna and swordfish, and shrimping operations actually operate most of the time in federal waters. Many of these fishing boats go out into the Gulf and stay out for a week to 3 months. When returning to Texas ports, each vessel operates for only 2 to 3 hours within Texas waters (Wells 2012).

Fishing operations within state waters are dominated by the oyster fishery in the upper Texas Coast with most vessels operating in the Galveston area. These vessels rarely leave the bays or Texas waters and can include bait shrimping, black drum, blue crabs, flounder, and other inshore fisheries (Wells 2012). These boats spend 100 percent of the time within Texas waters and are basically regulated by the fishing season, fishing permits, and the TPWD. ERG obtained the number of vessels associated with each type of fishing operations using the TPWD buyback program in Table 3-2.

The main fishery ports in the Houston-Galveston-Brazoria area are Freeport, Galveston, and Houston. ERG obtained 2013 fish landings for each port from the National Marine Fisheries Service (NMFS, 2015); these numbers are presented in Table 3-3. Table 3-4 presents each port’s percentage of the total, both as total catch and by fishery operations (e.g., snapper, shrimp, oyster, and other).

Table 3-3. 2013 Port Landings for Port Allocations

Port	County	Millions of Pounds	Percent by Poundage	Snapper Vessels	Shrimp Vessels	Oyster Vessels	Other Vessel
Aransas Pass-Rockport	Aransas	2.5	3.4%	3	36	9	7
Brownsville-Port Isabel	Cameron	20.7	27.7%	23	301	70	54
Freeport	Brazoria	2.7	3.6%	3	39	9	7
Galveston	Galveston	22.6	30.3%	25	329	76	59
Houston	Harris	0.3	0.4%	1	5	1	1
Palacios	Matagorda	10.9	14.6%	12	159	37	28
Port Arthur	Jefferson	14.9	20.0%	17	217	50	39
	Total	74.6	100.0%	84	1086	252	195

NMFS, 2015.

ERG used the fractions and number of vessels in Table 3-2 to estimate what portion of the Texas fleet for each fisheries operation. Also, ERG applied the vessel count data presented in Table 3-2 to the per vessel annual kWhs data presented in Table 3-3 to estimate the kWhs associated with the different fishing operations and port which are presented in Table 3-4.

Table 3-4. Kilowatt Hours for Texas Fishing Vessel Fleet by Port and Fishing Operation

Port	County	Snapper kWh	Shrimp kWh	Oyster kWh	Other Vessel kWh	2014 Total kWh
Aransas Pass-Rockport	Aransas	48,680	681,521	730,201	177,479	1,637,882
Brownsville-Port Isabel	Cameron	373,214	5,698,275	5,679,344	1,369,128	13,119,960
Freeport	Brazoria	48,680	738,315	730,201	177,479	1,694,676
Galveston	Galveston	405,667	6,228,347	6,166,145	1,495,899	14,296,058
Houston	Harris	16,227	94,656	81,133	25,354	217,370
Palacios	Matagorda	194,720	3,010,052	3,001,939	709,918	6,916,629
Port Arthur	Jefferson	275,854	4,108,059	4,056,674	988,814	9,429,401
	Total	1,363,043	20,559,224	20,445,638	4,944,072	47,311,976

ERG applied these kilowatt hours to the EPA's emission factors to estimate VOC and NO_X emissions using the following equation:

$$DEf = Actf \times EF \times CF \times D$$

Where:

DEf = Annual emissions associated with fishing vessels (tons per day)
Actf = Annual activity (kWh)
EF = Emission factor (g/kWh)
CF = Conversion factor (1.10231 E-6 ton/g)
D = Conversion of annual emissions to summer season daily emissions (1 year / 365 days)

Example: Fishing Vessel Emission Calculation

Snapper fishing vessels in 2014 account for 1,363,043 kWhs. Using the equation directly above, ERG calculated fishing vessel emissions:

$$DEf = Actf \times EF \times CF \times D$$

$$\begin{aligned} DEf &= 1{,}363{,}043 \text{ kWh} \times 14.30 \text{ g/kWh} \times 1.10231\text{E-6 ton/gr} \times 1/365 \\ &= 0.059 \text{ tons of } NO_X \text{ per day} \end{aligned}$$

ERG used 2013 as the base year for all the trend inventory years. ERG used fish landings to allocate the activity data spatially to the ports and their surrounding areas. Similar to the data processing for the AIS Category 1 and 2 vessels, total activity was split between port and underway SCCs to account for hoteling. 11.75% of the activity was considered hoteling while the remaining 88.25% was considered underway as identified in a previous Category 2 Census Report from the EPA (U.S. EPA, 2007).

4.0 Emission Factors

EPA reviewed CMV emission factors for planned use with the 2014 National Emission Inventory (NEI) (USEPA 2010). ERG developed controlled emission factors from EPA data which took into account fleet turnover and the implementation of regulatory programs (US EPA 2010). Appendix A includes a summary table of the various control programs associated with CMV. These control programs and their reductions are already taken into account in the controlled emission factors in the tables that follow. The controlled and uncontrolled criteria emission factors are shown below in Tables 4-1 through 4-4. Note that the controlled emission factors vary annually for all criteria pollutants except for CO_2, which remains the same for all years as well as under both controlled and uncontrolled scenarios. Tables 4-5 through 4-9 contain the HAP speciation profiles by vessel category and mode. The HAP component of the VOC or PM emissions were estimated using speciation fractions from the EPA's NEI as shown in the following equation:

$$E = A \times SF$$

Where:

E = Annual emissions for HAP (tons)
A = Annual emissions for speciation base (tons)
SF = Speciation factor (unitless fraction)

Organic HAP is calculated as a fraction of VOC emissions; a metal HAP is calculated as a fraction of PM emissions. In the following example the EPA data suggests that 11.22 percent (equating to 11.22/100= 0.1122) of VOC emissions from total VOC diesel marine engine emissions are formaldehyde.

Example: HAP Emission Calculation

Using the equation directly above, ERG estimated the formaldehyde emissions of a vessel with annual total VOC emissions of 78.59 tons. The formaldehyde speciation value is 0.1122.

$$E = A \times SF$$

$$E = 78.59 \text{ tons of VOC} * 0.1122 \text{ formaldehyde fraction per VOC}$$

$$E = 8.817798 \text{ tons of formaldehyde}$$

Table 4-1. Uncontrolled Criteria Emission Factors for CMV Vessels

Pollutant	Uncontrolled Emission Factors (g/kW-hr)		
	Category 1	Category 2	Category 3
CO	2.34	3.74	1.35
CO_2[a]	1,044.40	1,044.83	956.13
NO_X	13.67	18.13	16.06
SO_2	0.28	0.32	10.08
PM_{10}	0.21	0.50	1.35
$PM_{2.5}$	0.20	0.49	1.24
VOC	0.41	0.22	0.60

[a] CO_2 emission factors are the same under both controlled and uncontrolled scenarios.

Table 4-2. Category 1 CMV Controlled Criteria Emission Factors (g/kWh) for All Years

Year	Category 1 Controlled Emission Factors (g/kW-hr)					
	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
2008	2.34	13.67	0.21	0.20	0.28	0.41
2009	2.28	13.22	0.21	0.20	0.28	0.41
2010	2.21	12.77	0.21	0.20	0.20	0.40
2011	2.15	12.35	0.21	0.20	0.15	0.39
2012	2.09	11.88	0.16	0.15	0.08	0.38
2013	2.04	11.42	0.14	0.14	0.04	0.36
2014	1.98	10.92	0.11	0.10	0.04	0.34
2015	1.93	10.44	0.11	0.10	0.04	0.33
2016	1.88	9.88	0.09	0.09	0.04	0.31
2017	1.83	9.28	0.08	0.07	0.04	0.29
2018	1.79	8.67	0.06	0.06	0.04	0.27
2019	1.76	8.10	0.06	0.06	0.04	0.25
2020	1.73	7.58	0.06	0.06	0.04	0.23
2021	1.72	7.11	0.06	0.06	0.04	0.21
2022	1.70	6.68	0.06	0.06	0.04	0.20
2023	1.69	6.27	0.06	0.06	0.04	0.18
2024	1.68	5.89	0.06	0.06	0.04	0.17
2025	1.67	5.54	0.06	0.06	0.04	0.16
2026	1.67	5.23	0.06	0.06	0.04	0.15
2027	1.66	4.95	0.06	0.06	0.04	0.14
2028	1.66	4.71	0.06	0.06	0.04	0.13
2029	1.65	4.50	0.06	0.06	0.04	0.13
2030	1.65	4.35	0.06	0.06	0.04	0.12
2031	1.65	4.24	0.06	0.06	0.04	0.12
2032	1.65	4.15	0.06	0.06	0.04	0.12
2033	1.65	4.08	0.06	0.06	0.04	0.11
2034	1.65	4.02	0.06	0.06	0.04	0.11
2035	1.65	3.98	0.06	0.06	0.04	0.11
2036	1.65	3.94	0.06	0.06	0.04	0.11
2037	1.65	3.91	0.06	0.06	0.04	0.11
2038	1.65	3.89	0.06	0.06	0.04	0.11
2039	1.65	3.87	0.06	0.06	0.04	0.11
2040	1.65	3.86	0.06	0.06	0.04	0.11

Table 4-3. Category 2 CMV Controlled Criteria Emission Factors (g/kWh) for All Years

Year	Category 2 Controlled Emission Factors (g/kW-hr)					
	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
2008	3.74	18.13	0.50	0.49	0.32	0.22
2009	3.71	17.46	0.50	0.49	0.32	0.22
2010	3.68	16.83	0.50	0.49	0.25	0.22
2011	3.64	16.25	0.50	0.49	0.20	0.22
2012	3.61	15.72	0.48	0.46	0.13	0.22
2013	3.58	15.21	0.25	0.24	0.09	0.22
2014	3.55	14.30	0.22	0.21	0.09	0.21
2015	3.52	13.70	0.18	0.18	0.09	0.20
2016	3.49	13.06	0.11	0.11	0.09	0.20
2017	3.46	12.44	0.09	0.09	0.09	0.19
2018	3.44	11.82	0.07	0.07	0.09	0.18
2019	3.41	11.22	0.07	0.07	0.09	0.17
2020	3.38	10.63	0.07	0.07	0.09	0.16
2021	3.36	10.06	0.07	0.07	0.09	0.16
2022	3.33	9.51	0.07	0.07	0.09	0.15
2023	3.31	8.99	0.07	0.07	0.09	0.14
2024	3.28	8.50	0.07	0.07	0.09	0.13
2025	3.26	8.03	0.07	0.07	0.09	0.13
2026	3.24	7.58	0.07	0.07	0.09	0.12
2027	3.22	7.13	0.07	0.07	0.09	0.11
2028	3.19	6.70	0.07	0.07	0.09	0.11
2029	3.18	6.29	0.07	0.07	0.09	0.10
2030	3.16	5.89	0.07	0.07	0.09	0.09
2031	3.15	5.51	0.07	0.07	0.09	0.09
2032	3.15	5.14	0.07	0.07	0.09	0.08
2033	3.14	4.79	0.07	0.07	0.09	0.07
2034	3.13	4.46	0.07	0.07	0.09	0.07
2035	3.13	4.14	0.07	0.07	0.09	0.06
2036	3.12	3.85	0.07	0.07	0.09	0.06
2037	3.12	3.63	0.07	0.07	0.09	0.05
2038	3.12	3.48	0.07	0.07	0.09	0.05
2039	3.11	3.35	0.07	0.07	0.09	0.05
2040	3.11	3.24	0.07	0.07	0.09	0.05

Table 4-4. Category 3 CMV Controlled Criteria Emission Factors (g/kWh) for All Years

Year	Category 3 Controlled Emission Factors (g/kW-hr)					
	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
2008	1.35	16.06	1.35	1.24	10.08	0.60
2009	1.35	15.98	1.35	1.24	10.08	0.60
2010	1.41	15.79	0.60	0.54	4.72	0.62
2011	1.41	15.63	0.60	0.54	4.72	0.62
2012	1.41	15.34	0.60	0.54	4.72	0.62
2013	1.41	15.05	0.60	0.54	4.72	0.62
2014	1.41	14.79	0.59	0.54	4.72	0.62
2015	1.41	14.57	0.35	0.32	1.69	0.62
2016	1.41	14.24	0.35	0.32	1.69	0.62
2017	1.41	13.51	0.35	0.32	1.69	0.62
2018	1.41	12.68	0.35	0.32	1.68	0.62
2019	1.41	11.94	0.35	0.32	1.68	0.62
2020	1.41	11.24	0.21	0.19	0.59	0.62
2021	1.41	10.70	0.21	0.19	0.60	0.62
2022	1.41	10.24	0.21	0.19	0.60	0.62
2023	1.41	9.55	0.21	0.19	0.59	0.62
2024	1.41	9.00	0.21	0.19	0.59	0.62
2025	1.41	8.54	0.21	0.19	0.59	0.62
2026	1.41	8.11	0.21	0.19	0.59	0.62
2027	1.41	7.79	0.21	0.19	0.59	0.62
2028	1.41	7.43	0.21	0.19	0.59	0.62
2029	1.40	7.13	0.21	0.19	0.59	0.62
2030	1.41	6.81	0.21	0.19	0.59	0.62
2031	1.40	6.65	0.21	0.19	0.59	0.62
2032	1.40	6.49	0.21	0.19	0.59	0.62
2033	1.40	6.32	0.21	0.19	0.59	0.62
2034	1.40	6.13	0.21	0.19	0.59	0.62
2035	1.40	5.96	0.21	0.19	0.59	0.61
2036	1.39	5.78	0.21	0.19	0.59	0.61
2037	1.39	5.57	0.21	0.19	0.59	0.61
2038	1.39	5.43	0.21	0.19	0.59	0.61
2039	1.39	5.33	0.21	0.19	0.59	0.61
2040	1.39	5.23	0.21	0.19	0.59	0.61

Table 4-5. Category 1 and 2 HAP Speciation Profile for Port Activities

Pollutant Code	Pollutant	Fraction	Speciation Basis
540841	2,2,4-trimethylpentane	0.0003	VOC
83329	Acenaphthene	0.000018	$PM_{2.5}$
208968	Acenaphthylene	0.00002775	$PM_{2.5}$
75070	Acetaldehyde	0.0557235	VOC
107028	Acrolein	0.002625	VOC
NH3	Ammonia	0.01	PM_{10}
120127	Anthracene	0.00002775	$PM_{2.5}$
7440382	Arsenic	0.0000175	PM_{10}
56553	Benz[a]Anthracene	0.00003	$PM_{2.5}$
71432	Benzene	0.015258	VOC
50328	Benzo[a]Pyrene	0.0000025	PM_{10}
205992	Benzo[b]Fluoranthene	0.000005	PM_{10}
191242	Benzo[g,h,I,]Perylene	0.00000675	$PM_{2.5}$
207089	Benzo[k]Fluoranthene	0.0000025	PM_{10}
7440439	Cadmium	0.00000283	PM_{10}
16065831	Chromium III	0.0000165	PM_{10}
18540299	Chromium VI	0.0000085	PM_{10}
218019	Chrysene	0.00000525	$PM_{2.5}$
628	Dioxin	2.5E-09	PM_{10}
100414	Ethylbenzene	0.0015	VOC
206440	Fluoranthene	0.0000165	$PM_{2.5}$
86737	Fluorene	0.00003675	$PM_{2.5}$
50000	Formaldehyde	0.1122	VOC
118741	HCB	0.00000002	PM_{10}
193395	Indeno[1,2,3-c,d]Pyrene	0.000005	PM_{10}
7439921	Lead	0.000075	PM_{10}
7439965	Manganese	0.00000153	PM_{10}
7439976	Mercury	0.000000025	PM_{10}
91203	Naphthalene	0.00105075	$PM_{2.5}$
110543	n-Hexane	0.004125	VOC
7440020	Nickel	0.0005	PM_{10}
1336363	PCB	0.00000025	PM_{10}
85018	Phenanthrene	0.000042	$PM_{2.5}$
123386	Propionaldehyde	0.004575	VOC
129000	Pyrene	0.00002925	$PM_{2.5}$
7782492	Selenium	2.83E-08	PM_{10}
100425	Styrene	0.001575	VOC
108883	Toluene	0.0024	VOC
1330207	Xylene	0.0036	VOC

Table 4-6. Category 1 and 2 HAP Speciation Profile for Underway Activities

Pollutant Code	Pollutant	Fraction	Speciation Basis
540841	2,2,4-trimethylpentane	0.00025	VOC
83329	Acenaphthene	0.000015	$PM_{2.5}$
208968	Acenaphthylene	0.000023125	$PM_{2.5}$
75070	Acetaldehyde	0.04643625	VOC
107028	Acrolein	0.0021875	VOC
NH3	Ammonia	0.02	PM_{10}
120127	Anthracene	0.000023125	$PM_{2.5}$
7440382	Arsenic	0.00003	PM_{10}
56553	Benz[a]Anthracene	0.000025	$PM_{2.5}$
71432	Benzene	0.012715	VOC
50328	Benzo[a]Pyrene	0.000005	PM_{10}
205992	Benzo[b]Fluoranthene	0.00001	PM_{10}
191242	Benzo[g,h,I,]Perylene	0.000005625	$PM_{2.5}$
207089	Benzo[k]Fluoranthene	0.000005	PM_{10}
7440439	Cadmium	0.00000515	PM_{10}
7440473	Chromium	0.00005	PM_{10}
16065831	Chromium III	0.000033	PM_{10}
18540299	Chromium VI	0.000017	PM_{10}
218019	Chrysene	0.000004375	$PM_{2.5}$
628	Dioxin	0.000000005	PM_{10}
100414	Ethylbenzene	0.00125	VOC
206440	Fluoranthene	0.00001375	$PM_{2.5}$
86737	Fluorene	0.000030625	$PM_{2.5}$
50000	Formaldehyde	0.0935	VOC
118741	HCB	0.00000004	PM_{10}
193395	Indeno[1,2,3-c,d]Pyrene	0.00001	PM_{10}
7439921	Lead	0.00015	PM_{10}
7439965	Manganese	0.000001275	PM_{10}
7439976	Mercury	0.00000005	PM_{10}
91203	Naphthalene	0.000875625	$PM_{2.5}$
110543	n-Hexane	0.0034375	VOC
7440020	Nickel	0.001	PM_{10}
1336363	PCB	0.0000005	PM_{10}
85018	Phenanthrene	0.000035	$PM_{2.5}$
123386	Propionaldehyde	0.0038125	VOC
129000	Pyrene	0.000024375	$PM_{2.5}$
7782492	Selenium	5.15E-08	PM_{10}
100425	Styrene	0.0013125	VOC
108883	Toluene	0.002	VOC
1330207	Xylene	0.003	VOC

Table 4-7. Category 3 HAP Speciation Profile for Hoteling Activities

Pollutant Code	Pollutant	Fraction	Speciation Basis
83329	Acenaphthene	0.00000034	$PM_{2.5}$
208968	Acenaphthylene	0.000000525	$PM_{2.5}$
75070	Acetaldehyde	0.000229	VOC
NH3	Ammonia	0.0108	PM_{10}
120127	Anthracene	0.000000525	$PM_{2.5}$
7440382	Arsenic	0.0004	PM_{10}
56553	Benz[a]Anthracene	0.000000567	$PM_{2.5}$
71432	Benzene	0.0000098	VOC
50328	Benzo[a]Pyrene	0.000002	PM_{10}
205992	Benzo[b]Fluoranthene	0.000004	PM_{10}
191242	Benzo[g,h,I,]Perylene	0.000000128	$PM_{2.5}$
207089	Benzo[k]Fluoranthene	0.000002	PM_{10}
7440417	Beryllium	0.000000546	PM_{10}
7440439	Cadmium	0.0000059	PM_{10}
16065831	Chromium III	0.000396	PM_{10}
18540299	Chromium VI	0.000204	PM_{10}
218019	Chrysene	9.93E-08	$PM_{2.5}$
7440484	Cobalt	0.000292	PM_{10}
628	Dioxin	0.000000002	PM_{10}
206440	Fluoranthene	0.000000312	$PM_{2.5}$
86737	Fluorene	0.000000695	$PM_{2.5}$
50000	Formaldehyde	0.00157	VOC
118741	HCB	0.000000016	PM_{10}
193395	Indeno[1,2,3-c,d]Pyrene	0.000004	PM_{10}
7439921	Lead	0.00006	PM_{10}
7439965	Manganese	0.0000573	PM_{10}
7439976	Mercury	0.0000014	PM_{10}
91203	Naphthalene	0.0000199	$PM_{2.5}$
7440020	Nickel	0.0154	PM_{10}
85018	Phenanthrene	0.000000794	$PM_{2.5}$
7723140	Phosphorous	0.00438	PM_{10}
1336363	Polychlorinated Biphenyls	0.0000002	PM_{10}
129000	Pyrene	0.000000553	$PM_{2.5}$
7782492	Selenium	0.00000908	PM_{10}

Table 4-8. Category 3 HAP Speciation Profile for Maneuvering Activities

Pollutant Code	Pollutant	Fraction	Speciation Basis
83329	Acenaphthene	0.00000034	$PM_{2.5}$
208968	Acenaphthylene	0.000000525	$PM_{2.5}$
75070	Acetaldehyde	0.000229	VOC
NH3	Ammonia	0.00238	PM_{10}
120127	Anthracene	0.000000525	$PM_{2.5}$
7440382	Arsenic	8.74126E-05	PM_{10}
56553	Benz[a]Anthracene	0.000000567	$PM_{2.5}$
71432	Benzene	0.0000098	VOC
50328	Benzo[a]Pyrene	4.37063E-07	PM_{10}
205992	Benzo[b]Fluoranthene	8.74126E-07	PM_{10}
191242	Benzo[g,h,I,]Perylene	0.000000128	$PM_{2.5}$
207089	Benzo[k]Fluoranthene	4.37063E-07	PM_{10}
7440417	Beryllium	0.000000546	PM_{10}
7440439	Cadmium	0.0000226	PM_{10}
16065831	Chromium III	0.00012672	PM_{10}
18540299	Chromium VI	0.00006528	PM_{10}
218019	Chrysene	9.93E-08	$PM_{2.5}$
7440484	Cobalt	0.0000594	PM_{10}
628	Dioxin	4.37063E-10	PM_{10}
206440	Fluoranthene	0.000000312	$PM_{2.5}$
86737	Fluorene	0.000000695	$PM_{2.5}$
50000	Formaldehyde	0.00157	VOC
118741	HCB	3.4965E-09	PM_{10}
193395	Indeno[1,2,3-c,d]Pyrene	8.74126E-07	PM_{10}
7439921	Lead	1.39642E-05	PM_{10}
7439965	Manganese	0.0000573	PM_{10}
7439976	Mercury	2.7076E-07	PM_{10}
91203	Naphthalene	0.0000199	$PM_{2.5}$
7440020	Nickel	0.003250219	PM_{10}
1336363	PCB	4.37063E-08	PM_{10}
85018	Phenanthrene	0.000000794	$PM_{2.5}$
7723140	Phosphorous	0.00179	PM_{10}
129000	Pyrene	0.000000553	$PM_{2.5}$
7782492	Selenium	1.9125E-06	PM_{10}

Table 4-9. Category 3 HAP Speciation Profile for Maneuvering Activities

Pollutant Code	Pollutant	Fraction	Speciation Basis
83329	Acenaphthene	0.00000034	$PM_{2.5}$
208968	Acenaphthylene	0.000000525	$PM_{2.5}$
75070	Acetaldehyde	0.000229	VOC
NH3	Ammonia	0.00477	PM_{10}
120127	Anthracene	0.000000525	$PM_{2.5}$
7440382	Arsenic	0.000174825	PM_{10}
56553	Benz[a]Anthracene	0.000000567	$PM_{2.5}$
71432	Benzene	0.0000098	VOC
50328	Benzo[a]Pyrene	8.74126E-07	PM_{10}
205992	Benzo[b]Fluoranthene	1.74825E-06	PM_{10}
191242	Benzo[g,h,I,]Perylene	0.000000128	$PM_{2.5}$
207089	Benzo[k]Fluoranthene	8.74126E-07	PM_{10}
7440417	Beryllium	0.000000546	PM_{10}
7440439	Cadmium	0.0000226	PM_{10}
7440473	Chromium	0.000192	PM_{10}
16065831	Chromium III	0.00012672	PM_{10}
18540299	Chromium VI	0.00006528	PM_{10}
218019	Chrysene	9.93E-08	$PM_{2.5}$
7440484	Cobalt	0.000154	PM_{10}
628	Dioxin	8.74126E-10	PM_{10}
206440	Fluoranthene	0.000000312	$PM_{2.5}$
86737	Fluorene	0.000000695	$PM_{2.5}$
50000	Formaldehyde	0.00157	VOC
118741	HCB	6.99301E-09	PM_{10}
193395	Indeno[1,2,3-c,d]Pyrene	1.74825E-06	PM_{10}
7439921	Lead	0.0000262	PM_{10}
7439965	Manganese	0.0000573	PM_{10}
7439976	Mercury	5.24476E-07	PM_{10}
91203	Naphthalene	0.0000199	$PM_{2.5}$
7440020	Nickel	0.00589	PM_{10}
1336363	PCB	8.74126E-08	PM_{10}
85018	Phenanthrene	0.000000794	$PM_{2.5}$
7723140	Phosphorus	0.00573	PM_{10}
129000	Pyrene	0.000000553	$PM_{2.5}$
7782492	Selenium	0.00000348	PM_{10}

5.0 Projection Factors

ERG based projected commercial marine vessel activities for Texas ports on the carbon dioxide (CO_2) emission estimates from the business as usual (BAU) Global Scenario 13 developed in the International Maritime Organization's (IMO) Third Green House Gas Study (2014). CO_2 tends to be strongly correlated to fuel combustion as it is based on the carbon content of the fuel which tends to be relatively constant over time. It should be noted that the projection profiles in the IMO study represent the most current economic information on the marine vessel activities developed by an international consortium of leading experts. Studies that have been implemented prior to the global economic decline in 2008 and the uncertain period of recovery (2009-12) tend to overestimate projected growth in the sector. The IMO team addressed the still lingering uncertainties about future trends by providing four different BAU scenarios (13, 14, 15, and 16). All four of the BAU scenarios assumed modest engine efficiency improvement (no control options), no further expansion of global Emission Control Areas (ECA,) and limited use of liquefied natural gas (LNG). In the IMO report a wide range of control options were also included in BAU projection scenarios 1-12. It should be noted that none of these control options were used in projecting marine vessel activities for this TCEQ project. To insure that projected activities were not underestimated, BAU Scenario 13 was used as it assumed the highest level of projected growth.

Additional research supported this assessment, including the assessment developed by the Center for Transportation Research and Texas Transportation Institute for the "Trade Flows and Texas Gulf Ports: Panama Canal Expansion and South American Markets" (August 2013) report. This assessment suggests that international cargo volume will gradually increase as noted in the IMO BAU projections concurrent with an increase in vessel size due to the Panama Canal expansion, providing less vessel traffic with fewer emissions per cargo ton-mile. ERG reviewed other references such as the U.S. Department of Transportation Bureau of Transportation Statistics 2014 (TranStat 2014), the U.S. Department of Energy's Annual Energy Outlook (EIA 2014), and the Organization for Economic Co-operation and Development (OECD) Economic Outlook (2014) to ensure that projected vessel traffic estimates are reasonable. Table 5-1 lists forecasting and backcasting factors.

Note the projections provided in the IMO report did not account for recent changes in fuel costs. ERG anticipates that these changes may have limited impact on marine vessel activities as projected fuel usage in Texas ports will require fuels that comply with recently implemented emissions control area standards. Conversely, if vessels use high sulfur content fuels, they will need to install scrubbers to ensure that emissions are comparable with those from the use of low sulfur fuels.

Table 5-1. 2013-Based Commercial Marine Vessel Activity Growth Factors Based on Uncontrolled CO_2

Year	CO_2 Emissions (million tonnes)	Growth ratio from 2013 base year
2008	940	1.16
2009	873	1.08
2010	790	0.98
2011	871	1.08
2012	816	1.01
2013	816	1.00
2014	816	1.00
2015	810	0.99
2016	830	1.02
2017	850	1.04
2018	870	1.07
2019	890	1.09
2020	910	1.12
2021	948	1.16
2022	986	1.21
2023	1,024	1.25
2024	1,062	1.30
2025	1,100	1.35
2026	1,120	1.37
2027	1,140	1.40
2028	1,160	1.42
2029	1,180	1.45
2030	1,200	1.47
2031	1,260	1.54
2032	1,320	1.62
2033	1,380	1.69
2034	1,440	1.76
2035	1,500	1.84
2036	1,580	1.94
2037	1,660	2.03
2038	1,740	2.13
2039	1,820	2.23
2040	1,900	2.33

ERG matched projected activity to the appropriate future year emission factors in Table 6-1 to account for federal rules that are implemented relative to the year that the marine engine was originally manufactured, such that full benefit of the rule would occur in the future once fleet turnover was completed. ERG made additional adjustments to future year emissions estimates to account for compliance with emissions control area fuel sulfur standards and Texas Emissions Reduction Plan (TERP) investments. The TERP program provides grants to eligible businesses to reduce emissions from polluting vehicles and equipment. Appendix A includes a complete list of control programs addressed in this inventory.

6.0 Emissions Calculations for AIS Data

ERG estimated emissions as a function of vessel power demand multiplied by an emission factor, where the emission factor is expressed in terms of grams per kilowatt hour (g/kWh). ERG then applied emission factors and propulsion engine load to the activity data to estimate emissions. Below is the basic equation used to estimate port emissions:

$$DE = MCR \text{ x } LF \text{ x } A \text{ x } EF \text{ x } D$$

Where:

DE = Emissions from the engine(s), usually calculated as grams of emissions per day
MCR = Maximum continuous rated engine power, kW
LF = Load factor
A = Activity, hours
EF = Emission factor (g/kWh)
D = Conversion of annual emissions to summer season daily emissions (1 year / 365 days)

Example: AIS Vessel Emission Calculation

The example uses a category 3 vessel with main engines of 10,590 kW and has annual hrs of 150 on a certain shipping land, which it operates at a load factor of 0.54. Using the equation directly above, ERG estimated the NO_X emissions using a NO_X emission factor of 14.79 g/kWh and a gram to ton conversion factor of 1.10231E-6:

$$DE = MCR \text{ x } LF \text{ x } A \text{ x } EF \text{ x } D$$

$$DE = 10{,}590 \text{ kW} \times 0.54 \times 150 \text{ hours} * 14.79 \text{ g/kWh} \times 1.10231 \text{ E-6 ton/g} \times 1/365$$

$$DE = 0.038 \text{ tons per day}$$

Both controlled and uncontrolled emissions estimates were calculated using the emission factors in Section 4.0. Because the AIS data note the actual vessel speed and the IHS data provide maximum design speed, the engine load can be calculated directly. Where the engine load is below 20 percent, the emission factors in Tables 4-1 through 4-4 were adjusted for low load using the adjustment factors presented in Table 6-1, obtained from 2009 EPA port emissions inventory guidance (EPA 2009). The emissions estimates were multiplied by the adjustment factors to estimate the increase in emissions associated with low operating loads. Since data review indicated no significant seasonality in the AIS data, the annual values were divided by 365 to obtain ozone season daily emissions values.

Table 6-1. Emissions Adjustment Factors for Operating Loads Less Than 20%

Load	**NO$_X$**	**VOC**	**HC**	**CO**	**SO$_2$**	**CO$_2$**	**PM$_{10}$**	**PM$_{2.5}$**
0.01	11.47	62.32	59.28	19.32	5.99	5.82	19.17	19.17
0.02	4.63	22.27	21.18	9.68	3.36	3.28	7.29	7.29
0.03	2.92	12.28	11.68	6.46	2.49	2.44	4.33	4.33
0.04	2.21	8.11	7.71	4.86	2.05	2.01	3.09	3.09
0.05	1.83	5.9	5.61	3.89	1.79	1.76	2.44	2.44
0.06	1.6	4.57	4.35	3.25	1.61	1.59	2.04	2.04
0.07	1.45	3.7	3.52	2.79	1.49	1.47	1.79	1.79
0.08	1.35	3.1	2.95	2.45	1.39	1.38	1.61	1.61
0.09	1.27	2.65	2.52	2.18	1.32	1.31	1.48	1.48
0.10	1.22	2.31	2.2	1.96	1.26	1.25	1.38	1.38
0.11	1.17	2.06	1.96	1.79	1.21	1.21	1.3	1.3
0.12	1.14	1.85	1.76	1.64	1.18	1.17	1.24	1.24
0.13	1.11	1.68	1.6	1.52	1.14	1.14	1.19	1.19
0.14	1.08	1.55	1.47	1.41	1.11	1.11	1.15	1.15
0.15	1.06	1.43	1.36	1.32	1.09	1.08	1.11	1.11
0.16	1.05	1.32	1.26	1.24	1.07	1.06	1.08	1.08
0.17	1.03	1.24	1.18	1.17	1.05	1.04	1.06	1.06
0.18	1.02	1.17	1.11	1.11	1.03	1.03	1.04	1.04
0.19	1.01	1.1	1.05	1.05	1.01	1.01	1.02	1.02

7.0 Results

Tables 7-1 and 7-2 present the total statewide annual CMV activity (kWh) and emissions (tons) for criteria pollutants by SCC for the year 2014. Tables 7-3 through 7-6 present the controlled criteria emissions for 2014 by county and by SCC. Table 7-7 shows the total statewide annual CMV activity and criteria emissions by year for all years 2008-2040.

As a quality assurance step, the backcasted 2011 inventory developed in this effort was compared against the previously developed 2011 inventory. Overall activity levels were approximately 35% higher than previous estimates as shown in Table 7-8, due in large part to the increase in Category 1 and 2 underway activities. The use of AIS data in this effort captured significantly more Category 1 and 2 vessels than in the past, and they have much higher hours of operation in state waters compared to larger Category 3 vessels. Category 3 underway activities are in line with previous estimates, but in-port estimates are much lower than previously estimated. In the previous estimate, an assumption was made that 11.75% of activities were in port; however, AIS data included true hours of operation when vessels were not moving, such that ERG could more accurately estimate emissions associated with auxiliary engines. Port activities were estimated to be around 8.77% of total activity using AIS for this project. In addition, AIS data allowed ERG to estimate actual operating loads whereas the previous inventory used EPA load assumptions. The operating loads for this inventory in port were significantly smaller.

Emissions decreased from 2008 to around 2020 and then begin to increase from around 2020 to 2040. This is due to two main reasons. First, activity estimates remain relatively consistent prior to 2020, at which point it increases more dramatically as shown in Table 5-1. In addition to increasing activity levels, there are also changes to the emission factors over time due to compliance with the EPA's engine exhaust standards. Note this standard applies to newly manufactured engines that undergo major engine maintenance, so the anticipated emission reductions occur gradually as the current fleet is fully replaced with new engines. There are also fuel-related ECA standards that caused SO_2 and PM to decrease as cleaner lower sulfur fuels are used.

While this inventory effort provides a higher level of detail than in previous efforts for the larger vessels that use AIS transponders, future improvements could be made. Additional port activity data from Category 1 and 2 vessels could improve maneuvering estimates over the assumed 11.75% used for this project. As more and smaller vessels adopt AIS technology, AIS data will provide increasing vessel population and activity data over what is currently available. Additionally, engaging ports in future inventory efforts could provide valuable insight on the activity patterns between and within different ports and anticipated emission control or fuel conservation initiatives. Finally, inclusion of visiting naval vessel activity could be an improvement if activity and vessel data can be obtained.

Table 7-1. 2014 Annual Statewide Controlled Criteria Emissions by SCC (tons)

SCC	SCC Description	Activity (kWh)	2014 Annual Statewide Controlled Criteria Emissions by SCC (tons)					
			CO	NO$_X$	PM$_{10}$	PM$_{2.5}$	SO$_2$	VOC
2280002100	Category 1 and 2 Port	105,534,576	537.51	1,817.13	29.24	28.37	10.86	39.55
2280002200	Category 1 and 2 Underway	792,632,032	4,037.01	13,647.81	219.65	213.06	81.56	297.02
2280003100	Category 3 Port	11,210,592	18.10	184.31	7.46	6.81	58.83	8.09
2280003200	Category 3 Underway	422,984,032	730.53	7,136.25	294.08	268.82	2,263.04	351.00
Total		1,332,361,232	5,323	22,785	550	517	2,414	696

Table 7-2. 2014 Annual Statewide Uncontrolled Criteria Emissions by SCC (tons)

SCC	SCC Description	Activity (kWh)	2014 Annual Statewide Uncontrolled Criteria Emissions by SCC (tons)					
			CO	NO$_X$	PM$_{10}$	PM$_{2.5}$	SO$_2$	VOC
2280002100	Category 1 and 2 Port	105,534,576	567.61	2,372.87	67.13	65.12	40.78	41.11
2280002200	Category 1 and 2 Underway	792,632,032	4,263.14	17,821.77	504.21	489.08	306.32	308.78
2280003100	Category 3 Port	11,210,592	18.10	200.02	16.95	15.58	125.76	8.09
2280003200	Category 3 Underway	422,984,032	730.53	7,744.70	668.58	614.46	4,837.69	351.00
Total		1,332,361,232	5,579	28,139	1,257	1,184	5,311	709

Table 7-3. 2014 Annual Controlled Criteria Emissions by County for Category 1 and 2 Vessel Port Activities (tons)

Name	CO	HC	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aransas	55.20290	2.93326	212.64187	3.27151	3.17337	1.28990	3.49988
Brazoria	30.16566	0.84403	79.21021	1.42448	1.38174	0.45853	2.70082
Calhoun	27.38711	1.11695	89.07980	1.45642	1.41273	0.53730	1.99517
Cameron	6.18776	0.32688	23.91261	0.36898	0.35792	0.14528	0.39154
Chambers	4.62668	0.10031	10.68390	0.20173	0.19568	0.06255	0.41767
Galveston	115.48770	5.00008	380.63878	6.13673	5.95263	2.25885	8.72418
Harris	61.54444	2.25513	184.14987	3.10641	3.01322	1.07204	5.18366
Jefferson	51.97064	2.04802	161.81068	2.66941	2.58933	0.95188	4.18869
Kenedy	23.40026	1.30820	93.95305	1.42933	1.38645	0.57387	1.38978
Kleberg	0.50954	0.01148	1.17842	0.02202	0.02136	0.00693	0.04504
Matagorda	29.41985	0.87277	80.04154	1.41648	1.37399	0.46963	2.52648
Nueces	17.56654	0.78756	60.11897	0.96432	0.93539	0.35786	1.30739
Orange	39.67497	1.97356	146.67449	2.29122	2.22248	0.88960	2.61383
Refugio	0.00143	0.00002	0.00296	0.00006	0.00006	0.00002	0.00016
San Patricio	56.38427	3.08929	222.75310	3.40378	3.30166	1.35717	3.44013
Victoria	9.26840	0.47470	35.25827	0.54943	0.53294	0.21342	0.60597
Willacy	0.03425	0.00085	0.08312	0.00155	0.00150	0.00046	0.00333
Total	290	12.822	986.024	15.854	15.378	5.893	21.304

Table 7-4. 2014 Annual Controlled Criteria Emissions by County for Category 1 and 2 Vessel Underway Activities (tons)

Name	Activity (kWh)	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aransas	99,398,858	414.6090	1,597.0762	24.5712	23.8340	9.6880	26.2863
Brazoria	28,167,646	226.5634	594.9192	10.6987	10.3778	3.4439	20.2849
Calhoun	38,035,532	205.6947	669.0462	10.9387	10.6105	4.0354	14.9850
Cameron	11,145,670	46.4740	179.5990	2.7713	2.6882	1.0912	2.9407
Chambers	3,405,681	34.7493	80.2429	1.5151	1.4697	0.4698	3.1370
Galveston	165,031,048	867.3863	2,858.8402	46.0908	44.7080	16.9654	65.5242
Harris	73,899,558	462.2380	1,383.0830	23.3311	22.6312	8.0517	38.9326
Jefferson	67,375,122	390.3327	1,215.3015	20.0490	19.4475	7.1492	31.4597
Kenedy	44,688,315	175.7509	705.6474	10.7352	10.4131	4.3102	10.4382
Kleberg	384,581	3.8270	8.8507	0.1654	0.1605	0.0520	0.3383
Matagorda	29,516,848	220.9619	601.1631	10.6387	10.3195	3.5272	18.9755
Nueces	26,326,972	131.9359	451.5318	7.2426	7.0254	2.6877	9.8194
Orange	67,133,416	297.9843	1,101.6191	17.2085	16.6923	6.6815	19.6315
Refugio	664	0.0108	0.0222	0.0005	0.0005	0.0001	0.0012

Table 7-4. 2014 Annual Controlled Criteria Emissions by County for Category 1 and 2 Vessel Underway Activities (tons)

Name	Activity (kWh)	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
San Patricio	105,237,744	423.4819	1,673.0180	25.5645	24.7976	10.1932	25.8375
Victoria	16,214,403	69.6116	264.8121	4.1265	4.0027	1.6029	4.5512
Willacy	27,082	0.2573	0.6243	0.0116	0.0113	0.0035	0.0250
Total	430,804,704	2,176.39	7,405.67	119.07	115.50	44.26	160.01

Table 7-5. 2014 Annual Controlled Criteria Emissions by County for Category 3 Vessel In-Port Activities (tons)

Name	Activity(kWh)	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aransas	1,787,430	3.0649	29.8154	1.2184	1.1138	9.5414	1.3960
Brazoria	216,364	0.3514	3.5619	0.1442	0.1318	1.1371	0.1574
Calhoun	63,401	0.1155	1.0739	0.0444	0.0405	0.3446	0.0536
Cameron	28,555	0.0489	0.4761	0.0195	0.0178	0.1524	0.0223
Galveston	7,247,903	11.4658	118.5931	4.7805	4.3698	37.8209	5.0821
Harris	975,648	1.5535	15.9844	0.6452	0.5898	5.0974	0.6936
Jefferson	425,779	0.6929	7.0131	0.2840	0.2596	2.2392	0.3102
Matagorda	121,138	0.2140	2.0357	0.0836	0.0764	0.6523	0.0984
Nueces	241,992	0.3862	3.9677	0.1602	0.1464	1.2658	0.1717
Orange	14,354	0.0254	0.2414	0.0099	0.0091	0.0774	0.0117
San Patricio	88,028	0.1837	1.5469	0.0655	0.0598	0.4995	0.0885
Total	11,210,592.044	18.102	184.310	7.455	6.815	58.828	8.085

Table 7-6. 2014 Annual Controlled Criteria Emissions by County for Category 3 Vessel Underway Activities (tons)

Name	Activity (kWh)	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aransas	9,509,581	16.402	161.156	6.661	6.089	50.858	8.057
Brazoria	5,558,654	10.532	97.941	4.155	3.798	30.585	5.642
Calhoun	3,843,226	6.826	65.210	2.699	2.467	20.734	3.293
Cameron	1,231,716	2.553	22.197	0.956	0.873	6.976	1.379
Galveston	252,967,078	412.249	4,178.500	169.627	155.055	1,331.044	187.544
Harris	76,394,306	145.780	1,338.792	56.604	51.742	421.287	75.882
Jefferson	38,142,957	73.207	667.284	28.185	25.764	210.734	37.669
Matagorda	3,132,462	5.402	52.844	2.177	1.990	16.752	2.596
Nueces	20,672,012	36.435	353.456	14.698	13.435	111.263	18.288
Orange	2,507,643	6.445	49.794	2.267	2.072	15.336	3.953
San Patricio	9,024,396	14.698	149.078	6.052	5.532	47.477	6.694
Total	422,984,032	730.53	7,136.25	294.08	268.82	2,263.04	351.00

Table 7-7. Statewide Annual Controlled Criteria Emissions for Commercial Marine Vessels by Year (tons)

Year	Activity (kWh)	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
2008	2,049,057,049	8,549.63	42,016.13	1,735.50	1,642.92	6,340.14	942.79
2009	1,905,231,821	7,883.91	37,895.12	1,614.37	1,528.23	5,901.99	876.81
2010	1,726,317,162	7,085.34	33,295.73	1,087.69	1,038.51	2,657.38	794.70
2011	1,902,920,155	7,747.17	35,644.21	1,198.81	1,144.61	2,841.53	875.56
2012	1,781,262,976	7,193.76	32,373.82	1,079.68	1,030.25	2,547.74	818.72
2013	1,552,663,079	6,233.43	27,577.41	651.77	615.36	2,435.89	758.59
2014	1,332,361,232	5,323.15	22,785.50	550.43	517.06	2,414.29	695.65
2015	1,331,043,131	5,277.24	21,979.01	386.04	364.95	916.68	681.25
2016	1,362,917,228	5,364.62	21,645.34	314.77	295.53	942.67	688.82
2017	1,386,493,275	5,418.36	20,942.16	295.77	276.92	959.83	687.27
2018	1,423,704,980	5,524.72	20,355.26	278.49	259.87	985.46	691.98
2019	1,452,618,635	5,597.56	19,653.72	283.70	264.75	419.77	690.81
2020	1,489,830,339	5,702.46	19,059.03	213.03	199.66	431.05	694.72
2021	1,546,425,893	5,879.67	18,751.94	220.90	207.05	446.77	704.75
2022	1,611,319,497	6,086.41	18,543.13	230.24	215.79	465.76	719.49
2023	1,667,915,051	6,259.56	18,059.33	238.03	223.11	481.13	728.22
2024	1,729,113,388	6,449.50	17,688.59	247.03	231.54	499.65	740.70
2025	1,790,311,726	6,637.80	17,330.68	256.04	239.96	518.04	752.42
2026	1,826,615,914	6,731.42	16,712.16	260.53	244.20	526.37	749.00
2027	1,863,827,618	6,829.75	16,163.80	265.92	249.25	537.33	749.18
2028	1,892,741,273	6,897.57	15,497.04	269.81	252.91	544.91	744.45
2029	1,917,635,422	6,954.48	14,860.77	274.21	257.00	554.64	742.92
2030	1,934,231,521	6,990.54	14,147.04	276.99	259.78	560.62	737.43
2031	1,992,317,869	7,185.71	13,878.47	287.47	269.32	584.06	753.33
2032	2,058,702,266	7,413.99	13,656.34	299.32	280.33	610.42	773.66
2033	2,116,788,613	7,612.59	13,355.63	309.66	289.93	633.37	789.20
2034	2,174,874,960	7,811.87	13,026.24	319.98	299.52	656.26	804.45
2035	2,241,259,357	8,042.22	12,758.24	331.78	310.49	682.42	823.72
2036	2,324,239,854	8,333.32	12,585.40	346.55	324.21	715.18	851.42
2037	2,398,922,300	8,594.54	12,417.02	359.80	336.52	744.50	876.73
2038	2,481,902,796	8,886.22	12,447.84	374.52	350.20	777.05	907.95
2039	2,564,883,293	9,178.15	12,539.58	389.22	363.85	809.48	939.62
2040	2,647,863,789	9,470.08	12,657.92	403.89	377.48	841.80	972.27

Table 7-8. Comparison of NO_X Emissions and Activity between Previous 2011 Inventory and New Backcasted 2011 Inventory

Category	Annual NO_X Emissions (tons)		Annual Activity (kWh)	
	Previous 2011 Inventory	New Controlled 2011 Inventory	Previous 2011 Inventory	New Controlled 2011 Inventory
Category 1 and 2 Port	106.5	3,206.53	58,723,578	168,493,820
Category 1 and 2 Underway	7,055.73	24,083.08	468,531,767	1,265,496,140
Category 3 Port	8,516.98	210.34	481,242,002	12,107,439
Category 3 Underway	7,083.10	8,144.26	385,166,793	456,822,754
Total	22,762	35,644	1,393,664,139	1,902,920,155

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Appendix A. CMV 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
2008	TERP	Statewide	Reduction by 1,632 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2009	TERP	Statewide	Reduction by 1,688 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	PM$_{2.5}$ reduced by 3 tons this year, VOC reduced by 7 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2010	TERP	Statewide	Reduction by 1,190 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	MARPOL Annex VI - SO$_x$ reduction	North America (excluding Mexico)	1.50% mass/mass (m/m) prior to 1 July 2010	http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx
	MARPOL Annex VI - SO$_x$ reduction	North America (excluding Mexico)	1.00% m/m on and after 1 July 2010	http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	PM$_{2.5}$ reduced by 6 tons this year, VOC reduced by 14 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2011	TERP	Statewide	Reduction by 1,140 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	MARPOL Annex VI - NO$_X$ reduction	North America (excluding Mexico)	Tier II NO$_X$ reductions, ships constructed on or after Jan 1, 2011; $n < 130$: 14.4, $n = 130$-1999: $44 \cdot n^{(-0.23)}$, $n \geq 2000$: 7.7; n = engine's rated speed (rpm), units are g/kWh	http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Nitrogen-oxides-(NOx)-%E2%80%93-Regulation-13.aspx
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	PM$_{2.5}$ reduced by 8 tons this year, VOC reduced by 22 tons this year	http://www.epa.gov/nonroad/420d07001.pdf

Appendix A. CMV 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
2012	TERP	Statewide	Reduction by 850 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 76 tons this year, NO_X reduced by 1,463 tons this year, VOC reduced by 152 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2013	TERP	Statewide	Reduction by 767 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 321 tons this year, NO_X reduced by 4,935 tons this year, VOC reduced by 383 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2014	TERP	Statewide	Reduction by 595 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 776 tons this year, NO_X reduced by 17,326 tons this year, VOC reduced by 837 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2015	TERP	Statewide	Reduction by 428 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	MARPOL Annex VI - SO_x reduction	North America (excluding Mexico)	0.10% m/m on and after 1 January 2015	http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 1,149 tons this year, NO_X reduced by 29,723 tons this year, VOC reduced by 1,290 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2016	TERP	Statewide	Reduction by 296 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf

Appendix A. CMV 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
	MARPOL Annex VI - NO_X reduction	In ECA only (North America excluding Mexico)	Tier III NO_X reductions, ships constructed on or after Jan 1, 2016; $n < 130$: 3.4, $n = 130\text{-}1999$: $9 \cdot n(-0.2)$, $n \geq 2000$: 2.0; n = engine's rated speed (rpm), units are g/kWh	http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Nitrogen-oxides-(NOx)-%E2%80%93-Regulation-13.aspx
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 1,740 tons this year, NO_X reduced by 49,151 tons this year, VOC reduced by 1,848 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2017	TERP	Statewide	Reduction by 249 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 2,469 tons this year, NO_X reduced by 71,006 tons this year, VOC reduced by 2,497 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2018	TERP	Statewide	Reduction by 217 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 3,245 tons this year, NO_X reduced by 94,975 tons this year, VOC reduced by 3,183 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2019	TERP	Statewide	Reduction by 217 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 4,019 tons this year, NO_X reduced by 118,882 tons this year, VOC reduced by 3,867 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2020	TERP	Statewide	Reduction by 33 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf

Appendix A. CMV 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 4,808 tons this year, NO_X reduced by 142,666 tons this year, VOC reduced by 4,545 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2021	TERP	Statewide	Reduction by 33 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 5,644 tons this year, NO_X reduced by 166,339 tons this year, VOC reduced by 5,218 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2022	TERP	Statewide	Reduction by 23 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 6,491 tons this year, NO_X reduced by 189,855 tons this year, VOC reduced by 5,883 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2023	TERP	Statewide	Reduction by 1 ton this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 7,347 tons this year, NO_X reduced by 213,181 tons this year, VOC reduced by 6,539 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2024	TERP	Statewide	Reduction by 1 ton this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 8,210 tons this year, NO_X reduced by 236,257 tons this year, VOC reduced by 7,183 tons this year	http://www.epa.gov/nonroad/420d07001.pdf

Appendix A. CMV 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
2025	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 9,064 tons this year, NO_X reduced by 258,828 tons this year, VOC reduced by 7,794 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2026	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 9,899 tons this year, NO_X reduced by 280,771 tons this year, VOC reduced by 8,360 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2027	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 10,711 tons this year, NO_X reduced by 301,951 tons this year, VOC reduced by 8,880 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2028	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 11,503 tons this year, NO_X reduced by 322,410 tons this year, VOC reduced by 9,360 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2029	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 12,277 tons this year, NO_X reduced by 341,797 tons this year, VOC reduced by 9,811 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2030	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 13,027 tons this year, NO_X reduced by 359,780 tons this year, VOC reduced by 10,225 tons this year	http://www.epa.gov/nonroad/420d07001.pdf

Appendix A. CMV 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
2031	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 13,752 tons this year, NO_X reduced by 376,481 tons this year, VOC reduced by 10,605 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2032	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 14,458 tons this year, NO_X reduced by 392,324 tons this year, VOC reduced by 10,960 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2033	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 15,151 tons this year, NO_X reduced by 407,598 tons this year, VOC reduced by 11,300 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2034	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 15,834 tons this year, NO_X reduced by 422,367 tons this year, VOC reduced by 11,625 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2035	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 16,500 tons this year, NO_X reduced by 436,542 tons this year, VOC reduced by 11,936 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2036	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 17,126 tons this year, NO_X reduced by 449,899 tons this year, VOC reduced by 12,228 tons this year	http://www.epa.gov/nonroad/420d07001.pdf

Appendix A. CMV 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
2037	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 17,686 tons this year, NO_X reduced by 461,578 tons this year, VOC reduced by 12,490 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2038	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 18,198 tons this year, NO_X reduced by 471,739 tons this year, VOC reduced by 12,728 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2039	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 18,664 tons this year, NO_X reduced by 480,787 tons this year, VOC reduced by 12,947 tons this year	http://www.epa.gov/nonroad/420d07001.pdf
2040	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder	Nationwide	$PM_{2.5}$ reduced by 19,063 tons this year, NO_X reduced by 488,838 tons this year, VOC reduced by 13,143 tons this year	http://www.epa.gov/nonroad/420d07001.pdf

APPENDIX 10

2014 TEXAS STATEWIDE LOCOMOTIVE EMISSIONS INVENTORY AND 2008 THROUGH 2040 TREND INVENTORIES

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Eastern Research Group, Inc.

2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories

FINAL

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

August 26, 2015

ERG No. 0345.00.003.005

2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories

TCEQ Contract No. 582-15-50416
Work Order No. 582-15-51538-02-FY2015-11

Prepared for:

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August 26, 2015

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1.0 Introduction

The objective of this Texas Commission on Environmental Quality (TCEQ) project is to develop the 2014 Air Emissions Reporting Requirements (AERR) locomotive emissions inventory (EI) for actual annual and average summer weekday emissions as well as 2008 through 2040 locomotive statewide actual annual and average summer weekday trend emission inventories. Data developed was for all criteria pollutants, ozone precursors, and hazardous air pollutants (HAPs). Eastern Research Group (ERG) developed these inventories and relevant activity data by SCC for all Texas counties, summing emissions to the county level. During project development, activity data for 2014 were not available. Therefore, ERG obtained activity data from 2013 as this represented the most recent available data at the time the project began. ERG collected activity data for calendar year 2013, updated activity factors for future years, and used those factors to develop an actual annual and ozone season weekday locomotive emission inventory for the 2014 AERR submission to the United States Environmental Protection Agency's (EPA) Emissions Inventory System (EIS). ERG also developed trend emissions inventory data for both controlled and uncontrolled criteria emissions for years 2008 to 2040.

These Texas Locomotive Emissions Inventories include Class I, II, and III railroad activity and emissions by rail segment for all counties in the state. This report describes the inventory approach, including initial collection of local data, emission calculations, and spatial allocations used to develop the statewide locomotive inventories.

2.0 Data Collection

A primary objective of the Texas Locomotive Statewide Emissions Inventory was to include rail companies operating in the state of Texas in the inventory effort. To meet this objective, ERG solicited line-haul and yard data from all Class I, II, and III railroad companies operating in Texas. All railroad members listed in the American Short Line and Regional Railroad Association (ASLRRA) as operating in Texas were included, as well as Class I rail companies Union Pacific (UP), Burlington Northern – Santa Fe (BNSF), and Kansas City Southern (KCS). Additional input was requested from the Texas Department of Transportation and the Texas Transportation Institute (ASLRRA 2011). Approximately 47 different contacts were identified and ERG contacted the organizations via phone and email to solicit quantitative and/or qualitative data.

Table 2-1 identifies the contacts and summarizes the responses received from this outreach effort. The remainder of this section describes the data received.

Table 2-1. Summary of Data Solicitation Effort

Agency/Company Name	Contact Name	Contact Phone	Response
Alamo Gulf Coast Railroad	---	(210) 208-4417	No Response
Alliance Terminal Railroad	Tine Nelson, General Manager, Operations	(817) 224-7152	No Response
Angelina & Neches River Railroad Co.	Laura Ricks, Information Systems	(936) 634-4403	No Response
Austin Western Railroad	---	(512) 246-0738	Received
Blacklands Railroad	Walt Defebaugh, President	(903) 439-0738	No Response
Border Pacific Railroad Co.	---	(956) 487-5606	No Response
Brownsville & Rio Grande Int'l Railroad	Norma Porres	(956) 831-7731	No Response
Burlington Northern Santa Fe	Mike Clift, and Laura Fiffick	(800) 795-2673	No Response
Corpus Christi Terminal Railroad	Brent Azzo	(904) 223-1110	No Response
Dallas, Garland & Northeastern Railroad	---	(972) 808-9800	No Response
Fort Worth & Western Railroad	Bill Parker	(817) 222-9798, x 102	No Response
Galveston Railroad, L. P.	Brent Azzo	(904) 223-1110	No Response
Gardendale Railroad, Inc.	Greg Wheeler	(618) 632-4400	No Response
Georgetown Railroad Company	---	(512) 869-1542	No Response
Kansas City Southern	Kevin McIntosh (Government Relations)	(816) 983-1987	Received

Table 2-1. Summary of Data Solicitation Effort

Agency/Company Name	**Contact Name**	**Contact Phone**	**Response**
	Janet Sommerhauser (Environment)	(816) 983-1603	No Response
Kiamichi Railroad Co.	Seth Rutz, GM	(580) 916-7601	No Response
Moscow, Camden & San Augustine Railroad	---	(404) 652-4000	No Response
Panhandle Northern Railroad, LLC	---	(806) 273-3513	No Response
Pecos Valley Southern Railway Co.	Billy Edwards, Operations Mgr	(432) 445-2487	Received
Plainsman Switching Co., Inc.	---	(806) 744-0118	No Response
Point Comfort & Northern Railway Co.	Brent Azzo	(912) 964-5337	No Response
Port Terminal Railroad Association	---	(713) 393-6500	No Response
Rio Valley Switching Company	Greg Wheeler	(956) 971-9111 ext. 117	No Response
Rockdale, Sandow & Southern Railroad Co.	Brent Azzo	(912) 964-5337	No Response
Sabine River & Northern Railroad	David Clark	(409) 670-6751	No Response
San Antonio Central Railroad	Larry Jensen	(620) 231-2230	Received
South Plains Lamesa Railroad Ltd.	Shad Wisener	(806) 828-4841	Received
Southern Switching Company	Greg Wheeler	(325) 677-3601	No Response
Temple & Central Texas Railway, Inc.	---	(254) 778-8300	No Response
Texas & Northern Railway Co.	Tracy Larson Edwards	(903) 656-6762	Received
Texas Central Business Lines	---	(972) 775-1853	No Response
Texas DOT – Rail	Jackie Ploch	(512) 416-2621	Received
Texas DOT - Environmental Affairs	Air Quality contact	(512) 416-2691	No Response
Texas Gonzales & Northern Railway Co.	---	(830) 540-3788	No Response
Texas - New Mexico Railroad Co., Inc.	---	(806) 221-3150	No Response
Texas North Western Railway Co.	---	(972) 386-0117	No Response
Texas Northeastern Railroad	Dave Geraci	(817) 527-4913	No Response

Table 2-1. Summary of Data Solicitation Effort

Agency/Company Name	Contact Name	Contact Phone	Response
Texas Pacifico Transportation Company Ltd.	Jorge Gonzalez Chozas, VP Operations	(325) 277-3102	No Response
Texas Rock Crusher Railway Co.	Andy Scheriger	(325) 643-5105	No Response
Texas South-Eastern Railroad Co.	---	(859) 881-6588	No Response
Texas Transportation Institute	Les Olson	(979) 862-2846	No Response
Timber Rock Railroad	---	(409) 385-6611	Received
Union Pacific	Jon Germer	(402) 544-2235	Received
West Texas & Lubbock Railway	---	(806) 785-8668; (806) 221-3150 (operating office)	No Response
Western Rail Road Company	Frank Caballero	(830) 625-8084	No Response
Wichita, Tillman & Jackson Railway Co.	Martin Cicalla	(940) 723-1852	No Response

2.1 Union Pacific

Union Pacific (UP) is one of the largest Class I rail companies operating in Texas with over 6,300 miles of track and more than 7,700 employees in Texas alone. In response to ERG’s data solicitation, UP provided a 15-page document that contained line-haul and yard data for all activities in Texas for the year 2013. Line-haul mileage, annual average million gross tons (MGT) per mile, fuel usage, train counts, and emission estimates for hydrocarbon (HC), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM) were provided by county and track segment. The emission estimates were calculated using current EPA emission factors, and the fuel usage was calculated based on the system-wide average fuel consumption rate for 2013. Yard data were provided by county for 211 “yard job equivalents,” which equates to one switch locomotive operating 24 hours a day. The activity data were then provided in terms of estimated annual fuel use in gallons, based on an EPA activity factor of 226 gallons per day (gal/day) of operation.

2.2 Kansas City Southern

KCS provided 2013 fuel usage, gross ton miles, and maps for 13 distinct routes (e.g., Port Arthur to Beaumont, Houston to Beaumont, Corpus Christi to Robstown, etc.) They also provided number of engines and gallons of fuel pumped at each of the seven yard locations in Texas.

2.3 Texas & Northern Railway

Texas & Northern Railway provided information on a single yard location in Lone Star. The data included coordinate locations, annual fuel use, annual hours of operation, and number of engines for 2013.

2.4 South Plains Lamesa Railroad

South Plains Lamesa Railroad provided information on Slaton yard in Lubbock County. Data included coordinates, annual fuel use, annual hours of operation, and number of engines.

2.5 Watco Companies

Watco Companies provided information on Austin Western, Timber Rock, San Antonio Central, and Pecos Valley Railroads. Data included engine counts, average daily hours of use, and headquarter locations.

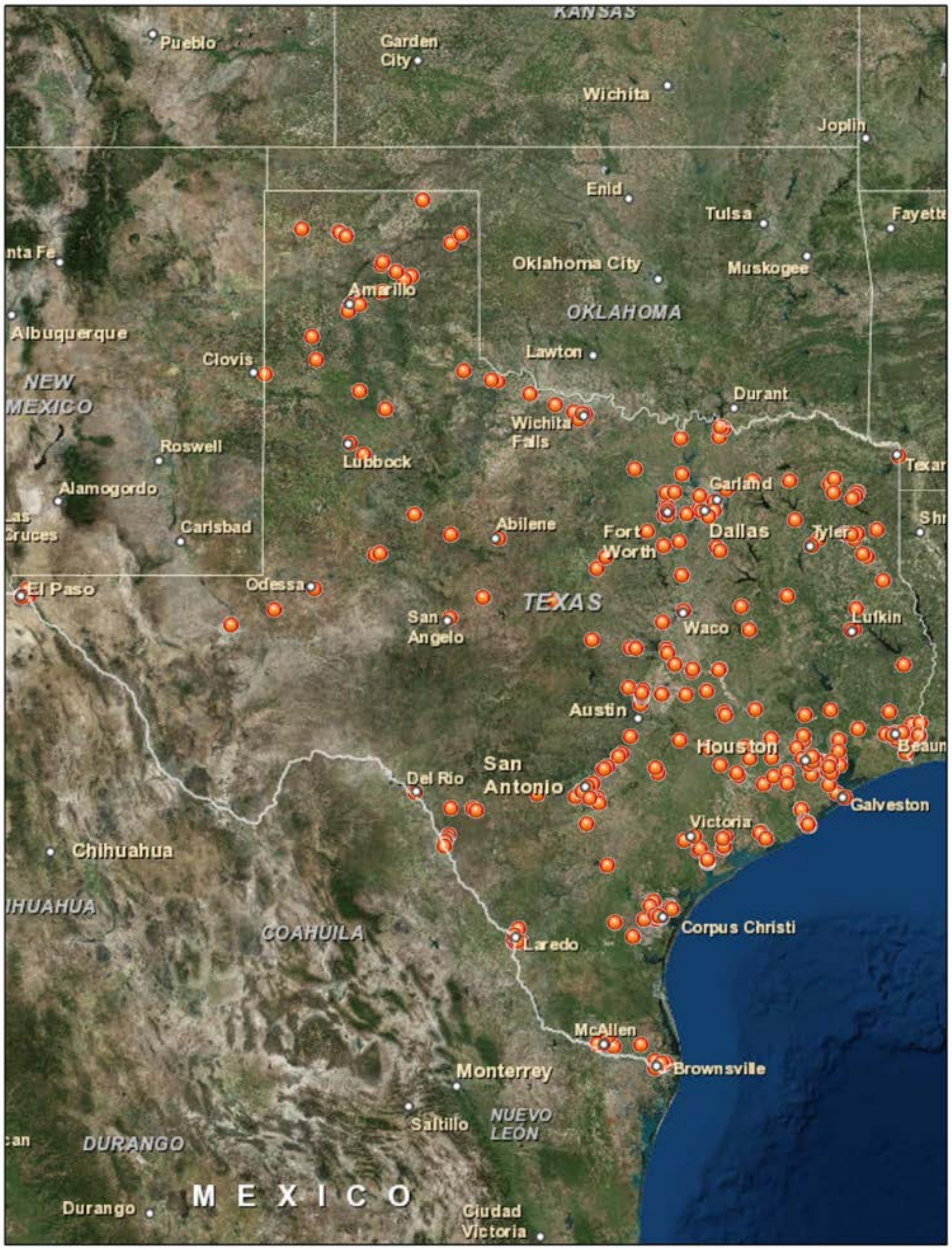
2.6 Switch Yard Locations

Switch yards have historically been under-represented in inventory efforts due to the lack of available data and low response to data requests. Because identifying more yard locations and estimating emissions that were not included in previous inventories was a priority in this project, ERG examined switch yard data carefully.

ERG reviewed previously identified yard locations against rail networks from the Bureau of Transportation Statistics (BTS) and the Texas Natural Resources Information System as well as satellite imagery via Google Earth. Two yards were removed due to lack of substantiation from these related data layers, and some yard coordinates were shifted slightly to better match the network and/or imagery data. The statewide rail networks and satellite imagery were also reviewed systematically to identify potential new yards. Potential new yards were identified as areas with several rail segments parallel to each other and located off of the main tracks according to either rail network. In many cases, these yards also had visible train activity in satellite imagery or collocated support equipment or trucking facilities. These potential yard locations were reviewed by several staff members, and those that seemed questionable were removed.

ERG also researched potential and future yards online via websites from transportation departments, trade associations, railroad company websites, as well as industry trends sites as listed in Appendix A. The 334 switch yards identified in Texas for this inventory are shown in Figure 2-1 and listed in Appendix B. This is approximately triple the number of yards identified in 2011, including many very small switch yards.

Figure 2-1. Class I, II, and III Rail Yard Locations in Texas



3.0 Processing of Local Data

3.1 Line-Haul Data

3.1.1 Union Pacific Railroad Data Processing

ERG converted UP's pdf data to text using Adobe Acrobat and then imported the data into Microsoft Excel. Line-haul fuel use and emissions data were summarized at the county level and hydrocarbon (HC) emissions were converted to VOC using a VOC/HC conversion ratio of 1.053. NO_x emissions were estimated using the fuel-based emission factors and methodology described in Section 4.

3.1.2 Kansas City Southern Railroad

KCS provided 2013 fuel usage, gross ton-miles, and maps for several distinct routes (e.g., Port Arthur to Beaumont, Houston to Beaumont, Corpus Christi to Robstown, etc.). ERG compared these maps against rail segment maps in a geographic information system (GIS) to identify the EIS shapes affiliated with each route. Total route fuel usage was divided among the segments in that route based on segment length, and emissions were calculated using segment-level fuel usage. The route from Ashdown, AR to Shreveport, LA was not processed because it is outside of Texas boundaries.

3.1.3 Burlington Northern Santa Fe

BNSF did not provide updated data for 2013; however, they did respond to a previous data request for the 2011 inventory effort. To maximize use of locally-provided data, this 2011 county-level fuel usage was extrapolated to 2013 using a growth factor derived from their R-1 data as described in Section 6. The 2013 emission factors were used to recalculate 2013 emissions as described in Section 4.

3.1.4 Class II and Class III Line-Haul Data

No Class II or III Railroad companies provided line-haul data. As a result, ERG used other locally-based data sources to estimate 2014 activity levels. The Eastern Regional Technical Advisory Committee (ERTAC) previously collaborated with the Federal Railroad Administration (FRA), the ASLRRA, and members of the Class II and III Railroad communities to develop activity and emissions profiles for Class II and Class III railroads for 2008 (Bergin et. al, 2009). The ASLRRA compiles data from the Class II and III railroads every few years, including total industry fuel use for locomotives and total Class II/III route miles. Unfortunately, at this time there are no newer data, so the 2008 activity data were grown to represent 2013 activity. ERG used the U.S. Energy Information Administration's (EIA) latest Annual Energy Outlook (AEO) to estimate the fuel usage growth by year and applied this growth rate directly to the fuel usage data before applying emission factors as further described in Section 6.

3.2 Switch Yard Data

The final yard list includes 42 UP yards, 42 BNSF yards, 12 KCS yards, 8 Class II/III yards, and an additional 230 small yards identified by ERG for a total of 334 yards. For the 230 yards that did not include fuel use or any other data, ERG developed appropriate surrogates using statewide fuel usage data to fill in the gaps in activity data, which is explained in more detail in Section 6.2. Most respondents provided fuel usage data such that emissions were calculated directly using emission factors in grams/gallon as described in Section 4.0. However, for certain yards, direct fuel usage data were not provided. For these yards, additional steps were required to calculate emissions. For example, BNSF's previous yard work included emissions but not fuel use. Without supporting data on the activity or emission factors used to develop BNSF's 2011 emissions data, ERG projected the emissions to 2013 (using growth factors in Section 5.0) and then divided the emissions by 2013 emission factors in grams per gallon (g/gal) to estimate fuel use in gallons. Watco provided engine count and daily hours of operation. To calculate fuel usage, ERG first calculated an average Class II/III fuel usage rate from data provided by Class II/III railroad companies in Texas to get an average value of 10.05 gallons per hour (gal/hr). ERG also used local Class I data to determine that the average railroad company uses 5.39% of their total fuel for switch operations. Assuming that the engines work 365 days per year, the total fuel use was calculated by yard using the following equation:

$$SG = L * DH * 365 \text{ days per year} * FR * S$$

Where

SG = total annual fuel use (gal)
L = number of locomotives
DH = daily hours of use (hr)
FR = fuel usage rate (gal/hr) = 10.05 gal/hr
S = portion of total fuel that is used in switch operations

Example:

Austin Western Railroad has 13 locomotives with an average daily use of 12 hours each.

$$SG = 13 * 12 \text{ hr/day} * 365 \text{ days/yr} * 10.05 \text{ gal/hr} * 0.0539$$
$$\text{Switch (gal)} = 30{,}844$$

For yard locations that were identified during our searches but did not match any of the locally-submitted data, a more general approach to activity and emissions estimates was needed. First, because ERG received relatively comprehensive data submittals from the Class I rail lines in the past, we assumed that these other switch yards were likely related to small Class II and III rail lines. Per the 2011 TCEQ Locomotive inventory and current GIS calculations, there are 2,247.66 miles of Class II and III rail lines in Texas. Using a Class II/III fuel use factor of 2,797.74 gallons per mile obtained from the ASLRR, ERG calculated the total Class II/III fuel use as follows:

$$2{,}247.66 \text{ mi} * 2{,}797.74 \text{ gal/mi} = 6{,}288{,}368 \text{ gallons of fuel}$$

Using the previously defined value of 5.39% of total fuel being consumed by switch operations, ERG estimated a statewide switch fuel use of 338,850 gallons for Class II/III yards. Because we had total fuel estimates from six small line-haul companies, we estimated their switch fuel use as 5.39% of the total and subtracted this “known” fuel use from the statewide total to avoid double-counting. The result was a statewide total of 262,509 gallons for Class II/III switch operations. Given there are 230 Class II/III yards, this fuel usage data equates to roughly 1,141 gallons of fuel per year per yard. This value equates to about 120 operating hours a year or only a couple of hours a week at each of these switching yards.

4.0 Projection Factors

Because activity data were requested for only 2013, projection factors were required to backcast and forecast activity data from 2008 to 2040 using 2013 as the baseline. ERG obtained data for UP, BNSF, and KCS from the Federal Railroad Administration’s Complete Class I Railroad Annual Reports (R-1) for years 2008 through 2013. By creating a ratio of annual fuel use in gallons, we calculated company-specific percent change values that we could use to adjust provided 2013 (UP and KCS) and 2011 (BNSF) data to backcasted 2008 activity levels. For clarification, BNSF did not provide new data for 2013. For Class II and III lines and for forecasted years for all companies, actual fuel use is not available, requiring a different approach. ERG used EIA Annual AEO for year 2013 (EIA 2014) as the baseline year to backcast activity to 2008 and to forecast (project) future activity levels through 2040. The AEO provides detailed annual projections in billion ton miles traveled through year 2040. These future projections show little to no growth in rail industry over the time period of interest. ERG verified the trend data in EIA AOE using the historic and projected data published by the Association of American Railroads (AAR 2014) and the U.S. Bureau of Transportation Statistics (BTS 2000).

ERG matched the projected activity to the appropriate future year emission factors provided in Table 4-1. The AEO-based growth factors account for implementation of federal rules that occur relative to the year that the locomotive engine was originally manufactured, such that the full benefit of the rule would occur in the future once fleet turnover was completed. The future year growth factors are listed in Table 4-1.

Table 4-1. AEO-based Growth Factors for Locomotive Activities

Year	Change from Baseline 2013
2008	1.049779
2009	0.865324
2010	0.946688
2011	0.997538
2012	0.976263
2013	1.000000
2014	1.021700
2015	1.024969
2016	0.988173
2017	1.023056
2018	1.048018
2019	1.059861
2020	1.067704
2021	1.080196
2022	1.095967
2023	1.107803
2024	1.116998
2025	1.131407
2026	1.130049
2027	1.137960
2028	1.132725
2029	1.137936
2030	1.142487
2031	1.139860
2032	1.145787
2033	1.141891
2034	1.137895
2035	1.141877
2036	1.149071
2037	1.137236
2038	1.139851
2039	1.138484
2040	1.141102

ERG also investigated whether the recent reduction in gasoline prices would change oil and gas activity in the United States and Texas in future years. However, given that this change in price occurred recently, no studies addressing this issue were found. Final activity estimates can be seen in Table 4-2.

Table 4-2. Statewide Fuel Usage Estimates by Year and SCC

Year	Activity, Fuel Usage (Gal)			
	Class I Line Haul	**Class II/III Line Haul**	**Yard**	**Total**
2008	357,651,785	7,652,815	24,110,683	389,415,283
2009	295,363,674	6,308,149	18,891,328	320,563,151
2010	316,322,957	6,901,293	21,025,872	344,250,122
2011	330,341,464	7,271,985	22,685,182	360,298,630
2012	325,870,637	7,116,888	21,999,022	354,986,546
2013	331,114,086	7,289,931	22,938,782	361,342,800
2014	338,299,262	7,448,123	23,436,554	369,183,938
2015	339,381,820	7,471,956	23,511,551	370,365,327
2016	327,198,012	7,203,713	22,667,486	357,069,212
2017	338,748,102	7,458,004	23,467,649	369,673,755
2018	347,013,556	7,639,980	24,040,259	378,693,795
2019	350,934,809	7,726,311	24,311,914	382,973,034
2020	353,531,726	7,783,486	24,491,822	385,807,035
2021	357,668,048	7,874,553	24,778,377	390,320,977
2022	362,890,001	7,989,521	25,140,141	396,019,663
2023	366,809,213	8,075,808	25,411,654	400,296,676
2024	369,853,730	8,142,837	25,622,571	403,619,138
2025	374,624,843	8,247,880	25,953,102	408,825,825
2026	374,175,293	8,237,983	25,921,959	408,335,234
2027	376,794,520	8,295,648	26,103,412	411,193,581
2028	375,061,265	8,257,488	25,983,337	409,302,090
2029	376,786,547	8,295,473	26,102,860	411,184,880
2030	378,293,693	8,328,655	26,207,271	412,829,619
2031	377,423,618	8,309,499	26,146,995	411,880,111
2032	379,386,221	8,352,708	26,282,959	414,021,888
2033	378,096,307	8,324,309	26,193,597	412,614,213
2034	376,772,970	8,295,174	26,101,919	411,170,064
2035	378,091,676	8,324,207	26,193,276	412,609,159
2036	380,473,653	8,376,650	26,358,294	415,208,597
2037	376,554,775	8,290,370	26,086,803	410,931,948
2038	377,420,851	8,309,438	26,146,803	411,877,092
2039	376,967,946	8,299,467	26,115,427	411,382,839
2040	377,834,972	8,318,555	26,175,492	412,329,020

5.0 Emission Factors

With fuel usage estimates established for all activity data, ERG could apply fuel-based emission factors to estimate emissions. ERG compiled emission factors for Class I and Class II/III line-haul and yard locomotives from various references. This section provides the source documents and calculations involved in identifying emission factors for the listed pollutants.

The EPA Technical Highlights publication, “Emission Factors for Locomotives” (EPA 2009) provides emission factors on a gram per brake horsepower-hour (g/bhp-hr) basis and then converts them to a grams per gallon basis with a factor based on the usable power of the locomotive engine. The conversion requires a factor of 20.8 bhp-hr/gal for large line-haul locomotives, 18.2 bhp-hr/gal for small line-haul locomotives, and 15.2 bhp-hr/gal for yard locomotives. The g/gal emission factors can also be converted to an energy basis for use if the heating value of diesel fuel is known. The conversion to grams emitted per ton-mile of freight hauled (g/ton-mile) is calculated based on data collected by the Association of American Railroads for revenue ton-miles and fuel consumption, which shows approximately one gallon of diesel fuel hauls 400 ton-miles of freight.

5.1 Criteria Pollutants by Locomotive Type

The 2009 EPA Technical Highlights publication includes emission rates for many criteria pollutants including particulate matter ($PM_{2.5}$ and PM_{10}), ammonia, methane, hydrocarbons (HC), and nitrogen oxide (NO_X) among others for line-haul and yard locomotives in g/bhp-hr. ERG converted these emission rates to g/gal by locomotive type. These emission factors were used to develop the uncontrolled emissions inventory. The 2009 EPA Technical Highlights publication also lists expected fleet average emission factors by calendar year and locomotive type, which are listed in Section 4.4.

ERG applied conversion factors to develop the emission factors as needed. Volatile organic compounds (VOC) emissions are estimated to be 1.053 times the HC emissions provided (EPA, 2009). The VOC factor is larger than the HC factor due to slight differences in definitions as well as the fact the VOC factor is actually calculated off of the total organic gas (TOG). Table 4-1 shows the uncontrolled emission factors in g/gal for the criteria pollutants that were used to develop uncontrolled emission estimates for all inventory years.

Table 5-1. Uncontrolled Emission Factors from 2009 EPA Technical Highlights Publication(g/gal)*

Pollutant	Uncontrolled Emission Factors (g/gal)		
	Class I Line Haul	Class II/III Line Haul	Switch
PM_{10}	6.7	5.8	6.7
$PM_{2.5}$	6.5	5.6	6.5
VOC	10.5	9.2	16.2
NO_X	270.4	236.6	264.5
CO	26.6	23.3	27.8
Black Carbon	4.8	4.2	4.9
CH_4	0.8	0.8	0.8
N_2O	0.26	0.26	0.26
NH_3	0.083	0.083	0.083
CO_2	10,217	10,217	10,217
SO_2	0.094	0.094	0.094

* EPA 2009

5.2 Controlled Criteria Emissions by Year

The 2009 EPA Technical Highlights publication (EPA 2009) lists expected fleet average emission factors that account for fleet turnover by calendar year and locomotive type. ERG included these emission factors for large line-haul, small line-haul, and large yard for the various inventories. Tables 5-2 through Table 5-5 list the emission factors by year from 2008 to 2040 for criteria emissions. The emission factors are in g/gal and are desegregated by large Class I line-haul, small Class II/III line-haul, and switch yards. Table 5-2 lists the emission factors that do not change over time. The one minor exception is SO_2 which changed due to transitions to cleaner locomotive diesel fuel. Tables 5-3 to 5-5 lists emission factors by SCC and by year which change based on EPA's expected control technology adoption rate.

The conversion factors listed in Section 5.1 apply for VOC. Additional adjustments were made to future year emission estimates to account for compliance with emission control area sulfur standards and Texas Emissions Reduction Plan (TERP) investments. The TERP program provides grants to eligible businesses to reduce emissions from polluting vehicles and equipment. For rail applications, this typically involves repowering or replacing switch engines. A complete list of control programs addressed in this inventory is presented in Appendix B. As BNSF, KCS, and UP provided data for Texas inventory use, the TERP reductions were already included in their estimates. The remaining TERP projects were for smaller Class II and III rail lines. ERG used the TERP project data to sum the NO_X reductions over time for each project and then summed by year to get total annual tons of NO_X avoided due to TERP projects. The NO_X tonnage was then added to the uncontrolled inventory to correctly account for the increased emissions that would be present were it not for the TERP projects.

For the controlled emissions, ERG also applied reductions related to the Texas Low Emission Diesel Program (TxLED). The TxLED Program is implemented to reduce emissions of nitrogen oxides from diesel-powered motor vehicles and non-road equipment and involves a 6.2% NO_X reduction in the 110 central and eastern counties that are impacted by this regulation, which include all of the counties in the following ozone nonattainment areas: Houston-Galveston-Brazoria, Beaumont-Port Arthur, and Dallas-Fort Worth.

Once the criteria emissions were finalized, HAP emissions were speciated off of VOC and PM emissions using the fractions from the EPA's 2011 National Emissions Inventory (NEI) (EPA 2013) and listed in Table 5-6

Table 5-2. Controlled Emission Factors for all years by Locomotive Type (g/gal)

Pollutant	**Controlled Emission Factors (g/gal)**		
	Class I Line Haul SCC 2285002006	**Class II/III Line Haul SCC 228502010**	**Switch SCC 2285002007**
CO	26.6	27.8	23.3
CO_2	10,217	10,217	10,217
CH_4	0.8	0.8	0.8
N_2O	0.26	0.26	0.26
NH_3	0.083	0.083	0.083
SO_2 (2008-2011)	1.88	1.88	1.88
SO_2 (2012-2040)	0.094	0.094	0.094

* EPA 2009

Table 5-3. Class I Line Haul Controlled Emission Factors by Year (g/gal)

Calendar Year	Class I Line Haul (SCC 228502006)				
	NO_X	PM_{10}	$PM_{2.5}$	Black Carbon	VOC
2008	169	5.1	4.95	3.71	9.48
2009	165	4.9	4.75	3.56	9.16
2010	157	4.7	4.56	3.42	8.74
2011	149	4.4	4.27	3.20	8.11
2012	144	4.1	3.98	2.98	7.48
2013	139	3.8	3.69	2.76	6.84
2014	135	3.6	3.49	2.62	6.42
2015	129	3.4	3.30	2.47	6.00
2016	121	3.1	3.01	2.26	5.37
2017	114	2.9	2.81	2.11	4.84
2018	108	2.7	2.62	1.96	4.42
2019	103	2.5	2.43	1.82	4.11
2020	99	2.3	2.23	1.67	3.79
2021	94	2.2	2.13	1.60	3.58
2022	89	2.0	1.94	1.46	3.37
2023	84	1.9	1.84	1.38	3.16
2024	79	1.7	1.65	1.24	2.95
2025	74	1.6	1.55	1.16	2.74
2026	69	1.5	1.46	1.09	2.63
2027	65	1.4	1.36	1.02	2.42
2028	61	1.3	1.26	0.95	2.21
2029	57	1.1	1.07	0.80	2.11
2030	53	1.0	0.97	0.73	2.00
2031	49	1.0	0.97	0.73	1.79
2032	46	0.9	0.87	0.65	1.68
2033	43	0.8	0.78	0.58	1.58
2034	40	0.7	0.68	0.51	1.47
2035	37	0.7	0.68	0.51	1.37
2036	35	0.6	0.58	0.44	1.26
2037	33	0.6	0.58	0.44	1.26
2038	31	0.5	0.49	0.36	1.16
2039	29	0.5	0.49	0.36	1.16
2040	28	0.4	0.39	0.29	1.05

* EPA 2009

Table 5-4. Class II/III Line Haul Controlled Emission Factors by Year (g/gal)

Calendar Year	**Class II/III Line Haul (SCC 228502010)**				
	NO$_X$	**PM$_{10}$**	**PM$_{2.5}$**	**Black Carbon**	**VOC**
2008	242	5.7	5.53	4.15	12.32
2009	242	5.7	5.53	4.15	12.32
2010	242	5.7	5.53	4.15	12.32
2011	242	5.7	5.53	4.15	12.32
2012	242	5.7	5.53	4.15	12.32
2013	242	5.6	5.43	4.07	12.32
2014	242	5.6	5.43	4.07	12.32
2015	240	5.5	5.34	4.00	12.32
2016	239	5.5	5.34	4.00	12.32
2017	237	5.4	5.24	3.93	12.32
2018	236	5.4	5.24	3.93	12.32
2019	233	5.4	5.24	3.93	12.32
2020	231	5.3	5.14	3.86	12.32
2021	228	5.3	5.14	3.86	12.32
2022	225	5.3	5.14	3.86	12.32
2023	223	5.2	5.04	3.78	12.32
2024	220	5.2	5.04	3.78	12.32
2025	217	5.1	4.95	3.71	12.32
2026	215	5.1	4.95	3.71	12.32
2027	212	5.1	4.95	3.71	12.32
2028	209	5.0	4.85	3.64	12.32
2029	206	5.0	4.85	3.64	12.32
2030	203	4.9	4.75	3.56	12.32
2031	200	4.8	4.66	3.49	12.32
2032	197	4.8	4.66	3.49	12.32
2033	193	4.7	4.56	3.42	12.32
2034	190	4.6	4.46	3.35	12.32
2035	187	4.6	4.46	3.35	12.32
2036	184	4.5	4.37	3.27	12.32
2037	180	4.4	4.27	3.20	12.32
2038	177	4.4	4.27	3.20	12.32
2039	174	4.3	4.17	3.13	12.32
2040	171	4.2	4.07	3.06	12.32

* EPA 2009

Table 5-5. Switch Yard Locomotive Controlled Emission Factors by Year (g/gal)

Calendar Year	Switch (SCC 2285002007)				
	NO$_X$	PM$_{10}$	PM$_{2.5}$	Black Carbon	VOC
2006	250	6.5	6.31	4.73	15.80
2007	249	6.5	6.31	4.73	15.80
2008	243	5.5	5.34	4.00	15.27
2009	241	5.5	5.34	4.00	15.27
2010	236	5.4	5.24	3.93	14.85
2011	235	5.3	5.14	3.86	14.74
2012	227	5.1	4.95	3.71	14.00
2013	225	5.0	4.85	3.64	14.00
2014	217	4.8	4.66	3.49	13.37
2015	215	4.8	4.66	3.49	13.27
2016	208	4.6	4.46	3.35	12.64
2017	206	4.5	4.37	3.27	12.43
2018	202	4.4	4.27	3.20	12.11
2019	200	4.4	4.27	3.20	12.00
2020	187	4.1	3.98	2.98	11.06
2021	185	4.0	3.88	2.91	10.95
2022	177	3.9	3.78	2.84	10.32
2023	172	3.7	3.59	2.69	10.00
2024	162	3.5	3.40	2.55	9.37
2025	150	3.2	3.10	2.33	8.42
2026	144	3.1	3.01	2.26	8.00
2027	138	3.0	2.91	2.18	7.69
2028	132	2.8	2.72	2.04	7.27
2029	126	2.7	2.62	1.96	6.84
2030	119	2.5	2.43	1.82	6.53
2031	112	2.4	2.33	1.75	6.11
2032	105	2.2	2.13	1.60	5.79
2033	98	2.1	2.04	1.53	5.37
2034	91	1.9	1.84	1.38	4.95
2035	84	1.7	1.65	1.24	4.63
2036	77	1.6	1.55	1.16	4.21
2037	71	1.5	1.46	1.09	3.90
2038	67	1.4	1.36	1.02	3.79
2039	63	1.3	1.26	0.95	3.58
2040	60	1.2	1.16	0.87	3.37

* EPA 2009

Table 5-6. Hazardous Air Pollutant Speciation Profile for Locomotive Activities

Pollutant Code	Pollutant Name	Fraction	Speciation Base
106990	1,3 Butadiene	6.146E-05	PM_{10}
540841	2-2-4 Trimethylpentane	2.243E-03	VOC
83329	Acenaphthene	7.999E-06	PM_{10}
208968	Acenaphthylene	2.182E-04	PM_{10}
75070	Acetaldehyde	4.492E-04	PM_{10}
107028	Acrolein	8.547E-05	PM_{10}
120127	Anthracene	5.350E-05	PM_{10}
7440382	Arsenic	3.570E-07	PM_{10}
71432	Benzene	5.173E-05	PM_{10}
56553	Benzo(a)anthracene	1.211E-05	PM_{10}
50328	Benzo(a)pyrene	4.368E-06	PM_{10}
205992	Benzo(b)fluoranthene	4.368E-06	PM_{10}
191242	Benzo(ghi)perylene	4.368E-06	PM_{10}
207089	Benzo(k)fluoranthene	4.368E-06	PM_{10}
7440417	Beryllium	2.802E-05	PM_{10}
7440439	Cadium	2.802E-05	PM_{10}
18540299	Chromium (VI)	3.400E-08	PM_{10}
218019	Chrysene	9.235E-06	PM_{10}
100414	Ethylbenzene	2.000E-03	VOC
206440	Fluoranthene	6.009E-05	PM_{10}
86737	Fluorene	6.188E-05	PM_{10}
50000	Formaldehyde	9.451E-04	PM_{10}
193395	Indeno(1,2,3-cd)pyrene	3.297E-06	PM_{10}
7439921	Lead	8.405E-05	PM_{10}
7439965	Manganese	2.040E-06	PM_{10}
7439976	Mercury	2.802E-05	PM_{10}
91203	Napthalene	1.851E-03	PM_{10}
110543	n-Hexane	5.500E-03	VOC
7440020	Nickel	6.550E-06	PM_{10}
85018	Phenanthrene	2.822E-04	PM_{10}
123386	Propionaldehyde	6.100E-03	VOC
129000	Pyrene	7.713E-05	PM_{10}
100425	Styrene	2.100E-03	VOC

Table 5-6. Hazardous Air Pollutant Speciation Profile for Locomotive Activities

Pollutant Code	Pollutant Name	Fraction	Speciation Base
108883	Toluene	3.200E-03	VOC
16065831	Trivalent chromium	6.600E-08	PM_{10}
1330207	Xylene	4.800E-03	VOC

6.0 Allocation of Class I Line-Haul Emissions

To facilitate processing and to protect confidential business information (CBI), ERG aggregated line-haul rail activity and emissions to the county level and then reallocated the activity and emissions back to rail segments within each county to meet format requirements of the NEI. This was necessary because railroad track identification information was limited to mile markers and segment IDs that are specific to individual rail lines' networks and do not relate to any publicly available railway networks to allow for accurate spatial mapping of rail activities. ERG allocated Class I line-haul emissions to rail segments based on segment-specific railroad traffic data (ton miles) obtained from the Department of Transportation (BTS, 2009). The BTS dataset categorizes the segments' level of activity into ranges of million gross ton miles (MGTM) and was populated by the Federal Railroad Administration (FRA). ERG divided emissions between all mainline segments using these activity ranges as a proxy to allocate more emissions to segments with higher Class I activity.

ERG reallocated the county emission sums to the segments by multiplying the county emissions by the segment's allocation value divided by the sum of the allocation values for all links within the county as follows:

$$E_{iL} = E_{iC} * \frac{A_L}{\sum_{C=1}^{N} A_{LC}}$$

Where:

E_{iL} = emissions of pollutant i per link L (tons/year).
E_{iC} = emissions of pollutant i per county C (tons/year).
A_L = allocation value for link L per activity category from public BTS dataset.
A_{LC} = sum of allocation values for all links in county C from public BTS dataset.

The spatial inventory was developed from confidential data from FRA very similar to the publically-available BTS rail dataset, so segment IDs were generally consistent with those used in EIS, thus facilitating later data processing.

6.1 Class II/III Line-Haul Emissions Allocation

The ERTAC Rail paper (Bergin 2011) extracted links that were identified as owned or operated by specific Shortline or Regional Railroads from the FRA-provided proprietary shapefile to create a shapefile of Class II/III mainline rail segments. Because Class II/III railroads are less likely to use rail segments that are heavily traveled by Class I railroads, the activity-based approach used for Class I lines is not appropriate for small line-haul rail activities. Instead, Class II/III line-haul emissions were allocated to rail segments using segment length as a proxy.

The county emission sums were reallocated to the segments by multiplying the county emissions by the segment's length divided by the sum of the length for all links within the county as follows:

$$E_{iL} = E_{iC} * \frac{l_L}{\sum_{C=1}^{N} l_{LC}}$$

Where:

E_{iL} = emissions of pollutant i per link L (tons/year)
E_{iC} = emissions of pollutant i per county C (tons/year)
l_L = allocation value for link L per activity category from public BTS dataset
l_{LC} = sum of allocation values for all links in county C from public BTS dataset

6.2 Class Yard Emissions Allocation

The yard activity/emissions data received were specific to individual yard locations, therefore, no further spatial allocation was needed. For yards which ERG had no locally provided data, ERG divided the statewide yard fuel use (minus the fuel usage provided by yards to remove double counting) equally among the 230 yard locations as described in Section 3-2.

7.0 Results

Some results of implementing the emission estimation methodology and emission projection procedures are presented in Table 7-1 through Table 7-3. Table 7-1 lists controlled emissions sums for criteria pollutants by county for all counties in which Locomotive activity occurred. Tables 7-2 and 7-3 show uncontrolled and controlled statewide criteria emissions totals for all years, respectively.

The 2014 emissions were comparable to those in the 2011 inventory. The emissions were approximately 15% lower in 2014 compared to the previous 2011 inventory. For example, statewide total VOC emissions were 16.9% lower than the 2011 estimate. This difference could be due to changes in both activity levels and emission factors between the two years. The VOC emission factor decreased approximately 21% from 2011 to 2014 due to compliance with the EPA's engine exhaust standards. Note this standard applies to newly manufactured locomotives or engines that undergo major engine maintenance, so the anticipated emission reductions occur gradually until the current fleet is fully replaced with new engines. Additionally there were differences in activity between the two years. While a direct comparison of industry-submitted activity was not always possible, as activity data were either received from the rail companies in different units of measure or not provided at all, activity increased approximately 2.5% where compatible data existed in 2011 and 2014.

Statewide total NO_X emissions decreased by approximately 7%, mostly as a result of the 9% decrease in EPA's emissions factor change due to engine exhaust standards. Other exceptions included pollutants where the emission factors do not change over time. CH_4, CO, CO_2, N_2O, and NH_3 all increased by approximately 2.5% from 2011 to 2014, which is consistent with the change in activity. One notable difference between the two inventory years was the large decrease in SO_2 emissions; this is due to the introduction of low sulfur fuel, which changed the SO_2 emission factor from 1.88 g/gal in 2011 to 0.094 g/gal in 2014.

Future inventory efforts could be enhanced by additional local input on yard locations and activity. This is an area that has lacked solid data sources and data from local owners and operators in Texas. While this effort garnered a larger than anticipated response rate from Class II/III rail companies, there are a number of smaller rail companies that did not respond; and their input may provide insight on line haul activity levels as well. Additionally, the FRA is currently improving their railway network and developing a Memorandum of Understanding with rail companies to increase industry participation in data development. These improvements could provide better refined data at the rail segment level as well as more accurate activity levels. While much of the data gathered by FRA will be limited to Class I lines and will likely be considered CBI, this may provide a pathway through which TCEQ could model future data requests and obtain a higher response rate.

Additionally, input from Class II/III rail lines that operate in Texas would be invaluable in improving activity estimates at small rail yards or in areas where smaller railroad companies dominate activity, such as in the Port of Houston.

As oil prices have dropped, crude oil activity may change and affect rail activity. At the time of development of the emissions inventory no studies or reports had been released to quantify these changes. These changes may increase refinery rail yard activity as well as line haul activity. Additional resources could be spent to insure activity from these sources are accurate.

Table 7-1. Controlled Emissions (tons) for Criteria Pollutants by County for 2014

FIPS Code	County Name	Activity (Gal)	Controlled 2014 Annual Emissions (Tons)									
			CH_4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-}PRI}$	$PM_{25\text{-}PRI}$	SO_2	VOC
48001	Anderson	1,543,465	1.361	45.196	17,382.986	0.442	0.141	221.611	6.239	6.052	0.160	11.358
48005	Angelina	555,672	0.490	16.024	6,258.154	0.159	0.051	86.421	2.381	2.309	0.058	4.461
48007	Aransas	7,878	0.007	0.231	88.728	0.002	0.001	1.100	0.031	0.030	0.001	0.056
48011	Armstrong	2,458,468	2.168	72.151	27,688.037	0.705	0.225	343.167	9.756	9.463	0.255	17.407
48013	Atascosa	409,679	0.361	12.025	4,613.931	0.117	0.037	57.284	1.627	1.578	0.042	2.910
48015	Austin	3,711,550	3.273	108.928	41,800.629	1.064	0.340	518.326	14.733	14.291	0.385	26.300
48017	Bailey	563,202	0.497	16.529	6,342.961	0.161	0.052	78.615	2.235	2.168	0.058	3.988
48021	Bastrop	1,259,262	1.110	36.448	14,182.203	0.361	0.115	191.272	5.306	5.146	0.130	9.830
48027	Bell	5,850,427	5.159	174.010	65,889.330	1.677	0.535	972.523	25.658	24.888	0.606	55.442
48029	Bexar	5,983,383	5.276	177.108	67,386.728	1.715	0.547	934.509	25.296	24.537	0.620	51.319
48035	Bosque	3,214,745	2.835	94.346	36,205.455	0.921	0.294	448.732	12.757	12.374	0.333	22.762
48037	Bowie	2,126,288	1.875	61.889	23,946.912	0.609	0.195	312.283	8.746	8.484	0.220	15.965
48039	Brazoria	2,955,362	2.606	86.966	33,284.204	0.847	0.270	427.514	11.962	11.603	0.306	22.280
48041	Brazos	2,331,200	2.056	68.416	26,254.705	0.668	0.213	325.402	9.251	8.973	0.242	16.506
48043	Brewster	2,412,112	2.127	70.450	27,165.957	0.691	0.221	346.977	9.777	9.484	0.250	17.683
48049	Brown	1,035,946	0.914	30.323	11,667.142	0.297	0.095	160.680	4.391	4.259	0.107	8.574
48051	Burleson	4,796,894	4.230	141.213	54,024.114	1.375	0.439	697.596	19.473	18.889	0.497	36.496
48053	Burnet	205,601	0.181	5.280	2,315.539	0.059	0.019	51.445	1.269	1.231	0.021	2.792
48055	Caldwell	1,506,236	1.328	44.205	16,963.700	0.432	0.138	210.249	5.977	5.798	0.156	10.665
48057	Calhoun	35,518	0.031	1.027	400.018	0.010	0.003	6.582	0.170	0.165	0.004	0.372
48059	Callahan	1,782,039	1.571	52.299	20,069.875	0.511	0.163	248.747	7.072	6.860	0.185	12.618
48061	Cameron	387,022	0.341	11.330	4,358.764	0.111	0.035	76.413	1.919	1.861	0.040	4.520
48063	Camp	943,870	0.832	27.632	10,630.162	0.271	0.086	133.962	3.789	3.676	0.098	6.816
48065	Carson	6,259,469	5.520	183.433	70,496.089	1.794	0.573	882.138	25.006	24.256	0.649	44.820
48067	Cass	2,762,516	2.436	81.089	31,112.318	0.792	0.253	386.589	10.978	10.649	0.286	19.649
48069	Castro	695,323	0.613	20.623	7,830.948	0.199	0.064	111.019	2.977	2.888	0.072	6.185

Table 7-1. Controlled Emissions (tons) for Criteria Pollutants by County for 2014

FIPS Code	County Name	Activity (Gal)	Controlled 2014 Annual Emissions (Tons)									
			CH_4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
48071	Chambers	50,423	0.044	1.456	567.881	0.014	0.005	8.325	0.224	0.217	0.005	0.445
48073	Cherokee	1,334,861	1.177	39.025	15,033.625	0.383	0.122	190.852	5.387	5.226	0.138	9.717
48075	Childress	2,229,290	1.966	65.569	25,106.959	0.639	0.204	320.485	8.992	8.722	0.231	16.625
48077	Clay	2,342,377	2.066	68.744	26,380.583	0.671	0.214	326.962	9.295	9.016	0.243	16.585
48079	Cochran	3,616	0.003	0.093	40.720	0.001	0.000	0.905	0.022	0.022	0.000	0.049
48083	Coleman	1,195,434	1.054	34.883	13,463.345	0.343	0.109	172.905	4.864	4.718	0.124	8.819
48085	Collin	864,237	0.762	24.945	9,733.311	0.248	0.079	133.244	3.681	3.570	0.090	6.860
48089	Colorado	1,879,966	1.658	55.030	21,172.768	0.539	0.172	267.668	7.562	7.335	0.195	13.640
48091	Comal	1,722,014	1.519	50.535	19,393.862	0.494	0.158	241.158	6.847	6.642	0.178	12.255
48093	Comanche	165,533	0.146	4.251	1,864.285	0.047	0.015	41.420	1.022	0.991	0.017	2.248
48097	Cooke	1,827,422	1.612	53.775	20,580.994	0.524	0.167	264.390	7.397	7.175	0.189	13.780
48099	Coryell	328,832	0.290	9.652	3,703.412	0.094	0.030	45.999	1.306	1.267	0.034	2.337
48103	Crane	79,227	0.070	2.290	892.278	0.023	0.007	12.109	0.335	0.325	0.008	0.623
48105	Crockett	1,258	0.001	0.032	14.170	0.000	0.000	0.315	0.008	0.008	0.000	0.017
48109	Culberson	2,724,472	2.403	79.958	30,683.856	0.781	0.249	380.297	10.812	10.487	0.282	19.291
48111	Dallam	2,632,898	2.322	77.414	29,652.522	0.755	0.241	376.823	10.593	10.276	0.273	19.483
48113	Dallas	3,484,991	3.073	103.263	39,249.050	0.999	0.319	604.011	15.738	15.266	0.361	34.754
48115	Dawson	43,961	0.039	1.129	495.101	0.013	0.004	11.000	0.271	0.263	0.005	0.597
48117	Deaf Smith	4,814,294	4.245	141.362	54,220.084	1.380	0.440	676.660	19.177	18.602	0.499	34.508
48119	Delta	1,509	0.001	0.039	16.989	0.000	0.000	0.377	0.009	0.009	0.000	0.020
48121	Denton	5,437,996	4.795	159.493	61,244.408	1.559	0.498	762.555	21.648	20.999	0.563	38.718
48123	DeWitt	228,438	0.201	6.704	2,572.738	0.065	0.021	31.887	0.907	0.879	0.024	1.617
48129	Donley	2,844,121	2.508	83.469	32,031.372	0.815	0.260	396.998	11.286	10.948	0.295	20.138
48131	Duval	1,546,099	1.363	45.375	17,412.648	0.443	0.141	215.813	6.135	5.951	0.160	10.947
48133	Eastland	1,806,226	1.593	52.993	20,342.278	0.518	0.165	252.613	7.177	6.962	0.187	12.818
48135	Ector	2,121,361	1.871	63.096	23,891.426	0.608	0.194	350.239	9.263	8.985	0.220	19.911

Table 7-1. Controlled Emissions (tons) for Criteria Pollutants by County for 2014

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48139	Ellis	2,629,671	2.319	77.244	29,616.173	0.754	0.241	371.508	10.505	10.190	0.272	19.021
48141	El Paso	6,018,981	5.308	178.502	67,787.640	1.725	0.551	960.020	25.755	24.983	0.624	53.447
48143	Erath	127,159	0.112	3.277	1,432.106	0.036	0.012	31.758	0.783	0.759	0.013	1.730
48145	Falls	1,665,023	1.468	48.865	18,752.003	0.477	0.152	232.413	6.607	6.409	0.173	11.789
48147	Fannin	101,232	0.089	2.600	1,140.102	0.029	0.009	25.330	0.625	0.606	0.010	1.375
48149	Fayette	2,573,487	2.269	75.528	28,983.415	0.738	0.235	359.320	10.214	9.908	0.267	18.230
48151	Fisher	531,190	0.468	15.589	5,982.426	0.152	0.049	74.146	2.108	2.045	0.055	3.761
48153	Floyd	51,559	0.045	1.330	580.672	0.015	0.005	12.871	0.317	0.308	0.005	0.702
48157	Fort Bend	6,465,570	5.702	189.723	72,817.261	1.853	0.592	913.714	25.850	25.075	0.670	46.661
48159	Franklin	268,207	0.237	7.769	3,020.629	0.077	0.025	40.533	1.126	1.092	0.028	2.081
48161	Freestone	1,290,277	1.138	38.011	14,531.506	0.370	0.118	189.412	5.265	5.107	0.134	9.977
48163	Frio	1,534,626	1.353	45.038	17,283.437	0.440	0.140	214.212	6.090	5.907	0.159	10.866
48165	Gaines	7,422	0.007	0.191	83.590	0.002	0.001	1.857	0.046	0.044	0.001	0.101
48167	Galveston	1,619,696	1.428	47.460	18,241.516	0.464	0.148	247.450	6.797	6.593	0.168	13.135
48169	Garza	1,097,069	0.967	32.197	12,355.535	0.314	0.100	153.135	4.354	4.223	0.114	7.768
48175	Goliad	28,589	0.025	0.839	321.981	0.008	0.003	3.991	0.113	0.110	0.003	0.202
48177	Gonzales	1,531,060	1.350	44.827	17,243.277	0.439	0.140	217.210	6.145	5.960	0.159	11.052
48179	Gray	3,561,798	3.141	104.677	40,114.073	1.021	0.326	506.582	14.281	13.853	0.369	26.069
48181	Grayson	4,730,434	4.172	138.290	53,275.624	1.356	0.433	702.861	19.542	18.956	0.490	36.561
48183	Gregg	1,687,856	1.488	49.835	19,009.161	0.484	0.154	254.974	7.000	6.790	0.175	13.701
48185	Grimes	2,079,009	1.833	61.016	23,414.449	0.596	0.190	290.298	8.252	8.004	0.215	14.729
48187	Guadalupe	2,375,578	2.095	69.718	26,754.501	0.681	0.217	331.597	9.427	9.144	0.246	16.820
48189	Hale	771,689	0.681	22.869	8,691.000	0.221	0.071	128.869	3.402	3.300	0.080	7.306
48191	Hall	1,305,306	1.151	38.308	14,700.765	0.374	0.119	182.202	5.180	5.024	0.135	9.242
48195	Hansford	67,023	0.059	1.721	754.832	0.019	0.006	16.770	0.414	0.401	0.007	0.910
48197	Hardeman	2,507,809	2.212	73.668	28,243.729	0.719	0.229	361.778	10.145	9.840	0.260	18.743

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FIPS Code	County Name	Activity (Gal)	Controlled 2014 Annual Emissions (Tons)									
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48199	Hardin	1,743,832	1.538	50.916	19,639.576	0.500	0.160	271.784	7.425	7.202	0.181	14.455
48201	Harris	19,617,526	17.300	580.137	220,938.688	5.622	1.795	3,092.191	83.466	80.962	2.033	170.173
48203	Harrison	605,979	0.534	17.829	6,824.725	0.174	0.055	87.502	2.450	2.377	0.063	4.554
48205	Hartley	2,585,952	2.280	75.892	29,123.802	0.741	0.237	360.962	10.262	9.954	0.268	18.310
48209	Hays	1,389,846	1.226	40.792	15,652.883	0.398	0.127	194.200	5.518	5.353	0.144	9.859
48211	Hemphill	5,473,443	4.827	160.637	61,643.618	1.569	0.501	764.211	21.723	21.072	0.567	38.772
48213	Henderson	897,023	0.791	26.326	10,102.552	0.257	0.082	125.212	3.560	3.453	0.093	6.351
48215	Hidalgo	150,664	0.133	3.892	1,696.829	0.043	0.014	37.579	0.926	0.898	0.016	2.052
48217	Hill	2,612,663	2.304	76.678	29,424.620	0.749	0.239	364.789	10.369	10.058	0.271	18.508
48219	Hockley	401,212	0.354	10.894	4,518.570	0.115	0.037	82.566	2.121	2.058	0.042	4.401
48221	Hood	82,969	0.073	2.136	934.421	0.024	0.008	20.730	0.511	0.496	0.009	1.128
48223	Hopkins	1,152,445	1.016	33.500	12,979.192	0.330	0.105	170.719	4.769	4.626	0.119	8.742
48225	Houston	747,385	0.659	21.934	8,417.280	0.214	0.068	104.324	2.966	2.877	0.077	5.292
48227	Howard	2,034,412	1.794	60.045	22,912.179	0.583	0.186	306.236	8.421	8.168	0.211	16.412
48229	Hudspeth	5,591,629	4.931	164.103	62,974.670	1.603	0.512	780.511	22.189	21.524	0.579	39.591
48231	Hunt	709,285	0.625	20.310	7,988.190	0.203	0.065	114.280	3.119	3.025	0.073	5.919
48233	Hutchinson	10,522	0.009	0.282	118.503	0.003	0.001	2.573	0.063	0.061	0.001	0.146
48235	Irion	110,827	0.098	2.846	1,248.172	0.032	0.010	27.731	0.684	0.664	0.011	1.505
48239	Jackson	1,145,193	1.010	33.301	12,897.520	0.328	0.105	169.564	4.737	4.595	0.119	8.688
48241	Jasper	341,228	0.301	9.310	3,843.015	0.098	0.031	82.544	2.010	1.949	0.035	4.761
48243	Jeff Davis	921,069	0.812	27.031	10,373.362	0.264	0.084	128.568	3.655	3.545	0.095	6.522
48245	Jefferson	4,087,876	3.605	121.463	46,038.937	1.172	0.374	674.569	17.854	17.319	0.424	38.260
48247	Jim Hogg	397,397	0.350	11.663	4,475.610	0.114	0.036	55.471	1.577	1.530	0.041	2.814
48249	Jim Wells	645,631	0.569	18.948	7,271.294	0.185	0.059	90.121	2.562	2.485	0.067	4.571
48251	Johnson	4,009,096	3.535	117.871	45,151.692	1.149	0.367	594.323	16.480	15.985	0.415	31.311
48257	Kaufman	1,301,795	1.148	38.205	14,661.220	0.373	0.119	181.712	5.166	5.011	0.135	9.217

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48261	Kenedy	258,023	0.228	7.572	2,905.937	0.074	0.024	36.016	1.024	0.993	0.027	1.827
48271	Kinney	1,834,259	1.618	53.833	20,657.993	0.526	0.168	256.135	7.280	7.062	0.190	12.996
48273	Kleberg	118,968	0.105	3.491	1,339.852	0.034	0.011	16.606	0.472	0.458	0.012	0.842
48277	Lamar	42,709	0.038	1.097	481.000	0.012	0.004	10.687	0.264	0.256	0.004	0.580
48279	Lamb	684,350	0.603	20.084	7,707.358	0.196	0.063	95.525	2.716	2.634	0.071	4.846
48281	Lampasas	1,364,797	1.204	39.940	15,370.771	0.391	0.125	194.073	5.487	5.322	0.141	9.876
48283	La Salle	1,593,358	1.405	46.742	17,944.894	0.457	0.146	223.011	6.335	6.145	0.165	11.317
48285	Lavaca	212,483	0.187	6.236	2,393.049	0.061	0.019	29.660	0.843	0.818	0.022	1.504
48287	Lee	1,443,601	1.273	42.205	16,258.281	0.414	0.132	206.380	5.826	5.651	0.150	10.508
48289	Leon	1,775,048	1.565	52.096	19,991.148	0.509	0.162	247.870	7.045	6.834	0.184	12.577
48291	Liberty	6,471,800	5.707	191.517	72,887.427	1.855	0.592	1,030.916	27.707	26.876	0.671	57.093
48293	Limestone	2,172,296	1.916	63.752	24,465.070	0.623	0.199	303.221	8.620	8.362	0.225	15.381
48295	Lipscomb	2,073,463	1.828	60.543	23,351.984	0.594	0.190	298.731	8.414	8.161	0.215	15.228
48297	Live Oak	407,366	0.359	11.957	4,587.880	0.117	0.037	56.961	1.618	1.570	0.042	2.893
48299	Llano	103,587	0.091	2.660	1,166.630	0.030	0.009	25.920	0.639	0.620	0.011	1.407
48303	Lubbock	1,578,058	1.392	46.063	17,772.586	0.452	0.144	255.369	6.880	6.674	0.164	13.829
48305	Lynn	144,376	0.127	3.918	1,626.002	0.041	0.013	29.779	0.765	0.742	0.015	1.588
48307	McCulloch	43,022	0.038	1.105	484.529	0.012	0.004	10.765	0.266	0.258	0.004	0.584
48309	McLennan	4,520,869	3.987	132.911	50,915.432	1.296	0.414	646.103	18.175	17.630	0.468	33.370
48313	Madison	256,533	0.226	7.529	2,889.151	0.074	0.023	35.808	1.018	0.987	0.027	1.816
48315	Marion	1,582,659	1.396	46.448	17,824.397	0.454	0.145	220.916	6.280	6.092	0.164	11.206
48317	Martin	604,341	0.533	17.736	6,806.273	0.173	0.055	84.357	2.398	2.326	0.063	4.279
48321	Matagorda	788,187	0.695	23.136	8,876.804	0.226	0.072	110.315	3.132	3.038	0.082	5.607
48323	Maverick	804,483	0.709	23.824	9,060.340	0.231	0.074	126.086	3.408	3.305	0.083	6.942
48325	Medina	2,664,834	2.350	78.209	30,012.195	0.764	0.244	372.071	10.576	10.259	0.276	18.877
48329	Midland	1,245,871	1.099	36.564	14,031.389	0.357	0.114	173.906	4.944	4.796	0.129	8.821

Table 7-1. Controlled Emissions (tons) for Criteria Pollutants by County for 2014

FIPS Code	County Name	Activity (Gal)	Controlled 2014 Annual Emissions (Tons)									
			CH_4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-}PRI}$	$PM_{25\text{-}PRI}$	SO_2	VOC
48331	Milam	5,241,037	4.622	153.762	59,026.192	1.502	0.480	733.558	20.836	20.211	0.543	37.235
48333	Mills	1,074,170	0.947	31.520	12,097.642	0.308	0.098	150.085	4.266	4.138	0.111	7.614
48335	Mitchell	1,813,674	1.599	53.228	20,426.159	0.520	0.166	253.163	7.197	6.981	0.188	12.842
48337	Montague	1,993,573	1.758	58.507	22,452.245	0.571	0.182	278.274	7.911	7.674	0.207	14.115
48339	Montgomery	2,627,016	2.317	76.715	29,586.267	0.753	0.240	378.360	10.657	10.337	0.272	19.289
48341	Moore	5,607,404	4.945	164.485	63,152.330	1.607	0.513	799.227	22.539	21.863	0.581	40.977
48343	Morris	805,877	0.711	23.558	9,076.033	0.231	0.074	116.399	3.273	3.174	0.084	5.959
48347	Nacogdoches	742,737	0.655	21.799	8,364.932	0.213	0.068	103.774	2.949	2.860	0.077	5.268
48349	Navarro	3,106,821	2.740	91.179	34,989.991	0.890	0.284	433.668	12.329	11.959	0.322	21.998
48351	Newton	342,798	0.302	9.900	3,860.701	0.098	0.031	52.678	1.457	1.413	0.036	2.711
48353	Nolan	2,300,943	2.029	67.391	25,913.938	0.659	0.211	332.139	9.329	9.049	0.238	17.083
48355	Nueces	1,639,771	1.446	48.466	18,467.611	0.470	0.150	250.989	6.852	6.646	0.170	13.607
48357	Ochiltree	85,970	0.076	2.213	968.219	0.025	0.008	21.481	0.530	0.514	0.009	1.169
48359	Oldham	436,407	0.385	12.808	4,914.953	0.125	0.040	60.916	1.732	1.680	0.045	3.090
48361	Orange	1,906,970	1.682	55.821	21,476.885	0.547	0.174	272.143	7.681	7.451	0.198	13.886
48363	Palo Pinto	2,065,025	1.821	60.604	23,256.958	0.592	0.189	288.248	8.195	7.949	0.214	14.621
48365	Panola	389,579	0.344	11.472	4,387.563	0.112	0.036	66.866	1.755	1.702	0.040	3.786
48367	Parker	1,980,625	1.747	58.123	22,306.416	0.568	0.181	276.586	7.862	7.626	0.205	14.031
48369	Parmer	8,504,109	7.499	249.579	95,775.919	2.437	0.778	1,187.150	33.749	32.736	0.881	60.222
48371	Pecos	351,112	0.310	9.656	3,954.336	0.101	0.032	68.781	1.787	1.733	0.036	3.652
48373	Polk	801,607	0.707	23.462	9,027.946	0.230	0.073	113.801	3.219	3.122	0.083	5.788
48375	Potter	5,663,561	4.994	167.879	63,784.793	1.623	0.518	897.975	24.151	23.426	0.587	49.807
48377	Presidio	1,418,643	1.251	40.900	15,977.203	0.407	0.130	220.160	6.071	5.889	0.147	11.345
48381	Randall	7,620,940	6.721	224.526	85,829.395	2.184	0.697	1,119.712	31.115	30.182	0.790	59.014
48383	Reagan	79,126	0.070	2.032	891.147	0.023	0.007	19.799	0.488	0.474	0.008	1.075
48389	Reeves	2,120,096	1.870	61.894	23,877.184	0.608	0.194	305.787	8.610	8.351	0.220	15.590

Table 7-1. Controlled Emissions (tons) for Criteria Pollutants by County for 2014

FIPS Code	County Name	Activity (Gal)	Controlled 2014 Annual Emissions (Tons)									
			CH_4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-}PRI}$	$PM_{25\text{-}PRI}$	SO_2	VOC
48391	Refugio	1,498,892	1.322	43.989	16,880.991	0.430	0.137	209.224	5.948	5.770	0.155	10.613
48393	Roberts	3,176,320	2.801	93.218	35,772.702	0.910	0.291	443.369	12.605	12.227	0.329	22.490
48395	Robertson	5,293,575	4.668	155.421	59,617.888	1.517	0.484	743.107	21.072	20.440	0.549	37.861
48397	Rockwall	36,638	0.032	0.941	412.625	0.011	0.003	9.167	0.226	0.219	0.004	0.498
48399	Runnels	90,910	0.080	2.340	1,023.857	0.026	0.008	22.718	0.560	0.543	0.009	1.236
48401	Rusk	456,620	0.403	13.335	5,142.599	0.131	0.042	65.864	1.854	1.798	0.047	3.361
48403	Sabine	51,185	0.045	1.314	576.458	0.015	0.005	12.807	0.316	0.306	0.005	0.695
48405	San Augustine	46,811	0.041	1.202	527.200	0.013	0.004	11.713	0.289	0.280	0.005	0.636
48407	San Jacinto	251,654	0.222	7.386	2,834.205	0.072	0.023	35.127	0.999	0.969	0.026	1.782
48409	San Patricio	1,182,606	1.043	34.713	13,318.873	0.339	0.108	165.469	4.699	4.558	0.123	8.409
48411	San Saba	88,941	0.078	2.284	1,001.679	0.025	0.008	22.255	0.549	0.533	0.009	1.208
48415	Scurry	1,003,186	0.885	29.443	11,298.198	0.288	0.092	140.129	3.983	3.863	0.104	7.112
48419	Shelby	879,214	0.775	25.703	9,901.977	0.252	0.080	139.396	3.781	3.668	0.091	7.499
48421	Sherman	3,405,092	3.003	99.932	38,349.204	0.976	0.312	475.302	13.512	13.107	0.353	24.110
48423	Smith	1,333,020	1.176	39.179	15,012.884	0.382	0.122	189.795	5.348	5.188	0.138	9.775
48427	Starr	42,511	0.037	1.092	478.776	0.012	0.004	10.637	0.262	0.255	0.004	0.577
48429	Stephens	307,942	0.272	9.037	3,468.143	0.088	0.028	42.984	1.222	1.185	0.032	2.180
48437	Swisher	443,775	0.391	13.024	4,997.934	0.127	0.041	61.945	1.761	1.708	0.046	3.142
48439	Tarrant	13,609,290	12.001	403.245	153,272.065	3.900	1.245	2,213.399	58.992	57.222	1.410	124.044
48441	Taylor	2,728,221	2.406	80.069	30,726.072	0.782	0.250	380.919	10.828	10.503	0.283	19.326
48443	Terrell	1,618,440	1.427	47.498	18,227.378	0.464	0.148	225.911	6.422	6.230	0.168	11.459
48445	Terry	192,181	0.169	4.935	2,164.399	0.055	0.018	48.088	1.186	1.151	0.020	2.610
48449	Titus	732,020	0.646	21.367	8,244.238	0.210	0.067	105.988	2.980	2.891	0.076	5.413
48451	Tom Green	90,712	0.080	2.335	1,021.627	0.026	0.008	22.668	0.559	0.542	0.009	1.233
48453	Travis	1,143,812	1.009	32.869	12,881.971	0.328	0.105	184.672	5.026	4.875	0.119	9.653

Table 7-1. Controlled Emissions (tons) for Criteria Pollutants by County for 2014

FIPS Code	County Name	Activity (Gal)	Controlled 2014 Annual Emissions (Tons)									
			CH_4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
48455	Trinity	325,209	0.287	9.544	3,662.607	0.093	0.030	45.395	1.291	1.252	0.034	2.303
48459	Upshur	1,605,073	1.415	47.106	18,076.836	0.460	0.147	224.045	6.369	6.178	0.166	11.365
48461	Upton	86,115	0.076	2.211	969.858	0.025	0.008	21.548	0.532	0.516	0.009	1.169
48463	Uvalde	2,378,068	2.097	69.794	26,782.547	0.682	0.218	332.141	9.440	9.157	0.246	16.856
48465	Val Verde	2,552,202	2.251	74.903	28,743.696	0.731	0.234	356.349	10.129	9.826	0.264	18.080
48467	Van Zandt	1,385,055	1.221	40.649	15,598.925	0.397	0.127	193.334	5.496	5.331	0.144	9.807
48469	Victoria	1,853,396	1.634	54.252	20,873.521	0.531	0.170	263.553	7.450	7.226	0.192	13.420
48471	Walker	546,463	0.482	16.038	6,154.441	0.157	0.050	76.278	2.169	2.103	0.057	3.869
48473	Waller	487,370	0.430	14.305	5,488.912	0.140	0.045	68.128	1.936	1.878	0.050	3.460
48475	Ward	2,048,709	1.807	60.061	23,073.204	0.587	0.187	288.048	8.171	7.926	0.212	14.631
48477	Washington	1,615,936	1.425	47.426	18,199.176	0.463	0.148	225.660	6.414	6.222	0.167	11.450
48479	Webb	3,228,273	2.847	94.885	36,357.821	0.925	0.295	460.507	12.966	12.577	0.335	23.744
48481	Wharton	1,694,576	1.494	49.194	19,084.840	0.486	0.155	252.779	7.048	6.837	0.176	12.953
48485	Wichita	2,129,135	1.878	62.293	23,978.979	0.610	0.195	310.545	8.693	8.432	0.221	16.022
48487	Wilbarger	2,528,285	2.230	74.201	28,474.337	0.725	0.231	353.011	10.035	9.734	0.262	17.910
48489	Willacy	101,106	0.089	2.967	1,138.692	0.029	0.009	14.113	0.401	0.389	0.010	0.716
48491	Williamson	1,457,992	1.286	42.024	16,420.365	0.418	0.133	227.743	6.265	6.077	0.151	11.772
48495	Winkler	70,875	0.063	1.820	798.221	0.020	0.006	17.734	0.438	0.424	0.007	0.963
48497	Wise	3,567,087	3.146	104.831	40,173.647	1.022	0.326	507.222	14.301	13.872	0.370	26.098
48499	Wood	1,412,304	1.245	41.450	15,905.813	0.405	0.129	197.236	5.606	5.438	0.146	10.009
Total		369,183,938	325.56	10,838	4,157,864	105.81	33.78	54,344	1,512	1,467	38.25	2,842

Table 7-2. Texas Statewide Annual Uncontrolled Criteria Emissions Estimates by Year (tons)

Year	CH_4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
2008	343.41	11,422.28	4,385,716.19	111.61	35.63	120,123.86	2,868.43	2,782.58	807.00	4,647.72
2009	282.69	9,401.43	3,610,282.04	91.87	29.33	99,571.47	2,361.26	2,290.58	664.32	3,819.94
2010	303.58	10,096.63	3,877,052.09	98.66	31.50	106,713.93	2,535.61	2,459.71	713.40	4,106.66
2011	317.73	10,568.04	4,057,795.39	103.26	32.96	111,288.20	2,653.77	2,574.33	746.66	4,302.31
2012	313.04	10,411.94	3,997,969.04	101.74	32.48	108,612.77	2,614.69	2,536.43	735.65	4,236.73
2013	318.65	10,598.93	4,069,555.14	103.56	33.06	110,621.54	2,661.46	2,581.80	748.83	4,315.96
2014	325.56	10,828.92	4,157,864.49	105.81	33.78	112,949.58	2,719.21	2,637.82	765.08	4,409.62
2015	326.61	10,863.58	4,171,169.66	106.15	33.89	111,443.59	2,727.91	2,646.26	767.52	4,423.73
2016	314.88	10,473.57	4,021,424.67	102.34	32.67	106,672.30	2,629.98	2,551.26	739.97	4,264.91
2017	326.00	10,843.29	4,163,380.96	105.95	33.82	110,402.90	2,722.82	2,641.32	766.09	4,415.47
2018	333.95	11,107.87	4,264,967.45	108.53	34.65	113,050.59	2,789.26	2,705.77	784.78	4,523.20
2019	337.72	11,233.39	4,313,161.58	109.76	35.04	114,321.09	2,820.78	2,736.34	793.65	4,574.32
2020	340.22	11,316.51	4,345,078.98	110.57	35.30	115,162.51	2,841.65	2,756.59	799.53	4,608.17
2021	344.20	11,448.92	4,395,916.40	111.87	35.71	116,502.70	2,874.90	2,788.85	808.88	4,662.08
2022	349.23	11,616.07	4,460,096.78	113.50	36.23	118,194.64	2,916.87	2,829.56	820.69	4,730.15
2023	353.00	11,741.53	4,508,265.83	114.73	36.62	119,464.49	2,948.37	2,860.12	829.55	4,781.23
2024	355.93	11,838.98	4,545,684.44	115.68	36.93	120,450.93	2,972.84	2,883.86	836.44	4,820.92
2025	360.52	11,991.70	4,604,323.77	117.17	37.40	121,986.68	3,011.19	2,921.06	847.23	4,883.11
2026	360.09	11,977.31	4,598,798.58	117.03	37.36	121,777.13	3,007.58	2,917.56	846.21	4,877.25
2027	362.61	12,061.15	4,630,990.17	117.85	37.62	122,574.20	3,028.63	2,937.98	852.13	4,911.39
2028	360.94	12,005.67	4,609,687.61	117.31	37.45	122,012.62	3,014.70	2,924.47	848.22	4,888.80
2029	362.60	12,060.90	4,630,892.17	117.85	37.62	122,410.29	3,028.57	2,937.92	852.12	4,911.28
2030	364.05	12,109.14	4,649,415.74	118.32	37.77	122,720.92	3,040.68	2,949.67	855.53	4,930.93
2031	363.22	12,081.29	4,638,722.09	118.05	37.68	122,439.01	3,033.69	2,942.89	853.56	4,919.59
2032	365.10	12,144.11	4,662,843.44	118.66	37.88	123,074.91	3,049.47	2,958.19	858.00	4,945.17
2033	363.86	12,102.82	4,646,989.77	118.26	37.75	122,505.31	3,039.10	2,948.13	855.08	4,928.36
2034	362.59	12,060.46	4,630,725.31	117.84	37.62	122,076.54	3,028.46	2,937.81	852.09	4,911.11

Table 7-2. Texas Statewide Annual Uncontrolled Criteria Emissions Estimates by Year (tons)

Year	CH_4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
2035	363.86	12,102.68	4,646,932.85	118.25	37.75	122,503.81	3,039.06	2,948.10	855.07	4,928.30
2036	366.15	12,178.92	4,676,208.53	119.00	37.99	123,275.58	3,058.21	2,966.67	860.46	4,959.34
2037	362.38	12,053.48	4,628,043.58	117.77	37.60	122,005.84	3,026.71	2,936.11	851.59	4,908.26
2038	363.21	12,081.20	4,638,688.08	118.04	37.68	122,286.46	3,033.67	2,942.86	853.55	4,919.55
2039	362.78	12,066.71	4,633,121.65	117.90	37.64	122,139.71	3,030.03	2,939.33	852.53	4,913.65
2040	363.61	12,094.46	4,643,777.83	118.17	37.72	122,420.64	3,037.00	2,946.09	854.49	4,924.95

Table 7-3. Texas Statewide Annual Controlled Criteria Emissions Estimates by Year(tons)

Year	CH4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
2008	343.41	11,432.14	4,385,716.19	111.61	35.63	70,469.07	2,204.90	2,138.75	807.00	4,245.97
2009	282.69	9,409.55	3,610,282.04	91.87	29.33	56,676.31	1,749.52	1,697.04	664.32	3,386.32
2010	303.58	10,105.34	3,877,052.09	98.66	31.50	58,207.13	1,807.34	1,753.12	713.40	3,485.32
2011	317.73	10,577.15	4,057,795.39	103.26	32.96	58,224.50	1,780.44	1,727.02	746.66	3,419.87
2012	313.04	10,420.92	3,997,969.04	101.74	32.48	55,463.51	1,641.15	1,591.92	36.78	3,121.83
2013	318.65	10,608.06	4,069,555.14	103.56	33.06	54,748.85	1,558.39	1,511.64	37.44	2,951.30
2014	325.56	10,838.25	4,157,864.49	105.81	33.78	54,343.87	1,512.46	1,467.09	38.25	2,841.95
2015	326.61	10,872.94	4,171,169.66	106.15	33.89	52,348.24	1,441.66	1,398.41	38.38	2,690.75
2016	314.88	10,482.60	4,021,424.67	102.34	32.67	47,590.93	1,276.70	1,238.40	37.00	2,350.49
2017	326.00	10,852.63	4,163,380.96	105.95	33.82	46,755.16	1,243.68	1,206.37	38.30	2,231.42
2018	333.95	11,117.44	4,264,967.45	108.53	34.65	45,635.85	1,194.87	1,159.03	39.24	2,116.37
2019	337.72	11,243.07	4,313,161.58	109.76	35.04	44,263.02	1,131.01	1,097.08	39.68	2,015.26
2020	340.22	11,326.26	4,345,078.98	110.57	35.30	42,783.10	1,052.48	1,020.90	39.98	1,881.49
2021	344.20	11,458.78	4,395,916.40	111.87	35.71	41,358.91	1,022.63	991.96	40.44	1,817.59
2022	349.23	11,626.08	4,460,096.78	113.50	36.23	39,853.93	954.79	926.15	41.03	1,742.38
2023	353.00	11,751.64	4,508,265.83	114.73	36.62	38,239.93	918.18	890.63	41.48	1,667.19
2024	355.93	11,849.18	4,545,684.44	115.68	36.93	36,355.05	838.61	813.45	41.82	1,577.32
2025	360.52	12,002.03	4,604,323.77	117.17	37.40	34,539.68	798.64	774.68	42.36	1,483.59
2026	360.09	11,987.63	4,598,798.58	117.03	37.36	32,385.96	753.58	730.97	42.31	1,426.34
2027	362.61	12,071.55	4,630,990.17	117.85	37.62	30,866.62	714.44	693.01	42.61	1,339.77
2028	360.94	12,016.02	4,609,687.61	117.31	37.45	28,986.62	663.17	643.28	42.41	1,234.47
2029	362.60	12,071.29	4,630,892.17	117.85	37.62	27,373.94	580.28	562.87	42.61	1,184.29
2030	364.05	12,119.58	4,649,415.74	118.32	37.77	25,703.35	534.20	518.18	42.78	1,136.00
2031	363.22	12,091.70	4,638,722.09	118.05	37.68	23,868.24	529.18	513.30	42.68	1,033.63
2032	365.10	12,154.58	4,662,843.44	118.66	37.88	22,599.39	484.31	469.79	42.90	985.81
2033	363.86	12,113.25	4,646,989.77	118.26	37.75	21,125.72	437.19	424.07	42.75	926.41
2034	362.59	12,070.86	4,630,725.31	117.84	37.62	19,668.42	387.45	375.83	42.60	867.32

Table 7-3. Texas Statewide Annual Controlled Criteria Emissions Estimates by Year(tons)

Year	CH4	CO	CO_2	N_2O	NH_3	NO_X	$PM_{10\text{-}PRI}$	$PM_{25\text{-}PRI}$	SO_2	VOC
2035	363.86	12,113.10	4,646,932.85	118.25	37.75	18,349.05	383.04	371.54	42.75	817.35
2036	366.15	12,189.42	4,676,208.53	119.00	37.99	17,461.10	339.68	329.49	43.02	766.09
2037	362.38	12,063.86	4,628,043.58	117.77	37.60	16,306.43	332.39	322.42	42.58	749.12
2038	363.21	12,091.61	4,638,688.08	118.04	37.68	15,429.54	288.67	280.01	42.68	704.00
2039	362.78	12,077.10	4,633,121.65	117.90	37.64	14,497.73	284.53	275.99	42.63	697.09
2040	363.61	12,104.88	4,643,777.83	118.17	37.72	14,033.40	239.73	232.54	42.72	648.76

8.0 References

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Appendix A. Internet Research for Existing and Potential Yard Locations

Location	Yard Name	Railroad	Status	Links
Beaumont	Beaumont Yard	UP	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Fort Worth	Davidson Yard	UP	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Houston	Englewood Yard	UP	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Kendleton	Kendleton Yard	KCS	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
Slaton	Slaton Yard	BNSF/South Plains Lamesa Railroad	Existing	http://en.wikipedia.org/wiki/List_of_rail_yards
La Porte	Strang Yard	UP	Existing	http://iaspub.epa.gov/enviro/fii_query_detail.disp_program_facility?p_registry_id=110035015079
Dallas	Miller Yard	UP	Existing	http://iaspub.epa.gov/enviro/fii_query_detail.disp_program_facility?p_registry_id=110035273398
Eagle Ford	San Antonio	UP	New	http://missionrailpark.com/
San Antonio	Southton Rail Yard	UP & BNSF	Existing	http://southtonrailyard.com/about.html
Dallas	KCS Rail Yard	KCS	Existing	http://wikimapia.org/10547329/Kansas-City-Southern-Rail-Yard
San Antonio	Alamo Junction Rail Park	UP & BNSF	Proposed	http://www.alamojunction.com/
Big Spring		UP	Proposed	http://www.bigspringherald.com/content/rail-yard-could-be-possibility
Port Corpus Christi Commission (PCCA)		BNSF/KCS/UP	Proposed	http://www.progressiverailroading.com/intermodal/news/Texas-port-awards-rail-yard-contract--36514
between Hearne and Mumford, Texas		UP	Proposed	http://www.progressiverailroading.com/union_pacific/news/Union-Pacific-Railroad-proposes-to-build-one-of-Texas-largest-classification-yards-Hearne-mayor-says--31785
Houston	Port Terminal Railroad (PTRA) North Yard	KCS, NS, BNSF	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html http://www.usa.com/frs/union-pacific-railroad-settegast-yard.html
Houston	PTRA Manchester Yard	UP/BNSF	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html

Appendix A. Internet Research for Existing and Potential Yard Locations

Location	Yard Name	Railroad	Status	Links
Houston	PTRA Pasadena Yard	UP/BNSF	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html
Houston	PTRA Storage Yard	UP	Existing	http://www.ptra.com/index.php/about-us/ptra-yards.html
Houston	Settsgast Yard	UP	Existing	http://www.railfanguides.us/tx/houston/map1/index.htm
Dallas	KCS Dallas Yard	KCS	Existing	http://www.railroadforums.com/forum/showthread.php?12220-KCS-yard-near-dallas-or-fort-worth
Wylie	KCS Wylie Yard	KCS, NS, BNSF	Existing	http://www.railroadforums.com/forum/showthread.php?12220-KCS-yard-near-dallas-or-fort-worth
Dallas	Dallas Garland & Northeastern (DGNO) at Mockingbird yard	BNSF, KCS, TNER, and UP	Existing	http://www.railroadforums.com/photos/showphoto.php/photo/23775/title/dgno-at-mockingbird-yarddallas-tx/cat/562
Dallas	Mockingbird yard	DGNO	Existing	http://www.railroadforums.com/photos/showphoto.php/photo/23775/title/dgno-at-mockingbird-yarddallas-tx/cat/562
Galveston	Texas International Terminals	UP	Existing	http://www.up.com/customers/coal/ports-docks/tx-terminals/index.htm
Robertson County		UP	Proposed	http://www.uprr.com/newsinfo/releases/capital_investment/2014/1002_tx-railyard.shtml
Blue Mound	Alliance Railyard	BNSF	Existing	http://www.waymarking.com/waymarks/WM73KD_BNSF_Alliance_Railyard_Blue_Mound_Texas

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48001	Anderson	Palestine	RY739	14461911	31.757692	-95.635833
48005	Angelina	Herty	RY1025	16912511	31.355473	-94.678973
48005	Angelina	Lufkin	RY1171	16923311	31.344356	-94.728319
48013	Atascosa	Pleasanton	RY1191	16924611	28.97427	-98.481283
48015	Austin	Bellville	RY1053	16914411	29.922351	-96.240637
48015	Austin	Sealy1	RY1108	16918211	29.781802	-96.16711
48021	Bastrop	Smithville	RY1104	16917811	30.003586	-97.157494
48027	Bell	Corpus Christi3 (Agnes St Yard)	RY953	15528711	27.785797	-97.477569
48027	Bell	Fort Hood	RY988	16933211	31.125511	-97.78053
48027	Bell	Rogers	RY1102	16917611	30.931574	-97.225284
48027	Bell	Temple 1	RY740	14462111	31.11474	-97.348822
48027	Bell	Temple 2	RY982	16929111	31.068564	-97.329459
48029	Bexar	Calaveras Lake	RY1057	16914711	29.29981	-98.322104
48029	Bexar	East 3	RY741	14462211	29.434091	-98.467212
48029	Bexar	Kirby	RY963	16927511	29.471846	-98.38799
48029	Bexar	Mitchell Lake	RY1163	16922611	29.308866	-98.640641
48029	Bexar	San Antonio Central	RY975	16928511	29.37842	-98.541273
48029	Bexar	San Antonio2	RY1109	16918311	29.376954	-98.556942
48029	Bexar	So San Antonio	RY974	16928411	29.295394	-98.432169
48037	Bowie	Texarkana	RY743	14462311	33.399495	-94.05799
48039	Brazoria	Angleton 1	RY744	14462411	29.157184	-95.433799
48039	Brazoria	Angleton 2	RY1300	16930111	29.152062	-95.433486
48039	Brazoria	Brazosport	RY1047	16913911	28.949548	-95.321535
48039	Brazoria	Clute1	RY1092	16916911	29.010993	-95.387195
48039	Brazoria	Clute2	RY1091	16931511	28.996955	-95.375762
48039	Brazoria	Clute3	RY1090	16916811	28.998359	-95.359885
48039	Brazoria	Freeport1	RY1028	16912811	28.964256	-95.348806
48039	Brazoria	Freeport2	RY1041	16933311	28.952796	-95.338393
48039	Brazoria	Oyster Creek1	RY1173	16934211	28.98326	-95.34286
48039	Brazoria	Oyster Creek2	RY1158	16922211	28.972508	-95.340582
48039	Brazoria	Pearland	RY1197	16925111	29.577526	-95.291657
48049	Brown	Brownwood	RY745	14462511	31.712634	-98.966355
48051	Burleson	Chriesman	RY1093	16917011	30.606182	-96.775294
48051	Burleson	Somerville	RY977	16928711	30.35103	-96.531718
48057	Calhoun	Long Mott1	RY1177	16933411	28.49311	-96.767357
48057	Calhoun	Long Mott2	RY1176	16933811	28.500873	-96.772772

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48057	Calhoun	Long Mott3	RY1160	16922411	28.512421	-96.771912
48057	Calhoun	Long Mott4	RY1174	16933511	28.521817	-96.769775
48057	Calhoun	Long Mott5	RY1188	16933911	28.534027	-96.764061
48057	Calhoun	Point Comfort1	RY1146	16921011	28.661036	-96.553703
48057	Calhoun	Point Comfort2	RY1103	16917711	28.687419	-96.543028
48057	Calhoun	Point Comfort3	RY1161	16934611	28.697426	-96.534372
48061	Cameron	Alamo Junction	RY1311	16926311	29.261258	-98.346338
48061	Cameron	Brownsville	RY747	14462611	25.912592	-97.489694
48061	Cameron	Cameron Park1	RY1059	16914911	25.941462	-97.439003
48061	Cameron	Harlingen	RY748	14462711	26.204216	-97.706849
48061	Cameron	Olmito 0	RY749	14462811	25.90313	-97.50719
48061	Cameron	Olmito 1	RY1201	16934011	25.999663	-97.507797
48061	Cameron	Reid Hope King1	RY1124	16934911	25.953804	-97.41116
48061	Cameron	Reid Hope King2	RY1123	16934511	25.958507	-97.386164
48061	Cameron	Reid Hope King3	RY1122	16935011	25.954362	-97.381916
48061	Cameron	Reid Hope King4	RY1121	16919211	25.975434	-97.352218
48061	Cameron	Reid Hope King5	RY1120	16919111	25.969089	-97.417659
48063	Camp	Pittsburg	RY1194	16924811	32.99762	-94.978054
48065	Carson	Panhandle	RY1200	16925311	35.34161	-101.37594
48065	Carson	Skellytown 1	RY1106	16918011	35.580678	-101.17095
48067	Cass	Hughes Springs	RY954	15528811	32.998464	-94.634842
48069	Castro	Dimmitt	RY1307	16926011	34.556851	-102.31117
48071	Chambers	Baytown2	RY1061	16915011	29.758596	-94.89949
48071	Chambers	Baytown3	RY1060	16930611	29.772596	-94.894913
48071	Chambers	Beach City	RY1044	16913711	29.696948	-94.89278
48071	Chambers	Mont Belvieu	RY1067	16915611	29.871641	-94.909055
48075	Childress	Childress	RY752	14463011	34.422742	-100.21081
48085	Collin	Wylie	RY955	15528911	33.032174	-96.499084
48089	Colorado	Eagle Lake1	RY1002	16910311	29.563454	-96.328963
48089	Colorado	Eagle Lake2	RY986	16932911	29.601906	-96.347254
48089	Colorado	Glidden	RY753	14463111	29.703364	-96.580978
48091	Comal	Garden Ridge	RY1001	16910211	29.636199	-98.258133
48091	Comal	Hunter	RY1020	16912011	29.803357	-98.036609
48091	Comal	Jama1	RY754	14463211	29.806695	-98.02403
48091	Comal	New Braunfels3	RY1147	16921111	29.678635	-98.181673
48091	Comal	Northcliff	RY1131	16919911	29.653876	-98.227899
48097	Cooke	Gainesville	RY755	14463311	33.641692	-97.145132

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48099	Coryell	Copperas Cove	RY1089	16916711	31.127656	-97.860036
48111	Dallam	Dalhart	RY1305	16925811	36.070668	-102.5148
48113	Dallas	Cadiaz	RY756	14463411	32.776399	-96.827491
48113	Dallas	Carrollton 2	RY1096	16917211	32.959155	-96.878801
48113	Dallas	Dallas	RY956	15529011	32.8577	-96.674332
48113	Dallas	Garland 2	RY1042	16913611	32.888027	-96.673711
48113	Dallas	Irving	RY959	16927111	32.81345	-96.881208
48113	Dallas	Mesquite	RY964	16927611	32.78078	-96.670368
48113	Dallas	Miller Yard	RY962	16927411	32.710739	-96.74846
48117	Deaf Smith	Hereford 2	RY1316	16926611	34.825079	-102.36994
48121	Denton	Denton	RY1006	16910711	33.21336	-97.12698
48121	Denton	Justin	RY1017	16911711	32.996909	-97.354136
48121	Denton	Roanoke	RY1119	16919011	33.00007	-97.230422
48135	Ector	Odessa	RY757	14488911	31.841812	-102.37186
48141	El Paso	Alfalfa	RY759	14463611	31.764201	-106.39349
48141	El Paso	Dallas Street	RY760	14487811	31.758912	-106.47871
48141	El Paso	El Paso 0	RY965	16935211	31.74995	-106.47871
48141	El Paso	El Paso 1	RY1308	16926111	31.753308	-106.49313
48141	El Paso	El Paso 2	RY1309	16930911	31.765651	-106.47961
48141	El Paso	Fort Bliss	RY989	16929411	31.836356	-106.41454
48139	Ellis	Ennis	RY1312	16926411	32.300988	-96.589346
48139	Ellis	Garrett	RY758	14463511	32.343809	-96.636944
48143	Erath	Dublin	RY1003	16910411	32.087055	-98.337189
48143	Erath	Stephenville	RY1156	16922011	32.223114	-98.209424
48149	Fayette	Halsted	RY1029	16912911	29.90784	-96.749174
48153	Floyd	Floydada	RY990	16929511	33.980715	-101.32867
48157	Fort Bend	Kendleton_Intermodal	RY967	16927811	29.463533	-95.974282
48157	Fort Bend	Rosenberg	RY1130	16919811	29.560409	-95.828585
48157	Fort Bend	Sugar Land	RY1155	16921911	29.620307	-95.640544
48157	Fort Bend	Thompsons	RY1145	16920911	29.472938	-95.634893
48161	Freestone	Teague	RY981	16929011	31.63	-96.287795
48167	Galveston	Dickinson	RY1005	16910611	29.459966	-95.044592
48167	Galveston	East 2	RY761	14488011	29.3489	-94.941395
48167	Galveston	Galveston	RY762	14463711	29.30052	-94.823747
48167	Galveston	Texas City	RY763	14463811	29.35393	-94.934279
48177	Gonzales	Harwood1	RY1027	16912711	29.605124	-97.468063
48177	Gonzales	Harwood2	RY1026	16912611	29.666476	-97.501541

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48179	Gray	Pampa 1	RY1054	16914511	35.482466	-101.05536
48179	Gray	Pampa 2	RY968	16927911	35.529388	-100.96277
48181	Grayson	Denison 1	RY1007	16910811	33.7537	-96.534072
48181	Grayson	Ray Yard	RY1306	16925911	33.771553	-96.584119
48181	Grayson	Sherman	RY764	14463911	33.654137	-96.599046
48183	Gregg	Greggton 1	RY1314	16926511	32.503945	-94.811731
48183	Gregg	Greggton 2	RY1034	16933611	32.501706	-94.788586
48183	Gregg	Greggton 3	RY1033	16913111	32.496285	-94.770163
48183	Gregg	Longview	RY765	14464011	32.493149	-94.727315
48185	Grimes	Navasot	RY1151	16921511	30.381244	-96.086452
48189	Hale	Plainview	RY971	16928111	34.192689	-101.69697
48197	Hardeman	Goodlett 2	RY1037	16913311	34.317627	-99.824209
48197	Hardeman	Quanah	RY972	16928211	34.30422	-99.738047
48199	Hardin	Silsbee	RY766	14464111	30.358535	-94.189046
48201	Harris	Basin	RY767	14464211	29.767723	-95.293528
48201	Harris	Bayport North Industrial Park	RY1062	16915111	29.639855	-95.089988
48201	Harris	Booth	RY769	14464311	29.735778	-95.281514
48201	Harris	Coady	RY770	14464511	29.751592	-95.020386
48201	Harris	Congress	RY771	14487711	29.765943	-95.355992
48201	Harris	Deer Park1	RY1079	16931811	29.725726	-95.153921
48201	Harris	Deer Park10	RY1078	16932011	29.704988	-95.085304
48201	Harris	Deer Park11	RY1077	16932111	29.705392	-95.062476
48201	Harris	Deer Park12	RY1076	16932211	29.699268	-95.062862
48201	Harris	Deer Park2	RY1075	16932411	29.724306	-95.143419
48201	Harris	Deer Park3	RY1074	16932311	29.720538	-95.124579
48201	Harris	Deer Park4	RY1030	16932511	29.721127	-95.099948
48201	Harris	Deer Park5	RY987	16932611	29.73898	-95.093049
48201	Harris	Deer Park6	RY1045	16932711	29.733578	-95.080292
48201	Harris	Deer Park7	RY1012	16911211	29.727554	-95.084177
48201	Harris	Deer Park8	RY1011	16932811	29.715635	-95.082191
48201	Harris	Deer Park9	RY1010	16911111	29.713203	-95.111229
48201	Harris	East 1	RY772	14487911	29.797557	-95.292164
48201	Harris	Englewood	RY773	14464611	29.787702	-95.315257
48201	Harris	Erinwilde	RY993	16929811	30.010395	-95.40042
48201	Harris	Eureka	RY774	14488111	29.782728	-95.421667
48201	Harris	Galena Park	RY1313	16935811	29.748052	-95.218042

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48201	Harris	Greens Port	RY1036	16913211	29.75234	-95.196799
48201	Harris	Hardy Street	RY775	14488311	29.771328	-95.356215
48201	Harris	Hockley	RY1023	16912311	30.023641	-95.863606
48201	Harris	Houston1	RY1318	16926811	29.744724	-95.276491
48201	Harris	Houston2	RY1319	16926911	29.715129	-95.262293
48201	Harris	Houston3	RY1021	16912111	29.70115	-95.252357
48201	Harris	La Porte1	RY1187	16924411	29.67599	-95.012984
48201	Harris	La Porte2	RY1186	16924311	29.624278	-95.056247
48201	Harris	Market Street	RY777	14488511	29.717766	-95.286374
48201	Harris	Mykawa	RY778	14464711	29.614838	-95.302751
48201	Harris	New South	RY779	14488611	29.70433	-95.329046
48201	Harris	North Yard	RY780	14488811	29.754853	-95.290042
48201	Harris	Old South	RY781	14464811	29.721474	-95.335379
48201	Harris	Pasadena1	RY969	16931011	29.722678	-95.199411
48201	Harris	Pasadena2	RY1199	16925211	29.727417	-95.174135
48201	Harris	Settegast	RY783	14489111	29.82028	-95.289579
48201	Harris	South	RY784	14489211	29.750607	-95.345575
48201	Harris	Spring	RY1157	16922111	30.05954	-95.409357
48201	Harris	Strang	RY785	14464911	29.680663	-95.039661
48201	Harris	Taylor Lake Village	RY1150	16921411	29.60348	-95.0108
48201	Harris	Woodgate	RY1132	16920011	29.913467	-95.502106
48203	Harrison	Ferguson Creek Reservoir	RY991	16929611	32.440928	-94.68728
48203	Harrison	Longview Heights	RY1172	16923411	32.503887	-94.639639
48203	Harrison	Marshall	RY786	14465011	32.55855	-94.367461
48209	Hays	Jama2	RY787	14488411	29.844798	-97.975179
48209	Hays	Mountain City	RY1175	16923511	30.050715	-97.860152
48211	Hemphill	Canadian	RY1098	16917411	35.906492	-100.4007
48211	Hemphill	Glazier	RY1039	16913411	36.011836	-100.2578
48215	Hidalgo	Alamo	RY1071	16915911	26.177803	-98.088345
48215	Hidalgo	Edinburg1	RY1000	16910111	26.318662	-98.163969
48215	Hidalgo	Kane	RY1129	16919711	26.207663	-98.247463
48215	Hidalgo	Mission	RY1165	16922811	26.214564	-98.329242
48217	Hill	Hillsboro	RY1024	16912411	32.009497	-97.133451
48221	Hood	Cresson	RY1082	16916311	32.535098	-97.621812
48223	Hopkins	Sulphur Springs	RY957	15529111	33.1339	-95.599774
48227	Howard	Big Spring	RY789	14465111	32.25336	-101.48547

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48227	Howard	Ziler	RY973	16928311	32.272861	-101.40899
48231	Hunt	Greenville	RY790	14465211	33.137239	-96.133632
48233	Hutchinson	Borger 1	RY1048	16914011	35.656805	-101.39016
48233	Hutchinson	Phillips	RY1195	16924911	35.689992	-101.36805
48239	Jackson	La Ward1	RY1185	16924211	28.816099	-96.504261
48239	Jackson	Point Comfort4	RY1190	16934711	28.709149	-96.543012
48239	Jackson	Redfish Lake	RY1125	16919311	28.78962	-96.548613
48241	Jasper	Jasper	RY960	16927211	30.925756	-93.984383
48245	Jefferson	Amelia	RY791	14465311	30.06967	-94.222215
48245	Jefferson	Beaumont0	RY792	14465411	30.084803	-94.112368
48245	Jefferson	Beaumont1	RY1072	16930711	30.068821	-94.07643
48245	Jefferson	Beaumont2	RY1056	16914611	30.075981	-94.090309
48245	Jefferson	Beaumont3	RY1055	16930811	30.083773	-94.095049
48245	Jefferson	Central Gardens1	RY1095	16931411	29.986176	-93.991318
48245	Jefferson	Central Gardens2	RY1094	16917111	29.999693	-93.983808
48245	Jefferson	Chaison	RY793	14465511	30.054845	-94.074835
48245	Jefferson	Guffy	RY794	14465611	30.019666	-94.082543
48245	Jefferson	Jefferson County1	RY961	16927311	30.078028	-94.242501
48245	Jefferson	Port Neches	RY1128	16919611	29.984083	-93.946568
48245	Jefferson	Port_Neeches	RY966	16927711	29.937528	-93.945796
48245	Jefferson	Portarthur	RY795	14465711	29.879483	-93.952974
48245	Jefferson	Smith Island	RY1105	16917911	30.061217	-94.042518
48245	Jefferson	Sunnyside	RY796	14465811	30.079539	-94.128833
48245	Jefferson	West Port Arthur1	RY1137	16935411	29.842258	-93.957541
48245	Jefferson	West Port Arthur2	RY1136	16920311	29.853767	-93.948576
48249	Jim Wells	Alice	RY1183	16924011	27.74792	-98.081037
48251	Johnson	Alvarado	RY1069	16915711	32.410154	-97.162628
48251	Johnson	Cleburne	RY797	14465911	32.3539	-97.383291
48271	Kinney	Spofford	RY799	14466011	29.168379	-100.4024
48281	Lampasas	Lometa	RY800	14466311	31.235143	-98.403714
48289	Leon	Newby	RY1144	16920811	31.349208	-96.169407
48291	Liberty	Hightower	RY1317	16926711	30.372323	-95.016209
48291	Liberty	Hull	RY958	16927011	30.141691	-94.631271
48291	Liberty	Stilson	RY978	16928811	30.005911	-94.904853
48297	Live Oak	Three Rivers	RY1159	16922311	28.460253	-98.186677
48303	Lubbock	Lubbock	RY801	14466411	33.580156	-101.83688
48303	Lubbock	Slaton	RY802	14466511	33.444147	-101.64069

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48321	Matagorda	Matagorda County1	RY1170	16934111	28.871153	-96.00391
48321	Matagorda	Matagorda County2	RY1169	16923211	28.862906	-96.023213
48321	Matagorda	Wadsworth	RY1140	16920511	28.789652	-95.941567
48323	Maverick	Eagle Pass	RY803	14466611	28.702588	-100.49848
48323	Maverick	Elm Creek1	RY1018	16911811	28.835211	-100.4351
48323	Maverick	Elm Creek2	RY1035	16933011	28.799258	-100.46372
48323	Maverick	Elm Creek3	RY1038	16933111	28.772273	-100.47349
48323	Maverick	Elm Creek4	RY1009	16911011	28.75816	-100.48703
48309	McLennan	Bellmead	RY1302	16925611	31.58012	-97.101521
48309	McLennan	Mcgregor	RY1168	16923111	31.442749	-97.405413
48325	Medina	Hondo	RY1022	16912211	29.344583	-99.176201
48331	Milam	Alcoa Lake	RY1070	16915811	30.561095	-97.070274
48331	Milam	Cameron1	RY1100	16931311	30.846703	-96.981575
48331	Milam	Cameron2	RY1099	16917511	30.874457	-96.978211
48339	Montgomery	Beach2	RY1058	16914811	30.315312	-95.384943
48341	Moore	Cactus 1	RY1046	16913811	36.041154	-101.9948
48341	Moore	Cactus 2	RY1086	16931211	36.028971	-101.97537
48341	Moore	Sunray 1	RY979	16931111	36.007858	-101.8911
48341	Moore	Sunray 2	RY1152	16921611	35.982023	-101.89081
48343	Morris	Daingerfield	RY1080	16916111	32.995427	-94.659246
48343	Morris	Lone Star	RY1178	16923611	32.95318	-94.663554
48343	Morris	Tn	RY1310	16926211	32.924907	-94.712187
48347	Nacogdoches	Nacogdoches	RY1153	16921711	31.60338	-94.659177
48353	Nolan	Sweetwater	RY980	16928911	32.494157	-100.4041
48355	Nueces	Agnesstreetyard	RY804	14487511	27.78563	-97.4848
48355	Nueces	Bishop1	RY1051	16914211	27.566487	-97.8229
48355	Nueces	Corpus Christi1	RY1304	16934811	27.823998	-97.451767
48355	Nueces	Corpus Christi2	RY1073	16916011	27.808592	-97.414636
48355	Nueces	Corpus Christi4	RY1087	16916511	27.821131	-97.426548
48355	Nueces	Corpus Christi6	RY1101	16931611	27.818226	-97.46178
48355	Nueces	Corpus Christi7	RY1085	16931711	27.817454	-97.480121
48355	Nueces	Corpus Christi8	RY1084	16931911	27.830165	-97.504066
48355	Nueces	Corpus Christi9	RY1083	16916411	27.841698	-97.522759
48355	Nueces	Nueces River Rail Yard/Proposed	RY1198	16934311	27.84218	-97.510594
48355	Nueces	Robstown	RY1118	16918911	27.785912	-97.663499
48357	Ochiltree	Perryton Yard	RY1196	16925011	36.401251	-100.80165

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48361	Orange	Lemonville	RY1181	16923811	30.20868	-93.843601
48361	Orange	Mauriceville	RY805	14466711	30.201928	-93.868283
48361	Orange	Mule Island	RY1154	16921811	30.045574	-93.779374
48361	Orange	Orange	RY806	14489011	30.088921	-93.766165
48361	Orange	Orangefield	RY1179	16935711	30.093865	-93.808438
48361	Orange	Owens-Illinois Reservoir	RY1189	16924511	30.214838	-93.748731
48361	Orange	Plant Reservoir1	RY1193	16934411	30.049283	-93.758592
48361	Orange	Plant Reservoir2	RY1192	16924711	30.056401	-93.762297
48361	Orange	Rose City	RY1116	16918711	30.084554	-94.07519
48361	Orange	Vidor	RY1141	16930211	30.099047	-94.005519
48361	Orange	West Orange	RY1138	16930411	30.068852	-93.768584
48365	Panola	Beckville	RY1301	16925511	32.231131	-94.50244
48369	Parmer	Farwell	RY992	16929711	34.390702	-103.03883
48371	Pecos	Pecos	RY970	16928011	31.409243	-103.51915
48375	Potter	Amarillo 1	RY1068	16930511	35.286018	-101.74415
48375	Potter	Amarillo 2	RY808	14466811	35.192681	-101.83187
48375	Potter	Amarillo 3	RY1066	16915511	35.217033	-101.79963
48375	Potter	Amarillo 4	RY1065	16915411	35.204283	-101.746
48375	Potter	Amarillo 5	RY1064	16915311	35.197775	-101.69289
48381	Randall	Amarillo 0	RY809	14487611	35.175463	-101.83828
48381	Randall	Canyon	RY1097	16917311	35.121278	-101.85741
48395	Robertson	Hearne 1	RY810	14466911	30.874762	-96.589704
48395	Robertson	Hearne 2	RY1315	16930311	30.864016	-96.603899
48399	Runnels	Ballinger	RY1063	16915211	31.738243	-99.950347
48401	Rusk	Dirgin	RY1004	16910511	32.260767	-94.566016
48409	San Patricio	Del Sol-Loma Linda	RY1008	16910911	28.010168	-97.529368
48409	San Patricio	Gregory1	RY1032	16933711	27.925216	-97.296283
48409	San Patricio	Gregory2	RY1031	16913011	27.910357	-97.267706
48409	San Patricio	Odem	RY1107	16918111	27.952409	-97.579317
48415	Scurry	Snyder	RY811	14467011	32.734416	-100.92016
48419	Shelby	Tenaha 2	RY983	16929211	31.940529	-94.278078
48423	Smith	Tyler	RY812	14489411	32.360122	-95.288832
48423	Smith	Winona	RY1133	16920111	32.441579	-95.187055
48439	Tarrant	Berkeley Place	RY1052	16914311	32.718943	-97.344553
48439	Tarrant	Centennial	RY813	14467111	32.725212	-97.376769
48439	Tarrant	Ft Worth	RY814	14467211	32.745423	-97.322403

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48439	Tarrant	Great Southwest	RY815	14488211	32.742351	-97.062948
48439	Tarrant	Hodge	RY816	14467311	32.826229	-97.332881
48439	Tarrant	North	RY817	14488711	32.783278	-97.335054
48439	Tarrant	Saginaw	RY818	14467411	32.842821	-97.358468
48439	Tarrant	Tower 55	RY819	14489311	32.743856	-97.323574
48441	Taylor	Abilene	RY1016	16911611	32.448959	-99.728013
48449	Titus	Lake Monticello	RY1184	16924111	33.091947	-95.033686
48449	Titus	Mount Pleasant	RY820	14467611	33.159441	-94.966074
48451	Tom Green	San Angelo 2	RY1110	16918411	31.496793	-100.41152
48453	Travis	Northtech Business Center	RY1117	16918811	30.444777	-97.711953
48463	Uvalde	Dabney	RY1081	16916211	29.163283	-100.09063
48463	Uvalde	Mine	RY1166	16922911	29.14162	-100.03964
48465	Val Verde	Del Rio	RY821	14467711	29.362357	-100.90551
48469	Victoria	Bloomington1	RY822	14467811	28.644604	-96.89578
48469	Victoria	Bloomington2	RY1049	16914111	28.661921	-96.871432
48469	Victoria	Raisin	RY1126	16919411	28.771198	-97.090286
48469	Victoria	Victoria2	RY1142	16920611	28.821866	-96.946411
48473	Waller	Katy	RY1013	16911311	29.792335	-95.856356
48475	Ward	Monahans	RY1162	16922511	31.591845	-102.90593
48477	Washington	Quarry	RY1127	16919511	30.315691	-96.511282
48479	Webb	El Cuatro	RY1014	16911411	27.506138	-99.516703
48479	Webb	Laredo	RY823	14467911	27.522694	-99.516579
48479	Webb	Laredo_Yard	RY1202	16925411	27.501126	-99.402717
48479	Webb	Lax	RY1182	16923911	27.498554	-99.490273
48479	Webb	Milo Distribution Center	RY1167	16923011	27.613699	-99.484956
48479	Webb	Missouri Pacific Railyards	RY1164	16922711	27.666101	-99.445618
48479	Webb	Tejas Industrial Park	RY1149	16921311	27.587831	-99.502833
48479	Webb	Tex-Mex Industrial Park	RY1148	16921211	27.511634	-99.452059
48485	Wichita	Electra	RY1015	16911511	34.029564	-98.921597
48485	Wichita	Iowa Park	RY1019	16911911	33.949852	-98.663938
48485	Wichita	Kay-Bub	RY1088	16916611	33.862578	-98.590921
48485	Wichita	Wichita Falls 1	RY1135	16935611	33.929796	-98.502339
48485	Wichita	Wichita Falls 2	RY984	16929311	33.908664	-98.483341
48485	Wichita	Wichita Falls 3	RY1134	16920211	33.931061	-98.541143

Appendix B. Texas Switch Yard Locations

FIPS Code	County Name	Facility Name	Alternative ID	EIS ID	Latitude	Longitude
48487	Wilbarger	Vernon	RY1143	16920711	34.161473	-99.283779
48491	Williamson	Georgetown	RY1040	16913511	30.620467	-97.680647
48491	Williamson	Liberty Hill	RY1180	16923711	30.64779	-97.885799
48491	Williamson	Round Rock1	RY1114	16935311	30.523004	-97.696295
48491	Williamson	Round Rock2	RY1113	16935111	30.53806	-97.699185
48491	Williamson	Round Rock3	RY1112	16935511	30.554088	-97.698567
48491	Williamson	Round Rock4	RY1111	16918511	30.570614	-97.698318
48491	Williamson	Soil Conservation Service Site 10A	RY1115	16918611	30.588143	-97.696639
48491	Williamson	Taylor	RY826	14468011	30.567394	-97.414481
48493	Wilson	Mission Rail Elmendorf	RY976	16928611	29.232801	-98.302306
48497	Wise	Chico	RY1303	16925711	33.274931	-97.795768
48499	Wood	West Mineola	RY1139	16920411	32.669933	-95.522961

Appendix C. Locomotive Emission Control Programs in Texas, 2008-2040

Rail 2008 to 2040 Control Programs

Year	Programs	Application	Notes	Source
2008 to 2040	TxLED	110 Counties	6.2% Reduction in NO_x	https://www.tceq.texas.gov/assets/public/legal/rules/rule_lib/adoptions/09001114_aex.pdf
2008	TERP	Statewide	NO_x reduced by 4507 tons this year to various counties (listed in detail in the TERP table)	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	More stringent PM and NO_x standards for remanufactured locomotives starting in 2008. - Full implementation of the rule will result in PM reductions of 90% and NO_x reductions of 80% compared to current 2008 standards.	http://www.epa.gov/nonroad/420f08004.pdf
2008 to 2011	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	More stringent PM and NO_x standards for new locomotives starting in 2008.	http://www.epa.gov/nonroad/420f08004.pdf
2009	TERP	Statewide	NO_x reduced by 4392 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2010	TERP	Statewide	NO_x reduced by 4509 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2011	TERP	Statewide	NO_x reduced by 4327 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2012	Fuel Sulfur limit	Nationwide, Incorporated into EPA's EF's already	Sulfur content of diesel fuel limited to 15 ppm starting in June. Included in EPA's Diesel fuel emission factors for locomotives.	http://www.epa.gov/OTAQ/fuels/dieselfuels/index.htm
	TERP	Statewide	NO_x reduced by 3,225	https://www.tceq.texas.gov/a

Appendix C. Locomotive Emission Control Programs in Texas, 2008-2040

Rail 2008 to 2040 Control Programs				
Year	**Programs**	**Application**	**Notes**	**Source**
			tons	ssets/public/comm_exec/pubs/sfr/079_08.pdf
2012 to 2014	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	New locomotives required to apply Tier 3 standards to remanufactured and new locomotives to reduce PM and NO_x emissions. Also creates new idle reduction requirement for new and remanufactured locomotives.	http://www.epa.gov/nonroad/420f08004.pdf
2013	TERP	Statewide	NO_x reduced by 3,349 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2014	TERP	Statewide	NO_x reduced by 3,349 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2015 to 2040	Control of Emissions of Air Pollution for Locomotive Engines and Marine Compression-ignition Engines Less than 30 Liters per Cylinder	Nationwide, Incorporated into EPA's EF's already	New locomotives required to use Tier 4 high-efficiency catalytic after treatment technology.	http://www.epa.gov/nonroad/420f08004.pdf
2015	TERP	Statewide	NO_x reduced by 1,473 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2016	TERP	Statewide	NO_x reduced by 649 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2017	TERP	Statewide	NO_x reduced by 638 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2018	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2019	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2020	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pub

Appendix C. Locomotive Emission Control Programs in Texas, 2008-2040

Rail 2008 to 2040 Control Programs				
Year	**Programs**	**Application**	**Notes**	**Source**
				s/sfr/079_08.pdf
2021	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2022	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2023	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2024	TERP	Statewide	NO_x reduced by 608 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2025	TERP	Statewide	NO_x reduced by 598 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2026	TERP	Statewide	NO_x reduced by 534 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2027	TERP	Statewide	NO_x reduced by 482 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2028	TERP	Statewide	NO_x reduced by 482 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2029	TERP	Statewide	NO_x reduced by 324 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2030	TERP	Statewide	NO_x reduced by 149 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2031	TERP	Statewide	NO_x reduced by 149 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf
2032	TERP	Statewide	NO_x reduced by 149 tons	https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/079_08.pdf

APPENDIX 11

DEVELOPMENT OF THE STATEWIDE AIRCRAFT INVENTORY FOR 2011

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-
BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER
PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE
2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY
STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Eastern Research Group, Inc.

Development of the Statewide Aircraft Inventory for 2011

Final

Prepared for:

Texas Commission on
Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

May 13, 2019

ERG No. 0345.00.002

DEVELOPMENT OF THE STATEWIDE AIRCRAFT INVENTORY FOR 2011

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1.0 Executive Summary

The purpose of this study is to develop a set of average summer weekday (tons per day) emission inventories (EI) for Texas airport activities based on a 2011 base year.

Eastern Research Group (ERG) developed emissions inventories for criteria and hazardous air pollutants (HAPs). The inventories will be used to support the State Implementation Plan (SIP) and other airport-related inquiries.

The emissions associated with airport activities are attributed to the following sources with associated source classification codes (SCC):

- Commercial aviation (SCC: 2275020000)
- Air taxis
  - Piston driven (SCC: 2275060011)
  - Turbine driven (SCC: 2275060012)
- General aviation
  - Piston driven (SCC: 2275050011)
  - Turbine driven (SCC: 2275050012)
- Military (SCC: 2275001000)
- Auxiliary Power Units (SCC: 2275070000)
- Ground Support Equipment
  - Compressed natural gas (CNG)-fueled (SCC: 2268008005)
  - Diesel-fueled (SCC: 2270008005)
  - Gasoline-fueled (SCC: 2265008005)
  - Liquefied petroleum gas (LPG)-fueled (SCC: 2267008005).

To estimate emissions from these sources, ERG used the original activity data obtained for Work Order 582-11-99776-FY12-09 for calendar year 2011 which included local airport data and publicly available activity data. Additionally, ERG, via TCEQ, also obtained local aircraft specific data from the DFW area from the North Central Texas Council of Governments (NCTCOG) during the previous work order as well. Two approaches were used to estimate emissions from the compiled activity data. For activity data that included aircraft-specific data, ERG used the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT) to estimate emissions. If such detailed data were not available, ERG applied a more general approach for different aircraft types (i.e., air taxis, general aviation, and military aircraft) using the United States Environmental Protection Agency's (EPA) available generic emission estimating procedures for the National Emission Inventory (NEI). Additional information on methodology are included later in the document.

In 2011, general aviation aircraft outfitted with piston engines account for 27.9% of the total aircraft activities. This included the data obtained from DFW. General aviation aircraft outfitted with jet engines, commercial aircraft, air taxi aircraft outfitted with piston engines, military aircraft, and air taxi aircraft outfitted with jet engines, and account for 23.9%, 16.5%, 14.6%, 8.6%, and 8.4% of the total aircraft activities, respectively. Harris County and Tarrant County had the highest aircraft activity, accounting for 14.8% and 11.4% respectively of all Texas activity.

2.0 Introduction

2.1 Purpose and Objectives

The purpose of this study is to develop a set of area-specific average summer weekday (tons per day) EIs for all airport sources including aircraft, Auxiliary Power Units (APU), and Ground Support Equipment (GSE) to support airport related inquires.

To develop the comprehensive inventories for the aircraft source category, ERG conducted the following tasks:

- Recompile previously collected 2011 activity data from local airports and publicly available data sources.
- Calculate 2011 emission estimates using FAA's AEDT 2d and generic emission factors.
- Project 2011 activity and emission estimates to 2017, 2018, 2020, and 2021, using the FAA's Terminal Area Forecast (TAF) dataset.
- Calculate average summer weekday emissions.
- Summarize activity and emissions data.

It should be noted that the engine-specific factors used in the AEDT model were derived from testing data used to certify the engines and account for U.S. and international emissions standards. The inventories will be used to support the airport-related inquires.

Section 3.0 of this report identifies the national and local activity data sources included in this study. This section describes how ERG pulled from each activity data source to compile the 2011 activity dataset. This section also documents any assumptions or adjustments that were made to each data source to facilitate the development of the activity dataset.

Section 4.0 summarizes the emissions estimation methodology and also summarizes the activity and emission projection procedures for 2011. This section includes summary emissions tables on a county-level basis by SCC for criteria pollutants.

The criteria and HAP emissions associated with airport activities are included in the Excel Files submitted with this report for 2011.

2.2 Background

This report covers airport activities as point sources in the emission calculation but are summarized as nonroad sources. The AEDT model treats airports as point/facilities. Once the emissions are estimated the data are aggregated to the county level as nonroad sources. The aircraft source category includes all aircraft types used for public, private, and military purposes. The emissions associated with airport activities are attributed to the following sources with associated SCC:

- Commercial aviation (SCC: 2275020000)
- Air taxis
  - Piston driven (SCC: 2275060011)
  - Turbine driven (SCC: 2275060012)
- General aviation
  - Piston driven (SCC: 2275050011)
  - Turbine driven (SCC: 2275050012)
- Military (SCC: 2275001000)
- Auxiliary Power Units (SCC: 2275070000)
- Ground Support Equipment
  - Compressed natural gas (CNG)-fueled (SCC: 2268008005)
  - Diesel-fueled (SCC: 2270008005)
  - Gasoline-fueled (SCC: 2265008005)
  - Liquefied petroleum gas (LPG)-fueled (SCC: 2267008005).

Commercial aircraft transport passengers, freight, or both and tend to be larger aircraft that are driven with jet engines. Air taxis (AT), which are also considered to be commercial aircraft, are usually smaller aircraft (less than 60 passengers) that operate on a limited basis compared to larger commercial aircraft that carry between 60 and 800 passengers. General aviation (GA) includes most other aircraft used for recreational flying and personal transportation. Aircraft that support business travel, usually on an unscheduled basis, are included in the GA category.

Aircraft tend to emit significant amounts of air pollutants. The national AT and GA fleet includes both jet and propeller-driven aircraft. Most of the AT and GA fleet are comprised of piston- (or propeller-) driven aircraft, though these aircraft types also include smaller business jets and turboprops. The piston-driven aircraft tend to have higher VOC emissions and lower NO_x emissions than larger turbine-powered aircraft. According to the EPA, propeller-driven aircraft and turbine-driven aircraft account for 72.1% and 27.9%, respectively, of all GA emissions. Propeller-driven aircraft and turbine-driven aircraft account for 21.8% and 78.2%, respectively, of all AT emissions[1]. EPA has used this estimate as a national-scale default value in recently published studies investigating lead emissions from aviation sources.

Military aircraft comprise a wide range of aircraft types such as training aircraft, fighter jets, helicopters, and jet- and propeller-driven cargo planes of varying sizes. Because of a lack of information concerning the make-up of the military aircraft fleet, EPA has assumed that most military aircraft are jet-powered.

Aircraft emissions are associated with an aircraft's landing and takeoff (LTO) cycle. The cycle begins when the aircraft approaches the airport on its descent from cruising altitude, then lands and taxis to the gate, where it idles during passenger deplaning. The cycle continues as the aircraft idles during passenger boarding, taxis back onto the runway, takes off, and ascends (or climbs out) to cruising altitude. Figure 2-1 illustrates the six specific operating modes in an LTO cycle:

- Approach
- Taxi/idle-in
- Taxi/idle-out
- Idling
- Takeoff
- Climb out.

The LTO cycle provides a basis for calculating aircraft emissions associated with airports. During each mode of operation, an aircraft engine operates at a specific power setting and fuel consumption rate for a given aircraft make and model. Emissions for one complete cycle are calculated by multiplying emission factors for each operating mode for each specific aircraft engine and the typical period of time the aircraft is operating.

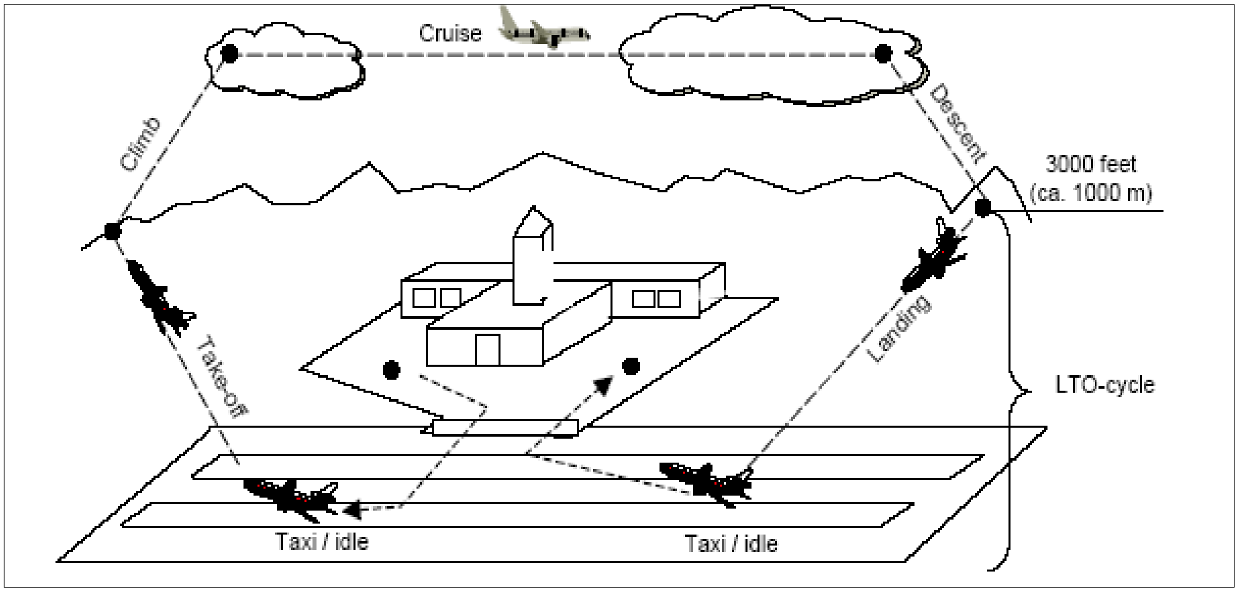

Figure 2-1. Landing and Takeoff Cycle

3.0 Data Sources of Texas Airport Activities Inventoried

ERG used detailed activity data obtained for work order 582-11-99776-FY12-09 for calendar year 2011 as well as data from NCTCOG to develop a base year inventory for Texas airports. The DFW data from NCTCOG was not part of the previous work order but was obtained during the work order so it could be incorporated in the inventory to a comprehensive inventory for the entire state of Texas. The original 2011 activity data ERG compiled, including DFW area data from NCTCOG, is presented in Appendix A. Below is a brief discussion of the work done in the previous work order to obtain the activity data.

3.1 National Data Sources of Texas Airport Activities

To estimate emissions from aircraft operating in Texas, ERG used the activity data compiled by EPA intended for use in the 2011 National Emissions Inventory (NEI). Activity data were compiled from the following sources:

- Bureau of Transportation Statistics (BTS) T-100 segment dataset,[2]
- FAA Terminal Area Forecast (TAF) dataset/Air Traffic Activity System (ATADS) and [3, 4]
- FAA Airport Master Record (5010) dataset.[5]

The compiled data are adjusted for duplicates associated with the three datasets and supplemented with local data discussed further in Section 3.1.4. This section discusses each data source investigated for this project summarizing the publicly available data and noting any limitations or data gaps.

3.1.1 T-100 Dataset

The T-100 data is an activity dataset that includes information provided by domestic and international commercial air carriers. During the time period of this study, only January through August activity data were available for 2011. In order to obtain the missing months from the 2011 activity dataset, data from September through December for 2010 were adjusted to reflect 2011 data using scale factors developed from the TAF dataset. This dataset had the most specific data of the three datasets. The T-100 data included airport, aircraft make and model, and LTO cycle data. The engine information was incorporated into the dataset from the FAA's AEDT default engine list. The aircraft categories were assigned to each aircraft with the assumption that T-100 only includes commercial aircraft and air taxis. Aircraft were assigned the AT aircraft category, if the number of seats on the aircraft were less than or equal to 60, otherwise the aircraft was assigned to the commercial air carrier (AC) category Appendix A summarizes the T-100 data used for this study.

3.1.2 TAF Dataset

The TAF dataset is an FAA dataset derived from a variety of sources such as reported traffic at FAA towered facilities, data reported directly by airports and FAA derived estimates from historical information. This dataset includes airport, aircraft categories, and operations data.

The aircraft categories included AC, AT, military (MIL), and GA. It can be assumed that 72.1% of all GA activity are powered by propeller-driven aircraft and 27.9% are jet (or turbine) driven; and 21.8% of all AT activity are powered by propeller-driven aircraft and 78.2% are jet (or turbine) driven. The aircraft categories from AT and GA were broken out into piston and jet engines. This breakout is important because piston engines have different emission factors than jet engines.

For consistency between the other two datasets, the TAF operations data were converted into LTO cycles. There was overlap between the TAF dataset and T-100 dataset. The T-100 activity had a higher priority than the TAF dataset because it had greater detail; consequently, the duplicate data were removed from the TAF dataset.

3.1.3 5010 Dataset

The 5010 dataset was EPA compiled data from the FAA's airport 5010 master plan data and estimated activity levels based on statistical techniques described in greater detail in the EPA aviation lead report from December 2010[6]. The 5010 data were provided to the states via the EPA's National Emissions Inventory (NEI). This data includes airport, aircraft categories, and LTO cycle data.

The aircraft categories include AC, AT, MIL, and GA. The aircraft categories provided by the EPA in the 5010 dataset were AT and GA broken out into piston and jet engines as they tend to include some of the smallest airports and landing strips.

3.2 Contacting Airports

The medium to large airports were contacted in order to provide 2011 activity data and to identify and characterize control strategies used or planned at each airport. The medium to large airports identified for contacting were based on estimated activity levels. Thirty-five candidate airports were identified that had 19,000 LTO cycles or more in the previous 2008 inventory. These candidate airports accounted for 32% of the activity in Texas, not including airports included in the DFW Metropolitan Planning Organizations' planning area. DFW area airports provided data separately through NCTCOG. ERG did not need to contact NCTCOG. Prior to the project, NCTCOG had already agreed to provide TCEQ their activity and emissions data.

Once the medium to large candidate airports were identified, each airport was contacted by telephone and asked to provide the following.

- 2011 landing & take-off data for the airport,
- Average taxi-in and taxi-out times for the airport, and
- List emission control strategies (i.e. gate electrification, auxiliary power units, etc.) for 2011and the expected emission reduction.

Of the airports contacted 40% of the airports submitted 2011 operations data, 26% submitted taxi time estimates, and 11% provided control strategies. ERG located 2011 operations data for 9% of the airports by conducting internet searches at each airport website.

3.2.1 Summary of Local Data Received

As noted in the previous section, ERG collected local data from 49% of the airports contacted (40% of the airports submitted data and ERG located data for an additional 9% of the airports by conducting internet searches). In addition, 26% of the airports submitted taxi time estimates and 11% provided emission control strategies.

The local data was available in different formats depending on how each airport recorded airport activity. The 2011 operations data were submitted as annual totals, annual totals by generic aircraft type categories, or annual totals by specific aircraft make and model.

For additional details on local data, please refer to Development of Statewide Annual Emissions Inventory and Activity Data for Airports, Final Report TCEQ Contract No. 582-11-99776, Work Order No. 582-11-99776-FY12-09.

4.0 Summary of 2011 Emissions Development

4.1 Emission Estimation Methodology

To develop the most accurate aircraft emission inventory possible, ERG took two different approaches. If aircraft-specific data were available, ERG used the FAA's AEDT model in conjunction with detailed aircraft activity data from T-100 (see Appendix A for T-100 data). If such detailed data were not available, then ERG applied a more general approach for different aircraft types (i.e., air taxis, general aviation, and military aircraft) using available generic emission estimating procedures. Using these two complementary approaches provides the most accurate emission estimates for the larger commercial jets, which tend to be the most significant aircraft emission source, while still providing estimates for smaller aircraft.

4.1.1 Aircraft Specific Estimation Methodology (AEDT)

AEDT was used for the aircraft-specific activity data. To pull the data into AEDT, EDMS legacy files were employed. The aircraft-specific activity data were formatted and imported into EDMS. Once the data were in EDMS and quality checks implemented, the EDMS study was exported into an EDMS legacy text file.

Through extensive EDMS legacy file testing, edits were made to the file to successfully import into AEDT. Empty International Civil Aviation Organization (ICAO) airport codes were populated with FAA airport codes to prevent the appearance of duplicates during the EDMS to ASIF file conversion. ASIF is an XML file format created by FAA specific to AEDT for importation. Through this conversion, a unique airport code is required.

Additional changes to the EDMS legacy file included updating two outdated aircraft/engine combinations and updating the fuel type for one Ground Support Equipment (GSE) code.

- ERJ140/AE3A13 and B757-3/PW2043 required engine code updates: PW2043 to XPW204, and AE3A13 to 6AL011.
- The GSE code "21", Taylor Dunn – Cart, fuel type was updated from D (diesel) to G (gasoline).

Once the EDMS legacy file was successfully imported into AEDT, additional tweaks were required. These updates included:

- Dallas Love Field/Lockheed P-3 Orion updated to Lockheed P-3 Orion ANP:P3A (Lockheed P-3 Orion did not have a flight path)
- Engine 1PW003 updated to 1PW002. (1PW003 and an index of -1)

After confirming all operations had been successfully imported into AEDT, the emissions inventory was run and exported into two .csv files, one file for aircraft operations and one file for criteria emissions. Two files were exported due to how the AEDT software was designed. These files were exported and formatted for the fight path below mixing height, APU operations, and GSE operations. The emissions were converted from grams to short tons, and additional IDs were added to each file, including state facility identifier, SCC codes, and aircraft engine type codes. The emissions data were exported as emission factors; these emission factor data were multiplied by the operations to estimate total emissions by aircraft type and airport.

4.1.2 Generic Emissions Estimating Procedures

AEDT can provide emission estimates if the aircraft make and model are known. Often this is not the case for air taxis, general aviation, and military aircraft activity in the TAF and 5010 datasets. For smaller airports in Texas without aircraft specific activity from the T100, ERG used the generic approach that relies upon representative criteria emission factors and HAP Speciation Profiles provided by EPA[7,8,9], using the following equation:

$$E_{ixj} = LTO_i \times FR_x \times EF_{ij}$$

Where:

E_{ixj} = Emission estimate for aircraft type i equipped with engine type x and pollutant j (lbs/year)
LTO_i = Annual count of LTO cycles for aircraft type i
FR_x = Fraction of LTOs equipped with engine type x
EF_{ij} = Generic emission factor for aircraft type i equipped with engine type x and pollutant j (lbs/LTO)
i = Aircraft type (i.e., air taxi, general aviation, and military)
x = Engine type (i.e., jet or turboprop, and piston engine)
j = Criteria pollutant j

Critical to the calculation is the application of representative emission factors that account for the different aircraft in the national fleet. Table 4-1 lists the generic emission factors for Criteria Pollutants by aircraft type.

As discussed above, when the GA and AT breakout is unknown, EPA has assumed that 72.1% of all GA activity are powered by propeller-driven aircraft and 27.9% are jet- (or turbine) driven; and 21.8% of all AT activity are powered by propeller-driven aircraft and 78.2% are jet- (or turbine) driven. The 5010 data had the piston and jet engines already disaggregated.

Table 4-1. Emission Factors for Aircraft Types (pounds per LTO)[9]

Aircraft Type	Pollutant					
	CO	NO_x	$PM_{10\text{-PRI}}$	$PM_{2.5\text{-PRI}}$	SO_x	VOC
Commercial	22.38	18.58	1.08	1.05	1.78	6.16
Air Taxi (turbine)	3.61	0.78	0.60	0.59	0.16	1.01
Air Taxi (propeller)	28.13	0.16	0.60	0.42	0.02	0.17
General Aviation (turbine)	9.58	0.32	0.24	0.23	0.07	0.69
General Aviation (propeller)	12.01	0.07	0.24	0.16	0.01	0.15
Military	25.96	22.33	1.39	1.36	2.11	10.87

It should be noted that the military emission factors were updated since the previous 2011 inventory was calculated; therefore, military emissions will indicate an overall increase.

4.1.3 Controlled and Uncontrolled 2011 Base Year Inventory

This project required controlled and uncontrolled baseline 2011 inventories. The updated inventory served as the uncontrolled 2011 emissions inventory, and the controlled 2011 baseline inventory was adjusted to account for APU control strategies.

APU emissions can be reduced by using electricity and pretreated ventilation air from the terminals. Where local data indicated that such activities are part of the facilities emission reduction strategy, ERG reduced APU emissions by 90% based on EPA guidance for the following airports:

- George Bush Intercontinental (IAH)
- Austin-Bergstrom Intl. (AUS)
- William P Hobby (HOU)
- San Antonio Intl. (SAT)
- El Paso Intl (ELP)
- Lubbock Preston Smith Intl. (LBB)
- Valley Intl. (HRL).

No control information were obtained from NCTCOG.

4.1.4 Calculating Summer Daily Emissions

Summer weekday emissions for the analysis years 2011 were developed by dividing annual emissions by 365. T-100 data were analyzed to assess if there were any significant seasonality that would warrant a different factor. There was no significant difference. For consistency with past inventories the 1/365 factor (0.00274) was used.

4.2 Summary of Texas Airport Emissions

The results of implementing the emission estimation methodology for the years 2011 are presented in Table 4-2 through Table 4-6. It is important to note that emissions may seem abnormally high for Wichita County compared to previous inventories, but emissions are correct. This is due to the higher than normal military activity from Sheppard Air Force Base (SPS) in Wichita County and the fact that the generic military emission factors were updated by the EPA recently. Emissions for all counties are in Appendix C and D. Figure 4-1 summarizes the LTOs by county using a color gradient. Quality assurance checks implemented for this project are summarized in Appendix E.

Table 4-2. 2011 Controlled and Uncontrolled Daily Criteria Emissions Compared to Previous Controlled (Tons Per Day)

Pollutant	Controlled Emissions	Uncontrolled Emissions	Previous Controlled Emissions*
CO	149.12	149.72	115.63
NO_X	39.58	39.88	25.16
$PM_{10\text{-PRI}}$	1.93	1.99	1.53
$PM_{25\text{-PRI}}$	1.77	1.83	0.95
SO_2	4.27	4.32	2.68
VOC	16.73	16.78	8.38

* Used FAA's older software (EDMS) and older EPA generic emission factors. For more information refer to Development of Statewide Annual Emissions Inventory and Activity Data for Airports, Final Report TCEQ Contract No. 582-11-99776, Work Order No. 582-11-99776-FY12-09.

Table 4-3. Controlled Daily Criteria Emissions by Type (Tons Per Day)

Type	CO	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
Air Taxi, Piston	30.51	0.04	0.04	0.03	0.03	0.57
Air Taxi, Turbine	7.58	1.63	0.07	0.07	0.27	2.81
APU	0.85	0.39	0.08	0.08	0.07	0.05
Commercial	26.90	22.01	0.18	0.18	2.43	3.88
General Aviation, Piston	25.15	0.12	0.42	0.29	0.02	0.35
General Aviation, Turbine	18.15	1.24	0.34	0.34	0.27	2.10
GSE	22.85	2.62	0.09	0.08	0.05	0.79
Military	17.12	11.53	0.71	0.69	1.13	6.17
Totals	**149.12**	**39.58**	**1.93**	**1.77**	**4.27**	**16.73**

Table 4-4. Uncontrolled Daily Criteria Emissions by Type (Tons Per Day)

Type	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC
Air Taxi, Piston	30.51	0.04	0.04	0.03	0.03	0.57
Air Taxi, Turbine	7.58	1.63	0.07	0.07	0.27	2.81
APU	1.45	0.70	0.14	0.14	0.12	0.10
Commercial	26.90	22.01	0.18	0.18	2.43	3.88
General Aviation, Piston	25.15	0.12	0.42	0.29	0.02	0.35
General Aviation, Turbine	18.15	1.24	0.34	0.34	0.27	2.10
GSE	22.85	2.62	0.09	0.08	0.05	0.79
Military	17.12	11.53	0.71	0.69	1.13	6.17
Total	**149.72**	**39.88**	**1.99**	**1.83**	**4.32**	**16.78**

Table 4-5. Controlled Daily Criteria Emission for Top 25 Counties (Tons Per Day)

County	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC	LTO
Harris	2.49E+01	8.66E+00	1.75E-01	1.57E-01	8.38E-01	2.28E+00	2.89E+03
Tarrant	2.99E+01	1.27E+01	2.06E-01	2.05E-01	1.45E+00	3.36E+00	2.46E+03
Medina	7.00E+00	2.10E-01	1.49E-01	1.45E-01	4.81E-02	4.78E-01	1.29E+03
Dallas	1.20E+01	1.70E+00	4.13E-02	4.10E-02	2.28E-01	1.32E+00	9.53E+02
Bexar	8.77E+00	1.15E+00	2.54E-02	2.39E-02	1.44E-01	8.92E-01	5.68E+02
Travis	4.94E+00	1.36E+00	2.35E-02	2.19E-02	1.34E-01	4.72E-01	5.37E+02
Wichita	6.02E+00	4.82E+00	3.08E-01	2.99E-01	4.57E-01	2.35E+00	5.04E+02
Denton	6.57E+00	1.07E-01	9.46E-03	9.41E-03	2.59E-02	3.51E-01	4.77E+02
Brazoria	2.01E+00	1.05E-01	4.78E-02	4.02E-02	1.43E-02	1.06E-01	3.59E+02
El Paso	2.25E+00	7.77E-01	2.92E-02	2.54E-02	8.50E-02	1.93E-01	2.49E+02
Fort Bend	1.21E+00	4.06E-02	2.71E-02	2.12E-02	5.38E-03	4.35E-02	2.04E+02
Midland	1.48E+00	5.70E-01	4.29E-02	3.94E-02	5.81E-02	2.59E-01	1.85E+02
Nueces	1.78E+00	1.02E+00	6.78E-02	6.45E-02	1.01E-01	4.90E-01	1.80E+02
Lubbock	1.29E+00	3.49E-01	2.62E-02	2.31E-02	3.68E-02	1.42E-01	1.75E+02
Collin	2.89E+00	7.49E-02	5.31E-03	5.27E-03	1.73E-02	3.10E-01	1.69E+02
Hidalgo	1.16E+00	2.30E-01	2.49E-02	2.11E-02	2.84E-02	9.10E-02	1.66E+02
Williamson	9.44E-01	2.20E-02	2.01E-02	1.56E-02	3.28E-03	2.97E-02	1.65E+02
Tom Green	1.38E+00	8.28E-01	6.03E-02	5.72E-02	7.93E-02	4.03E-01	1.49E+02
Cameron	1.26E+00	5.64E-01	3.54E-02	3.29E-02	5.72E-02	2.49E-01	1.47E+02
Bell	1.02E+00	3.24E-01	2.89E-02	2.59E-02	3.30E-02	1.47E-01	1.43E+02
McLennan	9.61E-01	2.67E-01	2.91E-02	2.58E-02	2.69E-02	1.43E-01	1.40E+02
Gregg	7.97E-01	1.09E-01	2.02E-02	1.68E-02	1.11E-02	6.43E-02	1.29E+02
Potter	9.92E-01	5.93E-01	3.61E-02	3.43E-02	5.65E-02	2.53E-01	1.16E+02
Aransas	9.65E-01	5.02E-01	3.91E-02	3.65E-02	4.79E-02	2.52E-01	1.13E+02
Webb	1.05E+00	5.01E-01	3.22E-02	3.03E-02	5.30E-02	2.47E-01	1.09E+02

Table 4-6. Uncontrolled Daily Criteria Emission for Top 25 Counties (Tons Per Day)

COUNTY	CO	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC	LTO
Harris	2.53E+01	8.88E+00	2.16E-01	1.98E-01	8.76E-01	2.31E+00	2.89E+03
Tarrant	2.99E+01	1.27E+01	2.06E-01	2.05E-01	1.45E+00	3.36E+00	2.46E+03
Medina	7.00E+00	2.10E-01	1.49E-01	1.45E-01	4.81E-02	4.78E-01	1.29E+03
Dallas	1.20E+01	1.70E+00	4.13E-02	4.10E-02	2.28E-01	1.32E+00	9.53E+02
Bexar	8.83E+00	1.18E+00	3.08E-02	2.94E-02	1.49E-01	8.96E-01	5.68E+02
Travis	5.03E+00	1.39E+00	3.18E-02	3.02E-02	1.41E-01	4.78E-01	5.37E+02
Wichita	6.02E+00	4.82E+00	3.08E-01	2.99E-01	4.57E-01	2.35E+00	5.04E+02
Denton	6.57E+00	1.07E-01	9.46E-03	9.41E-03	2.59E-02	3.51E-01	4.77E+02
Brazoria	2.01E+00	1.05E-01	4.78E-02	4.02E-02	1.43E-02	1.06E-01	3.59E+02
El Paso	2.29E+00	7.94E-01	3.27E-02	2.89E-02	8.80E-02	1.96E-01	2.49E+02
Fort Bend	1.21E+00	4.06E-02	2.71E-02	2.12E-02	5.38E-03	4.35E-02	2.04E+02
Midland	1.48E+00	5.70E-01	4.29E-02	3.94E-02	5.81E-02	2.59E-01	1.85E+02
Nueces	1.78E+00	1.02E+00	6.78E-02	6.45E-02	1.01E-01	4.90E-01	1.80E+02
Lubbock	1.30E+00	3.55E-01	2.71E-02	2.41E-02	3.77E-02	1.42E-01	1.75E+02
Collin	2.89E+00	7.49E-02	5.31E-03	5.27E-03	1.73E-02	3.10E-01	1.69E+02
Hidalgo	1.16E+00	2.30E-01	2.49E-02	2.11E-02	2.84E-02	9.10E-02	1.66E+02
Williamson	9.44E-01	2.20E-02	2.01E-02	1.56E-02	3.28E-03	2.97E-02	1.65E+02
Tom Green	1.38E+00	8.28E-01	6.03E-02	5.72E-02	7.93E-02	4.03E-01	1.49E+02
Cameron	1.26E+00	5.68E-01	3.61E-02	3.35E-02	5.78E-02	2.50E-01	1.47E+02
Bell	1.02E+00	3.24E-01	2.89E-02	2.59E-02	3.30E-02	1.47E-01	1.43E+02
McLennan	9.61E-01	2.67E-01	2.91E-02	2.58E-02	2.69E-02	1.43E-01	1.40E+02
Gregg	7.97E-01	1.09E-01	2.02E-02	1.68E-02	1.11E-02	6.43E-02	1.29E+02
Potter	9.92E-01	5.93E-01	3.61E-02	3.43E-02	5.65E-02	2.53E-01	1.16E+02
Aransas	9.65E-01	5.02E-01	3.91E-02	3.65E-02	4.79E-02	2.52E-01	1.13E+02
Webb	1.05E+00	5.01E-01	3.22E-02	3.03E-02	5.30E-02	2.47E-01	1.09E+02

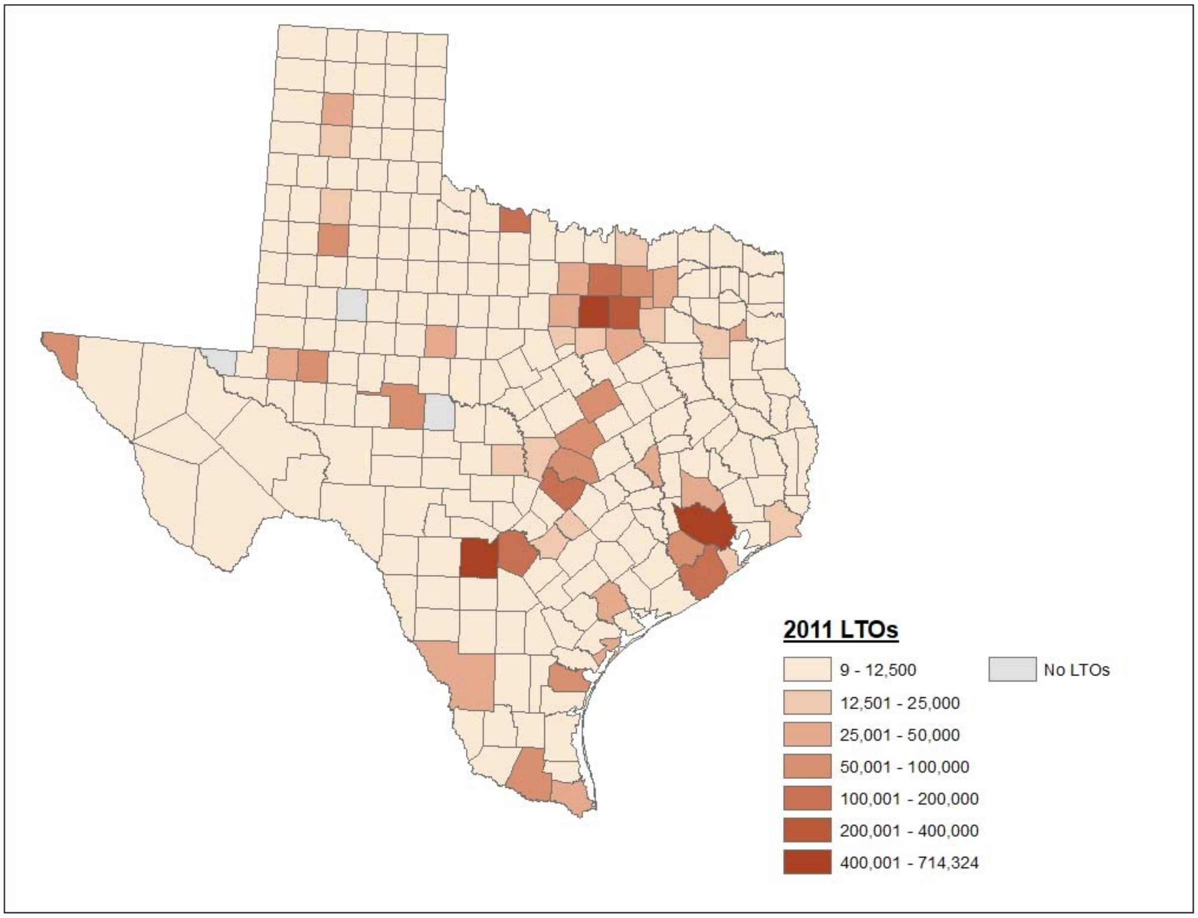

Figure 4-1. 2011 Activity by County (LTOs)

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Appendix A

TCEQ 2011 Activity Data (Including DFW Area Airports from NCTCOG)

Appendix A
TCEQ 2011 Activity Data (Including DFW Area Airports from NCTCOG)

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	00TX	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	0.24101441
2011	00TX	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	11.8097062
2011	01TE	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	750
2011	01TE	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	750
2011	01TE	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	1000
2011	03TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	03TX	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	04TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	04TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	06TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	109.040176
2011	06TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	308.452147
2011	07TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	113.556698
2011	08XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	70.0318392

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	09T	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	39.1116459
2011	09T	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	16.5697409
2011	09T	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	60
2011	0T7	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	495
2011	0T7	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	495
2011	0T7	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	660
2011	0TA0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	0TA0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	0TA5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	0TA5	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	0TA9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	0TA9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	0TS3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	0TS3	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	0TS6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	0TS6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	0XA3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	0XA3	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	10TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	10TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	11TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	11TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	11TE	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	1
2011	12TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	12TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	15XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	77.2859824

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	16X	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	330
2011	16X	2275060011	Air Taxi, Piston	AT	2061	Piper PA-28 Cherokee Series	O320	330
2011	16X	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	440
2011	16XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	95.3609356
2011	19TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	547.886627
2011	19TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	345.202934
2011	1F7	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	2400
2011	1F7	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	2400
2011	1F7	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	3200
2011	1TA0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	1TA0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	1TA3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	1TA3	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	1TA9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	1TA9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	1TE2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	286.689718
2011	1TS0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	55.2348463
2011	1TS1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	1TS3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	77.8615079
2011	1TS5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	1TS5	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	1XA4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	16.478206
2011	1XA4	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	6.90405869
2011	1XA9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	1XA9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	1XS1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	293.943861
2011	21TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	21TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	21TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	21TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	21TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	21XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	135.319128
2011	22XA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	22XA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	24TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	24TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	25TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	286.689718
2011	25XS	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	975
2011	25XS	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	975
2011	25XS	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	1300

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	26TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	26TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	26TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	26TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	26TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	26TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	27TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	27TX	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	27XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	527.209032
2011	29TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	80.1169726
2011	29TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	192.510262
2011	29TE	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	22.1930672
2011	29TE	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	1476.21328
2011	29TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	29TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	2H5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	2TA0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	2TA0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	2TE0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	444.211761
2011	2TE0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	248.546113
2011	2TE1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	2TE1	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	2TE2	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	900
2011	2TE2	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	900
2011	2TE2	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	1200
2011	2TX7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561
2011	2TX9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	2TX9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	2XA2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	2XA3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	2XA3	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	30F	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	1350
2011	30F	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	1350
2011	30F	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	1800
2011	31TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	31TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	33TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	88.1067924
2011	33TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	33TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	34TE	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	25

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	35TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	35TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	35TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	539.938674
2011	35TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	345.202934
2011	36TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	36TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	37TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	647.926409
2011	37TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	414.243521
2011	37X	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	4032.00117
2011	37X	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	2140.25819
2011	38TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	38TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	38TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	322.622667

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	38TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	962.55131
2011	38TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	38TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	38TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	38TX	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	39R	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	109.209656
2011	39R	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	41.4243521
2011	39TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	39TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	3T2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	5915.52301
2011	3T2	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	2243.81907
2011	3TA7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	93.066772
2011	3TE1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	3TE2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	3TE2	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	3TE9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	80.0236031
2011	3TS3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	70.0318392
2011	3TS4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	3TS4	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	3TS5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	77.7607262
2011	3TS6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	3TS6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	3TS7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	65.5153167
2011	3TS8	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	3TS8	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	3XA5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	3XA5	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	3XS0	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	1050
2011	3XS0	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	1050
2011	3XS0	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	1400
2011	3XS8	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	40TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	40TX	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	42TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	42TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	42TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	42TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	43TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	43TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	43XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	43XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	44XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	44XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	45TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	45TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	45TE	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	400
2011	46TS	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	615
2011	46TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	84.5401256
2011	47TA	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	365
2011	49T	2275060011	Air Taxi, Piston	AT	2142	Robinson R22	O320	300
2011	49TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	286.689718
2011	4T2	2275050011	General Aviation, Piston	GA	2095	Raytheon Beech Baron 58	TIO540	405
2011	4T2	2275050012	General Aviation, Turbine	GA	1542	Cessna 525 CitationJet	1PW035	270

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	4T2	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	162
2011	4T2	2275060011	Air Taxi, Piston	AT	2061	Piper PA-28 Cherokee Series	O320	162
2011	4T2	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	216
2011	4T2	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	135
2011	4TA0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	99.5231557
2011	4TA4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	55.6897248
2011	4TA9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	4TA9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	4TS0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	4TS0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	4TS1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	4TS1	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	4TS2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	4TS2	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	4TS4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	4TS4	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	4TS6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	4TS6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	4TX0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	76.9972759
2011	4XS0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	4XS2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561
2011	4XS3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	4XS3	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	50F	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	2430
2011	50F	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	2430
2011	50F	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	3240

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	52F	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	79680
2011	52F	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	2490
2011	52F	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	830
2011	52TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	52TX	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	52XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	52XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	54T	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	3385.49932
2011	54T	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	1284.15492
2011	55TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	55TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	56TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	56XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	56XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	58F	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	35
2011	58T	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	209.133063
2011	59TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	59TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	59TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	293.943861
2011	5T0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	120.858686
2011	5T0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	45.8429497
2011	5TA5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	77.8615079
2011	5TA7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	5TA9	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	182
2011	5TS4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561
2011	5TS6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	5TS6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	5TX3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	5TX3	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	61TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	61TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	62TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	62TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	63TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	63TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	64TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	64TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	64TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	64TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	65TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	66TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	66TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	66TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	66TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	67TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	67TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	68TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	68TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	6R3	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	200
2011	6R3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	4974.9
2011	6R3	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	1925.1
2011	6R5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	982.886901
2011	6R5	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	372.819169

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	6TA5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	161.602231
2011	6TA5	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	481.275655
2011	6TA5	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	4.17808169
2011	6TA5	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	344.449764
2011	6TA6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	6TA6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	6X8	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	50
2011	6XS0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	6XS0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	6XS1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	6XS1	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	6XS6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	6XS6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	6XS7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	64.0501993

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	72TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	72TX	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	76T	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	150
2011	76TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	76TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	77TX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	62.9438679
2011	77XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	99.048412
2011	7R9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	400.435404
2011	7R9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	151.889291
2011	7TA0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	286.689718
2011	7TA2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	7TA2	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	7TS0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	114.829202
2011	7TS6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	7TS6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	7TX6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	7TX6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	7XS0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	324.502376
2011	7XS4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	7XS4	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	7XS8	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	7XS8	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	7XS9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	7XS9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	80TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	80TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	81D	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	655.257934

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	81D	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	248.546113
2011	81XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	81XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	82TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	82TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	83XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	83XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	84TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	84TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	84TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	84TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	85XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	85XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	87TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	85.0148694
2011	87TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	87TS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	89TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	62.9438679
2011	89XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	89XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	8TA4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	70.6073647
2011	8TE9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	8TE9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	8TS4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	8TS4	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	8TX4	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	8TX4	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	8TX7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	366.485293
2011	8XS5	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	8XS5	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	90XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	90XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	91TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	128.064985
2011	93XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	164.335701
2011	94XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	96XS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	96XS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	97TA	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	97TA	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	97TE	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	97TE	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	97TS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	80.8526492
2011	9F9	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	585
2011	9F9	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	585
2011	9F9	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	780
2011	9TA3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	301.198004
2011	9TA6	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TA6	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TA7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TA7	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TA9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TA9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TE1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	9TE1	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TE8	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TE8	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TE9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TE9	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TS2	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TS2	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TS3	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	9TS7	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TS7	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9TX0	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9TX0	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	9X1	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	3640.32185

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	9X1	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	1380.81174
2011	9X9	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	315.70629
2011	9XS8	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	9XS8	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	ADS	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	9144
2011	ADS	2275050012	General Aviation, Turbine	GA	1868	Gulfstream G550	3BR001	4572
2011	ADS	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	16764
2011	ADS	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	4064
2011	ADS	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	8128
2011	ADS	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	8128
2011	AFW	2275020000	Commercial Aircraft, Total: All Types	AC	1335	Boeing MD-11	1GE031	5725

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	AFW	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	22900
2011	AFW	2275050012	General Aviation, Turbine	GA	1877	Gulfstream V-SP	4BR008	5725
2011	AFW	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	14312
2011	AFW	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	2862
2011	AFW	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	2862
2011	AFW	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	2862
2011	AXH	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	457.5
2011	AXH	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	16753.156
2011	AXH	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	6482.844
2011	AXH	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	18.094
2011	AXH	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	64.906
2011	CPT	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	167
2011	CPT	2275050012	General Aviation, Turbine	GA	1877	Gulfstream V-SP	4BR008	500

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CPT	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	13322
2011	CPT	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	333
2011	CPT	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	666
2011	CPT	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	1665
2011	CXO	2275001000	Military Aircraft, Total	MIL	1633	Embraer 312 Tucano	PT625C	1
2011	CXO	2275001000	Military Aircraft, Total	MIL	2105	Raytheon Hawker 1000	TFE731	2
2011	CXO	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	1333.5
2011	CXO	2275020000	Commercial Aircraft, Total: All Types	AC	1856	Gulfstream G400	1RR019	22
2011	CXO	2275020000	Commercial Aircraft, Total: All Types	AC	1859	Gulfstream G500	4BR008	4
2011	CXO	2275020000	Commercial Aircraft, Total: All Types	AC	2144	Rockwell 1121 Jet Commander	1AS002	21

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275020000	Commercial Aircraft, Total: All Types	AC	2166	Rockwell Sabreliner 65	1AS002	4
2011	CXO	2275050011	General Aviation, Piston	GA	1524	Cessna 340	TIO540	42
2011	CXO	2275050011	General Aviation, Piston	GA	1527	Cessna 414	TIO540	10
2011	CXO	2275050011	General Aviation, Piston	GA	2032	Mooney M20-K	TSIO36	106
2011	CXO	2275050011	General Aviation, Piston	GA	2056	Piper PA-23 Apache/Aztec	TIO540	2
2011	CXO	2275050011	General Aviation, Piston	GA	2057	Piper PA-24 Comanche	TIO540	10
2011	CXO	2275050011	General Aviation, Piston	GA	2058	Piper PA-27 Aztec	TIO540	6
2011	CXO	2275050011	General Aviation, Piston	GA	2062	Piper PA-30 Twin Comanche	IO320	16
2011	CXO	2275050011	General Aviation, Piston	GA	2090	Raytheon Beech 60 Duke	TIO540	14
2011	CXO	2275050011	General Aviation, Piston	GA	2095	Raytheon Beech Baron 58	TIO540	34
2011	CXO	2275050011	General Aviation, Piston	GA	2149	Rockwell Commander 690	TPE10	8
2011	CXO	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	19490.6

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275050012	General Aviation, Turbine	GA	1399	Bombardier CL-415	PW123	1
2011	CXO	2275050012	General Aviation, Turbine	GA	1427	Bombardier Challenger 300	6AL006	3
2011	CXO	2275050012	General Aviation, Turbine	GA	1428	Bombardier Challenger 600	1TL001	6
2011	CXO	2275050012	General Aviation, Turbine	GA	1449	Bombardier Learjet 25	CJ6106	2
2011	CXO	2275050012	General Aviation, Turbine	GA	1453	Bombardier Learjet 31	1AS001	15
2011	CXO	2275050012	General Aviation, Turbine	GA	1454	Bombardier Learjet 35	1AS001	7
2011	CXO	2275050012	General Aviation, Turbine	GA	1457	Bombardier Learjet 40	1AS001	4
2011	CXO	2275050012	General Aviation, Turbine	GA	1458	Bombardier Learjet 45	1AS001	6
2011	CXO	2275050012	General Aviation, Turbine	GA	1460	Bombardier Learjet 55	1AS002	1
2011	CXO	2275050012	General Aviation, Turbine	GA	1462	Bombardier Learjet 60	TFE731	9
2011	CXO	2275050012	General Aviation, Turbine	GA	1529	Cessna 425 Conquest I	PT6A60	4

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275050012	General Aviation, Turbine	GA	1541	Cessna 501 Citation ISP	1PW035	22
2011	CXO	2275050012	General Aviation, Turbine	GA	1542	Cessna 525 CitationJet	1PW035	48
2011	CXO	2275050012	General Aviation, Turbine	GA	1554	Cessna 680 Citation Sovereign	7PW080	8
2011	CXO	2275050012	General Aviation, Turbine	GA	1575	Dassault Falcon 10	1RR020	6
2011	CXO	2275050012	General Aviation, Turbine	GA	1579	Dassault Falcon 20-C	CF700D	1
2011	CXO	2275050012	General Aviation, Turbine	GA	1849	Gulfstream G150	1AS002	2
2011	CXO	2275050012	General Aviation, Turbine	GA	1882	Hawker HS-125 Series 400	1AS002	2
2011	CXO	2275050012	General Aviation, Turbine	GA	1913	Israel IAI-1124 Westwind I	1AS002	32
2011	CXO	2275050012	General Aviation, Turbine	GA	1915	Israel IAI-1125 Astra	1AS002	33
2011	CXO	2275050012	General Aviation, Turbine	GA	1916	Israel IAI-1126 Galaxy	7PW077	1
2011	CXO	2275050012	General Aviation, Turbine	GA	1984	Lockheed L-1329 Jetstar II	1AS002	14

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275050012	General Aviation, Turbine	GA	2009	Maule MT-7-235	TIO540	2
2011	CXO	2275050012	General Aviation, Turbine	GA	2029	Mitsubishi MU-2	TPE6	109
2011	CXO	2275050012	General Aviation, Turbine	GA	2051	Piaggio P.180 Avanti	PT6A66	21
2011	CXO	2275050012	General Aviation, Turbine	GA	2069	Piper PA-42 Cheyenne Series	PT6A41	5
2011	CXO	2275050012	General Aviation, Turbine	GA	2080	Piper PA46-TP Meridian	PT6A42	144
2011	CXO	2275050012	General Aviation, Turbine	GA	2112	Raytheon King Air 100	TPE6	9
2011	CXO	2275050012	General Aviation, Turbine	GA	2119	Raytheon Premier I	1PW035	34
2011	CXO	2275050012	General Aviation, Turbine	GA	494	Ayres Turbo Thrush T-65	P665AG	2
2011	CXO	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	7565.4
2011	CXO	2275060011	Air Taxi, Piston	AT	1511	Cessna 150 Series	O200	6
2011	CXO	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	175
2011	CXO	2275060011	Air Taxi, Piston	AT	1516	Cessna 182	IO360	114
2011	CXO	2275060011	Air Taxi, Piston	AT	1517	Cessna 206	IO360	26

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275060011	Air Taxi, Piston	AT	1520	Cessna 210 Centurion	TIO540	64
2011	CXO	2275060011	Air Taxi, Piston	AT	1521	Cessna 310	TIO540	22
2011	CXO	2275060011	Air Taxi, Piston	AT	1525	Cessna 402	TIO540	12
2011	CXO	2275060011	Air Taxi, Piston	AT	1528	Cessna 421 Golden Eagle	TIO540	60
2011	CXO	2275060011	Air Taxi, Piston	AT	1567	Cirrus SR20	IO360	73
2011	CXO	2275060011	Air Taxi, Piston	AT	1568	Cirrus SR22	TIO540	70
2011	CXO	2275060011	Air Taxi, Piston	AT	2048	Partenavia P.68 Victor	IO360	1
2011	CXO	2275060011	Air Taxi, Piston	AT	2061	Piper PA-28 Cherokee Series	O320	159
2011	CXO	2275060011	Air Taxi, Piston	AT	2063	Piper PA-31 Navajo	TIO540	38
2011	CXO	2275060011	Air Taxi, Piston	AT	2065	Piper PA-32 Cherokee Six	TIO540	182
2011	CXO	2275060011	Air Taxi, Piston	AT	2067	Piper PA-34 Seneca	TSIO36	40
2011	CXO	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	23
2011	CXO	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	277
2011	CXO	2275060011	Air Taxi, Piston	AT	2147	Rockwell Commander 500	TIO540	2

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	192.24
2011	CXO	2275060012	Air Taxi, Turbine	AT	1519	Cessna 208 Caravan	P6114A	5
2011	CXO	2275060012	Air Taxi, Turbine	AT	1530	Cessna 441 Conquest II	TPE10	8
2011	CXO	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	4
2011	CXO	2275060012	Air Taxi, Turbine	AT	1543	Cessna 550 Citation II	1PW036	40
2011	CXO	2275060012	Air Taxi, Turbine	AT	1549	Cessna 560 Citation V	1PW037	55
2011	CXO	2275060012	Air Taxi, Turbine	AT	1553	Cessna 650 Citation III	1AS002	21
2011	CXO	2275060012	Air Taxi, Turbine	AT	1557	Cessna 750 Citation X	6AL022	8
2011	CXO	2275060012	Air Taxi, Turbine	AT	1590	Dassault Falcon 50	1AS002	2
2011	CXO	2275060012	Air Taxi, Turbine	AT	1592	Dassault Falcon 900	1AS002	1
2011	CXO	2275060012	Air Taxi, Turbine	AT	1602	DeHavilland DHC-6-100 Twin Otter	PT6A20	2
2011	CXO	2275060012	Air Taxi, Turbine	AT	1632	EADS Socata TBM-700	PT6A64	4

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275060012	Air Taxi, Turbine	AT	1637	Embraer EMB110 Bandeirante	PT6A34	4
2011	CXO	2275060012	Air Taxi, Turbine	AT	1747	Fairchild SA-226-T Merlin III	TPE3U	28
2011	CXO	2275060012	Air Taxi, Turbine	AT	1764	Fairchild SA-227-AC Metro III	TPE10	1
2011	CXO	2275060012	Air Taxi, Turbine	AT	1781	Fairchild SA-26-T Merlin II	PT6A60	4
2011	CXO	2275060012	Air Taxi, Turbine	AT	2052	Pilatus PC-12	PT67B	42
2011	CXO	2275060012	Air Taxi, Turbine	AT	2064	Piper PA-31T Cheyenne	PT6A28	20
2011	CXO	2275060012	Air Taxi, Turbine	AT	2082	Raytheon Beech 18	R1820	5
2011	CXO	2275060012	Air Taxi, Turbine	AT	2099	Raytheon Beechjet 400	1PW037	26
2011	CXO	2275060012	Air Taxi, Turbine	AT	2108	Raytheon Hawker 800	1AS002	76
2011	CXO	2275060012	Air Taxi, Turbine	AT	2113	Raytheon King Air 90	P6135A	27
2011	CXO	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	43
2011	CXO	2275060012	Air Taxi, Turbine	AT	2128	Raytheon Super King Air 300	PT660A	8

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	CXO	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	74.76
2011	DAL	2275001000	Military Aircraft, Total	MIL	1199	Boeing C-17A	F1171	9
2011	DAL	2275001000	Military Aircraft, Total	MIL	1311	Boeing F/A-18 Hornet	F4044	9
2011	DAL	2275001000	Military Aircraft, Total	MIL	1455	Bombardier Learjet 35A/36A (C-21A)	1AS001	292
2011	DAL	2275001000	Military Aircraft, Total	MIL	1744	Fairchild Metro IVC	T12UHR	21
2011	DAL	2275001000	Military Aircraft, Total	MIL	1957	Lockheed C-130 Hercules	T56A15	35
2011	DAL	2275001000	Military Aircraft, Total	MIL	1999	Lockheed P-3 Orion ANP:P3A	T56A14	157
2011	DAL	2275001000	Military Aircraft, Total	MIL	2002	Lockheed S-3 Viking	TF3410	11
2011	DAL	2275001000	Military Aircraft, Total	MIL	2105	Raytheon Hawker 1000	TFE731	33
2011	DAL	2275001000	Military Aircraft, Total	MIL	2215	T-38 Talon	J855HA	22
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1270	Boeing DC-9-10 Series	1PW004	9

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1276	Boeing DC-9-30 Series	1PW008	3
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1370	Boeing MD-83	1PW019	26
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1372	Boeing MD-87	1PW017	27
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1404	Bombardier CRJ-200	5GE084	1086
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1438	Bombardier Global Express	4BR009	361
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1622	Dornier 328 Jet	7PW078	9
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1641	Embraer ERJ135	6AL012	96

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1711	Embraer ERJ145-XR	6AL020	267
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1870	Gulfstream II	MK511	270
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1872	Gulfstream II-B	1RR016	98
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	1876	Gulfstream IV-SP	1RR019	1244
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	2144	Rockwell 1121 Jet Commander	1AS002	1
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	2164	Rockwell Sabreliner 50	CF700D	125
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	220	Airbus A310-300 Series	1GE016	29

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	280	Airbus A319-100 Series	3CM028	75
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	326	Airbus A320-200 Series	1IA003	19
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	495	BAC 1-11 200	MK511	12
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	504	BAE 146-100	1TL003	1996
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	572	Boeing 727-100 Series	4PW070	3
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	583	Boeing 727-200 Series	1PW011	47
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	610	Boeing 737-200 Series	1PW011	26

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	620	Boeing 737-300 Series	1CM004	23046
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	627	Boeing 737-400 Series	CFM563	56
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	639	Boeing 737-500 Series	1CM007	3088
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	659	Boeing 737-700 Series	3CM031	19028
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	676	Boeing 737-800 Series	3CM033	40
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	861	Boeing 757-200 Series	4PW072	72
2011	DAL	2275020000	Commercial Aircraft, Total: All Types	AC	925	Boeing 767-200 Series	1GE010	12
2011	DAL	2275050011	General Aviation, Piston	GA	1522	Cessna 337 Skymaster	IO360	7

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275050011	General Aviation, Piston	GA	1524	Cessna 340	TIO540	64
2011	DAL	2275050011	General Aviation, Piston	GA	1527	Cessna 414	TIO540	135
2011	DAL	2275050011	General Aviation, Piston	GA	1927	Lancair 360	IO360	5
2011	DAL	2275050011	General Aviation, Piston	GA	2032	Mooney M20-K	TSIO36	224
2011	DAL	2275050011	General Aviation, Piston	GA	2056	Piper PA-23 Apache/Aztec	TIO540	42
2011	DAL	2275050011	General Aviation, Piston	GA	2057	Piper PA-24 Comanche	TIO540	44
2011	DAL	2275050011	General Aviation, Piston	GA	2058	Piper PA-27 Aztec	TIO540	12
2011	DAL	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	144
2011	DAL	2275050011	General Aviation, Piston	GA	2062	Piper PA-30 Twin Comanche	IO320	34
2011	DAL	2275050011	General Aviation, Piston	GA	2090	Raytheon Beech 60 Duke	TIO540	13
2011	DAL	2275050011	General Aviation, Piston	GA	2095	Raytheon Beech Baron 58	TIO540	377
2011	DAL	2275050011	General Aviation, Piston	GA	2140	Robinson R22	IO320	9
2011	DAL	2275050011	General Aviation, Piston	GA	2143	Robinson R22	TSIO36	85

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275050011	General Aviation, Piston	GA	2149	Rockwell Commander 690	TPE10	81
2011	DAL	2275050011	General Aviation, Piston	GA	2156	Rockwell Commander 690	TP10UK	53
2011	DAL	2275050011	General Aviation, Piston	GA	36	Aerostar PA-60	TIO540	4
2011	DAL	2275050012	General Aviation, Turbine	GA	1427	Bombardier Challenger 300	6AL006	1051
2011	DAL	2275050012	General Aviation, Turbine	GA	1449	Bombardier Learjet 25	CJ6106	65
2011	DAL	2275050012	General Aviation, Turbine	GA	1453	Bombardier Learjet 31	1AS001	192
2011	DAL	2275050012	General Aviation, Turbine	GA	1454	Bombardier Learjet 35	1AS001	1
2011	DAL	2275050012	General Aviation, Turbine	GA	1457	Bombardier Learjet 40	1AS001	468
2011	DAL	2275050012	General Aviation, Turbine	GA	1458	Bombardier Learjet 45	1AS001	797
2011	DAL	2275050012	General Aviation, Turbine	GA	1460	Bombardier Learjet 55	1AS002	134
2011	DAL	2275050012	General Aviation, Turbine	GA	1462	Bombardier Learjet 60	TFE731	654

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275050012	General Aviation, Turbine	GA	1529	Cessna 425 Conquest I	PT6A60	136
2011	DAL	2275050012	General Aviation, Turbine	GA	1541	Cessna 501 Citation ISP	1PW035	131
2011	DAL	2275050012	General Aviation, Turbine	GA	1542	Cessna 525 CitationJet	1PW035	1620
2011	DAL	2275050012	General Aviation, Turbine	GA	1548	Cessna 560 Citation Excel	1PW037	1938
2011	DAL	2275050012	General Aviation, Turbine	GA	1554	Cessna 680 Citation Sovereign	7PW080	646
2011	DAL	2275050012	General Aviation, Turbine	GA	1556	Cessna 750 Citation X	6AL021	755
2011	DAL	2275050012	General Aviation, Turbine	GA	1575	Dassault Falcon 10	1RR020	103
2011	DAL	2275050012	General Aviation, Turbine	GA	1579	Dassault Falcon 20-C	CF700D	369
2011	DAL	2275050012	General Aviation, Turbine	GA	1587	Dassault Falcon 200	CF700D	16
2011	DAL	2275050012	General Aviation, Turbine	GA	1588	Dassault Falcon 2000	7PW080	681
2011	DAL	2275050012	General Aviation, Turbine	GA	1631	EADS Socata TBM-700	PT6A60	141

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275050012	General Aviation, Turbine	GA	1782	Falcon 7X	8PW091	174
2011	DAL	2275050012	General Aviation, Turbine	GA	1849	Gulfstream G150	1AS002	288
2011	DAL	2275050012	General Aviation, Turbine	GA	1877	Gulfstream V-SP	4BR008	754
2011	DAL	2275050012	General Aviation, Turbine	GA	1880	Hawker HS-125 Series 1	1AS002	110
2011	DAL	2275050012	General Aviation, Turbine	GA	1883	Hawker HS-125 Series 600	1AS001	13
2011	DAL	2275050012	General Aviation, Turbine	GA	1913	Israel IAI-1124 Westwind I	1AS002	403
2011	DAL	2275050012	General Aviation, Turbine	GA	1915	Israel IAI-1125 Astra	1AS002	211
2011	DAL	2275050012	General Aviation, Turbine	GA	1916	Israel IAI-1126 Galaxy	7PW077	714
2011	DAL	2275050012	General Aviation, Turbine	GA	1984	Lockheed L-1329 Jetstar II	1AS002	5
2011	DAL	2275050012	General Aviation, Turbine	GA	2008	Maule MT-7-235	250B17	25
2011	DAL	2275050012	General Aviation, Turbine	GA	2009	Maule MT-7-235	TIO540	13

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275050012	General Aviation, Turbine	GA	2020	Mitsubishi MU-2	TPE1	420
2011	DAL	2275050012	General Aviation, Turbine	GA	2030	Mitsubishi MU-300 Diamond	1PW036	31
2011	DAL	2275050012	General Aviation, Turbine	GA	2051	Piaggio P.180 Avanti	PT6A66	531
2011	DAL	2275050012	General Aviation, Turbine	GA	2069	Piper PA-42 Cheyenne Series	PT6A41	47
2011	DAL	2275050012	General Aviation, Turbine	GA	2070	Piper PA-42 Cheyenne Series	PT6A61	12
2011	DAL	2275050012	General Aviation, Turbine	GA	2080	Piper PA46-TP Meridian	PT6A42	404
2011	DAL	2275050012	General Aviation, Turbine	GA	2111	Raytheon King Air 100	PT6A28	60
2011	DAL	2275050012	General Aviation, Turbine	GA	2115	Raytheon King Air 90	PT6A28	35
2011	DAL	2275050012	General Aviation, Turbine	GA	2119	Raytheon Premier I	1PW035	276
2011	DAL	2275050012	General Aviation, Turbine	GA	37	Agusta A-109	250B17	7
2011	DAL	2275060011	Air Taxi, Piston	AT	1253	Boeing DC-3	R1820	4
2011	DAL	2275060011	Air Taxi, Piston	AT	1511	Cessna 150 Series	O200	79

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	1154
2011	DAL	2275060011	Air Taxi, Piston	AT	1516	Cessna 182	IO360	521
2011	DAL	2275060011	Air Taxi, Piston	AT	1517	Cessna 206	IO360	193
2011	DAL	2275060011	Air Taxi, Piston	AT	1520	Cessna 210 Centurion	TIO540	172
2011	DAL	2275060011	Air Taxi, Piston	AT	1521	Cessna 310	TIO540	130
2011	DAL	2275060011	Air Taxi, Piston	AT	1525	Cessna 402	TIO540	126
2011	DAL	2275060011	Air Taxi, Piston	AT	1528	Cessna 421 Golden Eagle	TIO540	237
2011	DAL	2275060011	Air Taxi, Piston	AT	1567	Cirrus SR20	IO360	31
2011	DAL	2275060011	Air Taxi, Piston	AT	1568	Cirrus SR22	TIO540	409
2011	DAL	2275060011	Air Taxi, Piston	AT	1628	EADS Socata TB-20 Trinidad	TIO540	30
2011	DAL	2275060011	Air Taxi, Piston	AT	2060	Piper PA-28 Cherokee Series	IO360	64
2011	DAL	2275060011	Air Taxi, Piston	AT	2061	Piper PA-28 Cherokee Series	O320	131
2011	DAL	2275060011	Air Taxi, Piston	AT	2063	Piper PA-31 Navajo	TIO540	56
2011	DAL	2275060011	Air Taxi, Piston	AT	2065	Piper PA-32 Cherokee Six	TIO540	185
2011	DAL	2275060011	Air Taxi, Piston	AT	2066	Piper PA-34 Seneca	IO360	37

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	148
2011	DAL	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	859
2011	DAL	2275060011	Air Taxi, Piston	AT	2142	Robinson R22	O320	3044
2011	DAL	2275060011	Air Taxi, Piston	AT	2147	Rockwell Commander 500	TIO540	211
2011	DAL	2275060012	Air Taxi, Turbine	AT	1431	Bombardier Challenger 601	1GE034	1281
2011	DAL	2275060012	Air Taxi, Turbine	AT	1447	Bombardier Learjet 24	CJ6106	1
2011	DAL	2275060012	Air Taxi, Turbine	AT	1479	Bombardier de Havilland Dash 8 Q400	PW150A	4
2011	DAL	2275060012	Air Taxi, Turbine	AT	1519	Cessna 208 Caravan	P6114A	23
2011	DAL	2275060012	Air Taxi, Turbine	AT	1530	Cessna 441 Conquest II	TPE10	150
2011	DAL	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	68
2011	DAL	2275060012	Air Taxi, Turbine	AT	1543	Cessna 550 Citation II	1PW036	1094
2011	DAL	2275060012	Air Taxi, Turbine	AT	1544	Cessna 551 Citation IISP	1PW036	23

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275060012	Air Taxi, Turbine	AT	1549	Cessna 560 Citation V	1PW037	1353
2011	DAL	2275060012	Air Taxi, Turbine	AT	1553	Cessna 650 Citation III	1AS002	792
2011	DAL	2275060012	Air Taxi, Turbine	AT	1590	Dassault Falcon 50	1AS002	544
2011	DAL	2275060012	Air Taxi, Turbine	AT	1592	Dassault Falcon 900	1AS002	661
2011	DAL	2275060012	Air Taxi, Turbine	AT	1637	Embraer EMB110 Bandeirante	PT6A34	3
2011	DAL	2275060012	Air Taxi, Turbine	AT	1675	Embraer ERJ145	6AL012	2042
2011	DAL	2275060012	Air Taxi, Turbine	AT	1747	Fairchild SA-226-T Merlin III	TPE3U	118
2011	DAL	2275060012	Air Taxi, Turbine	AT	2052	Pilatus PC-12	PT67B	1425
2011	DAL	2275060012	Air Taxi, Turbine	AT	2064	Piper PA-31T Cheyenne	PT6A28	184
2011	DAL	2275060012	Air Taxi, Turbine	AT	2099	Raytheon Beechjet 400	1PW037	839
2011	DAL	2275060012	Air Taxi, Turbine	AT	2107	Raytheon Hawker 4000 Horizon	7PW079	46
2011	DAL	2275060012	Air Taxi, Turbine	AT	2113	Raytheon King Air 90	P6135A	769

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DAL	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	1684
2011	DAL	2275060012	Air Taxi, Turbine	AT	2128	Raytheon Super King Air 300	PT660A	1142
2011	DAL	2275060012	Air Taxi, Turbine	AT	543	Bell 206 JetRanger	250B17	6
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1095	Boeing 777-200 Series	2RR024	2349
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1238	Boeing DC-10-30ER	3GE078	1033
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1264	Boeing DC-8 Series 70	1CM001	188
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1350	Boeing MD-11-ER	2GE049	1373
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1366	Boeing MD-82	4PW071	74613

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1370	Boeing MD-83	1PW019	44454
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1385	Boeing MD-88	4PW071	2045
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1414	Bombardier CRJ-700	6GE092	5999
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1425	Bombardier CRJ-900-ER	6GE092	5331
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	155	Airbus A300C4-600 Series	2GE039	1488
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1641	Embraer ERJ135	6AL012	29097
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1690	Embraer ERJ145-EU	6AL009	50188

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1711	Embraer ERJ145-XR	6AL020	446
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1718	Embraer ERJ175	6GE094	3660
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	1722	Embraer ERJ190	XCF10E	1155
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	263	Airbus A318-100 Series	7CM048	244
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	280	Airbus A319-100 Series	3CM028	6614
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	319	Airbus A320-200 Series	3CM028	4913
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	351	Airbus A321-200 Series	3CM025	468

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	361	Airbus A330-200 Series	5GE085	195
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	418	Airbus A330-300 Series	2RR023	145
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	442	Airbus A340-300 Series	3CM022	187
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	561	Boeing 717-200 Series	4BR002	1279
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	624	Boeing 737-300 Series	1CM007	1283
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	632	Boeing 737-400 Series	1CM007	1554
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	639	Boeing 737-500 Series	1CM007	1298

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	665	Boeing 737-700 Series	3CM034	2154
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	678	Boeing 737-800 Series	3CM034	29867
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	702	Boeing 737-900 Series	3CM034	322
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	820	Boeing 747-400 Series	3GE057	2469
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	867	Boeing 757-200 Series	3RR028	14967
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	925	Boeing 767-200 Series	1GE010	588
2011	DFW	2275020000	Commercial Aircraft, Total: All Types	AC	977	Boeing 767-300 ER	2GE044	4446
2011	DFW	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	179

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DFW	2275050012	General Aviation, Turbine	GA	1458	Bombardier Learjet 45	1AS001	124
2011	DFW	2275050012	General Aviation, Turbine	GA	1548	Cessna 560 Citation Excel	1PW037	354
2011	DFW	2275050012	General Aviation, Turbine	GA	1554	Cessna 680 Citation Sovereign	7PW080	4414
2011	DFW	2275050012	General Aviation, Turbine	GA	1559	Cessna 750 Citation X	6AL024	128
2011	DFW	2275050012	General Aviation, Turbine	GA	1880	Hawker HS-125 Series 1	1AS002	228
2011	DFW	2275060011	Air Taxi, Piston	AT	1513	Cessna 172 Skyhawk	IO360	157
2011	DFW	2275060012	Air Taxi, Turbine	AT	1405	Bombardier CRJ-200	5GE083	527
2011	DFW	2275060012	Air Taxi, Turbine	AT	1519	Cessna 208 Caravan	P6114A	1413
2011	DFW	2275060012	Air Taxi, Turbine	AT	1549	Cessna 560 Citation V	1PW037	128
2011	DFW	2275060012	Air Taxi, Turbine	AT	1608	DeHavilland DHC-8-100	PW120A	587
2011	DFW	2275060012	Air Taxi, Turbine	AT	1639	Embraer EMB120 Brasilia	PW118A	683
2011	DFW	2275060012	Air Taxi, Turbine	AT	1764	Fairchild SA-227-AC Metro III	TPE10	735

Baseyear	**State Facility Identifier**	**SCC**	**Mode**	**Category**	**Code**	**Airframe**	**Engine**	**LTO**
2011	DFW	2275060012	Air Taxi, Turbine	AT	20	ATR 72-200	PW127	14943
2011	DFW	2275060012	Air Taxi, Turbine	AT	2086	Raytheon Beech 1900-C	PT67B	341
2011	DFW	2275060012	Air Taxi, Turbine	AT	2094	Raytheon Beech 99	PT6A36	873
2011	DFW	2275060012	Air Taxi, Turbine	AT	2099	Raytheon Beechjet 400	1PW037	136
2011	DFW	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	156
2011	DFW	2275060012	Air Taxi, Turbine	AT	543	Bell 206 JetRanger	250B17	883
2011	DTO	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	3700
2011	DTO	2275050012	General Aviation, Turbine	GA	1877	Gulfstream V-SP	4BR008	740
2011	DTO	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	48106
2011	DTO	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	1480
2011	DTO	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	5181
2011	DTO	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	14802
2011	DWH	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	1644

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	DWH	2275020000	Commercial Aircraft, Total: All Types	AC	999906	GENERIC	GENERIC	2
2011	DWH	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	65379.559
2011	DWH	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	25299.441
2011	DWH	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	502.49
2011	DWH	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	1802.51
2011	E58	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	120
2011	EFD	2275001000	Military Aircraft, Total	MIL	1986	Lockheed Martin F-16 Fighting Falcon	F10010	2561
2011	EFD	2275001000	Military Aircraft, Total	MIL	2105	Raytheon Hawker 1000	TFE731	57
2011	EFD	2275001000	Military Aircraft, Total	MIL	2215	T-38 Talon	J855HA	26624
2011	EFD	2275001000	Military Aircraft, Total	MIL	545	Bell AH-1S Cobra	T5311D	1536
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1034	Boeing 767-300 Series	1PW043	790

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1098	Boeing 777-200 Series	2RR027	115
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1270	Boeing DC-9-10 Series	1PW004	866
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1404	Bombardier CRJ-200	5GE084	115
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1676	Embraer ERJ145	6AL020	748
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1856	Gulfstream G400	1RR019	1155
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1859	Gulfstream G500	4BR008	288
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	1870	Gulfstream II	MK511	57

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	2163	Rockwell Sabreliner 40	CF700D	7671
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	306	Airbus A320-100 Series	1IA003	57
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	561	Boeing 717-200 Series	4BR002	57
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	584	Boeing 727-200 Series	1PW013	1976
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	624	Boeing 737-300 Series	1CM007	459
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	639	Boeing 737-500 Series	1CM007	115
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	659	Boeing 737-700 Series	3CM031	115

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	678	Boeing 737-800 Series	3CM034	174
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	861	Boeing 757-200 Series	4PW072	115
2011	EFD	2275020000	Commercial Aircraft, Total: All Types	AC	926	Boeing 767-200 Series	1GE011	57
2011	EFD	2275050011	General Aviation, Piston	GA	1524	Cessna 340	TIO540	1443
2011	EFD	2275050011	General Aviation, Piston	GA	1527	Cessna 414	TIO540	174
2011	EFD	2275050011	General Aviation, Piston	GA	2032	Mooney M20-K	TSIO36	980
2011	EFD	2275050011	General Aviation, Piston	GA	2057	Piper PA-24 Comanche	TIO540	115
2011	EFD	2275050011	General Aviation, Piston	GA	2062	Piper PA-30 Twin Comanche	IO320	57
2011	EFD	2275050011	General Aviation, Piston	GA	2090	Raytheon Beech 60 Duke	TIO540	635
2011	EFD	2275050011	General Aviation, Piston	GA	2095	Raytheon Beech Baron 58	TIO540	1212
2011	EFD	2275050011	General Aviation, Piston	GA	2149	Rockwell Commander 690	TPE10	172

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275050011	General Aviation, Piston	GA	489	Aviat Husky A1B	IO360	115
2011	EFD	2275050012	General Aviation, Turbine	GA	1427	Bombardier Challenger 300	6AL006	115
2011	EFD	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	578
2011	EFD	2275050012	General Aviation, Turbine	GA	1449	Bombardier Learjet 25	CJ6106	231
2011	EFD	2275050012	General Aviation, Turbine	GA	1453	Bombardier Learjet 31	1AS001	288
2011	EFD	2275050012	General Aviation, Turbine	GA	1454	Bombardier Learjet 35	1AS001	807
2011	EFD	2275050012	General Aviation, Turbine	GA	1457	Bombardier Learjet 40	1AS001	346
2011	EFD	2275050012	General Aviation, Turbine	GA	1458	Bombardier Learjet 45	1AS001	115
2011	EFD	2275050012	General Aviation, Turbine	GA	1460	Bombardier Learjet 55	1AS002	288
2011	EFD	2275050012	General Aviation, Turbine	GA	1462	Bombardier Learjet 60	TFE731	231
2011	EFD	2275050012	General Aviation, Turbine	GA	1529	Cessna 425 Conquest I	PT6A60	57

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275050012	General Aviation, Turbine	GA	1538	Cessna 441 Conquest II	TPE8	346
2011	EFD	2275050012	General Aviation, Turbine	GA	1541	Cessna 501 Citation ISP	1PW035	1040
2011	EFD	2275050012	General Aviation, Turbine	GA	1542	Cessna 525 CitationJet	1PW035	1558
2011	EFD	2275050012	General Aviation, Turbine	GA	1548	Cessna 560 Citation Excel	1PW037	748
2011	EFD	2275050012	General Aviation, Turbine	GA	1554	Cessna 680 Citation Sovereign	7PW080	115
2011	EFD	2275050012	General Aviation, Turbine	GA	1575	Dassault Falcon 10	1RR020	1385
2011	EFD	2275050012	General Aviation, Turbine	GA	1849	Gulfstream G150	1AS002	174
2011	EFD	2275050012	General Aviation, Turbine	GA	1884	Hawker HS-125 Series 700	1AS002	2079
2011	EFD	2275050012	General Aviation, Turbine	GA	1913	Israel IAI-1124 Westwind I	1AS002	231
2011	EFD	2275050012	General Aviation, Turbine	GA	1984	Lockheed L-1329 Jetstar II	1AS002	115
2011	EFD	2275050012	General Aviation, Turbine	GA	2025	Mitsubishi MU-2	TPE10N	346

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275050012	General Aviation, Turbine	GA	2050	Piaggio P.180 Avanti	PT6A60	288
2011	EFD	2275050012	General Aviation, Turbine	GA	2075	Piper PA-42 Cheyenne Series	TPE10N	115
2011	EFD	2275050012	General Aviation, Turbine	GA	2080	Piper PA46-TP Meridian	PT6A42	979
2011	EFD	2275050012	General Aviation, Turbine	GA	2114	Raytheon King Air 90	PT6A21	1268
2011	EFD	2275050012	General Aviation, Turbine	GA	2119	Raytheon Premier I	1PW035	174
2011	EFD	2275060011	Air Taxi, Piston	AT	1253	Boeing DC-3	R1820	57
2011	EFD	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	3977
2011	EFD	2275060011	Air Taxi, Piston	AT	1516	Cessna 182	IO360	1327
2011	EFD	2275060011	Air Taxi, Piston	AT	1517	Cessna 206	IO360	174
2011	EFD	2275060011	Air Taxi, Piston	AT	1520	Cessna 210 Centurion	TIO540	981
2011	EFD	2275060011	Air Taxi, Piston	AT	1521	Cessna 310	TIO540	231
2011	EFD	2275060011	Air Taxi, Piston	AT	1528	Cessna 421 Golden Eagle	TIO540	1155
2011	EFD	2275060011	Air Taxi, Piston	AT	1567	Cirrus SR20	IO360	115
2011	EFD	2275060011	Air Taxi, Piston	AT	1568	Cirrus SR22	TIO540	520

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275060011	Air Taxi, Piston	AT	2060	Piper PA-28 Cherokee Series	IO360	172
2011	EFD	2275060011	Air Taxi, Piston	AT	2063	Piper PA-31 Navajo	TIO540	403
2011	EFD	2275060011	Air Taxi, Piston	AT	2065	Piper PA-32 Cherokee Six	TIO540	981
2011	EFD	2275060011	Air Taxi, Piston	AT	2066	Piper PA-34 Seneca	IO360	1443
2011	EFD	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	692
2011	EFD	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	1440
2011	EFD	2275060012	Air Taxi, Turbine	AT	1447	Bombardier Learjet 24	CJ6106	346
2011	EFD	2275060012	Air Taxi, Turbine	AT	1519	Cessna 208 Caravan	P6114A	1501
2011	EFD	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	403
2011	EFD	2275060012	Air Taxi, Turbine	AT	1543	Cessna 550 Citation II	1PW036	1094
2011	EFD	2275060012	Air Taxi, Turbine	AT	1549	Cessna 560 Citation V	1PW037	1094
2011	EFD	2275060012	Air Taxi, Turbine	AT	1553	Cessna 650 Citation III	1AS002	1155

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275060012	Air Taxi, Turbine	AT	1557	Cessna 750 Citation X	6AL022	924
2011	EFD	2275060012	Air Taxi, Turbine	AT	1589	Dassault Falcon 2000-EX	7PW080	231
2011	EFD	2275060012	Air Taxi, Turbine	AT	1590	Dassault Falcon 50	1AS002	809
2011	EFD	2275060012	Air Taxi, Turbine	AT	1592	Dassault Falcon 900	1AS002	231
2011	EFD	2275060012	Air Taxi, Turbine	AT	1632	EADS Socata TBM-700	PT6A64	403
2011	EFD	2275060012	Air Taxi, Turbine	AT	1662	Embraer ERJ140	6AL017	520
2011	EFD	2275060012	Air Taxi, Turbine	AT	1777	Fairchild SA-227-AT Expeditor	TPE10N	3694
2011	EFD	2275060012	Air Taxi, Turbine	AT	2052	Pilatus PC-12	PT67B	520
2011	EFD	2275060012	Air Taxi, Turbine	AT	2064	Piper PA-31T Cheyenne	PT6A28	1038
2011	EFD	2275060012	Air Taxi, Turbine	AT	2091	Raytheon Beech 99	PT6A20	230
2011	EFD	2275060012	Air Taxi, Turbine	AT	2099	Raytheon Beechjet 400	1PW037	1382
2011	EFD	2275060012	Air Taxi, Turbine	AT	2124	Raytheon Super King Air 200	PT6A41	5540
2011	EFD	2275060012	Air Taxi, Turbine	AT	2129	Raytheon Super King Air 300	P660AG	6289

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	EFD	2275060012	Air Taxi, Turbine	AT	518	BAE Jetstream 31	TPE10	809
2011	EFD	2275060012	Air Taxi, Turbine	AT	543	Bell 206 JetRanger	250B17	3071
2011	EYQ	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	13833.223
2011	EYQ	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	5247.0846
2011	F41	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	3010
2011	F41	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	70
2011	F41	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	140
2011	F41	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	280
2011	F46	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	18250
2011	F46	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	152
2011	F46	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	190
2011	F46	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	418
2011	F69	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	10108

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	F69	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	51
2011	F69	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	41
2011	F78	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	575
2011	FTW	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	8340
2011	FTW	2275050012	General Aviation, Turbine	GA	1877	Gulfstream V-SP	4BR008	3791
2011	FTW	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	15542
2011	FTW	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	1327
2011	FTW	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	3033
2011	FTW	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	5876
2011	FWS	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	553
2011	FWS	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	20986
2011	FWS	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	968

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	FWS	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	2765
2011	FWS	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	2378
2011	GKY	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	1880
2011	GKY	2275050012	General Aviation, Turbine	GA	1877	Gulfstream V-SP	4BR008	752
2011	GKY	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	16166
2011	GKY	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	10527
2011	GKY	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	1504
2011	GKY	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	6767
2011	GLS	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	113
2011	GLS	2275020000	Commercial Aircraft, Total: All Types	AC	999906	GENERIC	GENERIC	4.5
2011	GLS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	5737.718

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	GLS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	2220.282
2011	GLS	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	1314.54
2011	GLS	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	4715.46
2011	GPM	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	3504
2011	GPM	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	2548
2011	GPM	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	319
2011	GPM	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	25482
2011	HOU	2275001000	Military Aircraft, Total	MIL	2105	Raytheon Hawker 1000	TFE731	190
2011	HOU	2275001000	Military Aircraft, Total	MIL	545	Bell AH-1S Cobra	T5311D	2066
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1270	Boeing DC-9-10 Series	1PW004	6
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1335	Boeing MD-11	1GE031	2

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1364	Boeing MD-82	4PW070	1400
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1369	Boeing MD-83	4PW070	557
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1404	Bombardier CRJ-200	5GE084	1263
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1411	Bombardier CRJ-700	5GE084	397
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1438	Bombardier Global Express	4BR009	31
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1676	Embraer ERJ145	6AL020	2052
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1852	Gulfstream G300	MK511	325

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1856	Gulfstream G400	1RR019	732
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1859	Gulfstream G500	4BR008	388
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	1870	Gulfstream II	MK511	660
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	2163	Rockwell Sabreliner 40	CF700D	67
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	285	Airbus A319-100 Series	3IA006	4
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	503	BAE 146-100	1TL002	3
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	561	Boeing 717-200 Series	4BR002	3182

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	608	Boeing 737-200 Series	1PW010	393
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	610	Boeing 737-200 Series	1PW011	194
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	620	Boeing 737-300 Series	1CM004	31930
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	624	Boeing 737-300 Series	1CM007	2023
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	635	Boeing 737-500 Series	1CM004	15830
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	639	Boeing 737-500 Series	1CM007	783
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	659	Boeing 737-700 Series	3CM031	17092

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	676	Boeing 737-800 Series	3CM033	843
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	678	Boeing 737-800 Series	3CM034	9
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	700	Boeing 737-900 Series	3CM033	6
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	772	Boeing 747-200 Series	1PW025	7
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	861	Boeing 757-200 Series	4PW072	6
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	867	Boeing 757-200 Series	3RR028	3
2011	HOU	2275020000	Commercial Aircraft, Total: All Types	AC	875	Boeing 757-300 Series	3RR034	4
2011	HOU	2275050011	General Aviation, Piston	GA	1524	Cessna 340	TIO540	20

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275050011	General Aviation, Piston	GA	1527	Cessna 414	TIO540	95
2011	HOU	2275050011	General Aviation, Piston	GA	2032	Mooney M20-K	TSIO36	47
2011	HOU	2275050011	General Aviation, Piston	GA	2056	Piper PA-23 Apache/Aztec	TIO540	2
2011	HOU	2275050011	General Aviation, Piston	GA	2057	Piper PA-24 Comanche	TIO540	2
2011	HOU	2275050011	General Aviation, Piston	GA	2062	Piper PA-30 Twin Comanche	IO320	2
2011	HOU	2275050011	General Aviation, Piston	GA	2090	Raytheon Beech 60 Duke	TIO540	52
2011	HOU	2275050011	General Aviation, Piston	GA	2095	Raytheon Beech Baron 58	TIO540	269
2011	HOU	2275050011	General Aviation, Piston	GA	2149	Rockwell Commander 690	TPE10	103
2011	HOU	2275050011	General Aviation, Piston	GA	489	Aviat Husky A1B	IO360	3
2011	HOU	2275050012	General Aviation, Turbine	GA	1427	Bombardier Challenger 300	6AL006	396
2011	HOU	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	785
2011	HOU	2275050012	General Aviation, Turbine	GA	1449	Bombardier Learjet 25	CJ6106	103

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275050012	General Aviation, Turbine	GA	1453	Bombardier Learjet 31	1AS001	496
2011	HOU	2275050012	General Aviation, Turbine	GA	1454	Bombardier Learjet 35	1AS001	496
2011	HOU	2275050012	General Aviation, Turbine	GA	1457	Bombardier Learjet 40	1AS001	192
2011	HOU	2275050012	General Aviation, Turbine	GA	1458	Bombardier Learjet 45	1AS001	1736
2011	HOU	2275050012	General Aviation, Turbine	GA	1460	Bombardier Learjet 55	1AS002	321
2011	HOU	2275050012	General Aviation, Turbine	GA	1462	Bombardier Learjet 60	TFE731	396
2011	HOU	2275050012	General Aviation, Turbine	GA	1529	Cessna 425 Conquest I	PT6A60	11
2011	HOU	2275050012	General Aviation, Turbine	GA	1538	Cessna 441 Conquest II	TPE8	117
2011	HOU	2275050012	General Aviation, Turbine	GA	1541	Cessna 501 Citation ISP	1PW035	797
2011	HOU	2275050012	General Aviation, Turbine	GA	1542	Cessna 525 CitationJet	1PW035	362
2011	HOU	2275050012	General Aviation, Turbine	GA	1548	Cessna 560 Citation Excel	1PW037	1056

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275050012	General Aviation, Turbine	GA	1554	Cessna 680 Citation Sovereign	7PW080	368
2011	HOU	2275050012	General Aviation, Turbine	GA	1575	Dassault Falcon 10	1RR020	89
2011	HOU	2275050012	General Aviation, Turbine	GA	1580	Dassault Falcon 20-C	1AS002	76
2011	HOU	2275050012	General Aviation, Turbine	GA	1848	Gulfstream G100	1AS002	114
2011	HOU	2275050012	General Aviation, Turbine	GA	1849	Gulfstream G150	1AS002	232
2011	HOU	2275050012	General Aviation, Turbine	GA	1850	Gulfstream G200	7PW077	210
2011	HOU	2275050012	General Aviation, Turbine	GA	1884	Hawker HS-125 Series 700	1AS002	2186
2011	HOU	2275050012	General Aviation, Turbine	GA	1913	Israel IAI-1124 Westwind I	1AS002	694
2011	HOU	2275050012	General Aviation, Turbine	GA	1984	Lockheed L-1329 Jetstar II	1AS002	15
2011	HOU	2275050012	General Aviation, Turbine	GA	2025	Mitsubishi MU-2	TPE10N	141

Baseyear	**State Facility Identifier**	**SCC**	**Mode**	**Category**	**Code**	**Airframe**	**Engine**	**LTO**
2011	HOU	2275050012	General Aviation, Turbine	GA	2031	Mitsubishi MU-300 Diamond	1PW037	92
2011	HOU	2275050012	General Aviation, Turbine	GA	2050	Piaggio P.180 Avanti	PT6A60	280
2011	HOU	2275050012	General Aviation, Turbine	GA	2075	Piper PA-42 Cheyenne Series	TPE10N	9
2011	HOU	2275050012	General Aviation, Turbine	GA	2080	Piper PA46-TP Meridian	PT6A42	117
2011	HOU	2275050012	General Aviation, Turbine	GA	2111	Raytheon King Air 100	PT6A28	118
2011	HOU	2275050012	General Aviation, Turbine	GA	2114	Raytheon King Air 90	PT6A21	929
2011	HOU	2275050012	General Aviation, Turbine	GA	2119	Raytheon Premier I	1PW035	214
2011	HOU	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	180
2011	HOU	2275060011	Air Taxi, Piston	AT	1516	Cessna 182	IO360	64
2011	HOU	2275060011	Air Taxi, Piston	AT	1517	Cessna 206	IO360	24
2011	HOU	2275060011	Air Taxi, Piston	AT	1520	Cessna 210 Centurion	TIO540	49
2011	HOU	2275060011	Air Taxi, Piston	AT	1521	Cessna 310	TIO540	22
2011	HOU	2275060011	Air Taxi, Piston	AT	1528	Cessna 421 Golden Eagle	TIO540	103

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275060011	Air Taxi, Piston	AT	1567	Cirrus SR20	IO360	2
2011	HOU	2275060011	Air Taxi, Piston	AT	1568	Cirrus SR22	TIO540	32
2011	HOU	2275060011	Air Taxi, Piston	AT	1628	EADS Socata TB-20 Trinidad	TIO540	2
2011	HOU	2275060011	Air Taxi, Piston	AT	2060	Piper PA-28 Cherokee Series	IO360	14
2011	HOU	2275060011	Air Taxi, Piston	AT	2063	Piper PA-31 Navajo	TIO540	17
2011	HOU	2275060011	Air Taxi, Piston	AT	2065	Piper PA-32 Cherokee Six	TIO540	18
2011	HOU	2275060011	Air Taxi, Piston	AT	2066	Piper PA-34 Seneca	IO360	24
2011	HOU	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	46
2011	HOU	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	177
2011	HOU	2275060012	Air Taxi, Turbine	AT	1447	Bombardier Learjet 24	CJ6106	17
2011	HOU	2275060012	Air Taxi, Turbine	AT	1519	Cessna 208 Caravan	P6114A	20
2011	HOU	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	95
2011	HOU	2275060012	Air Taxi, Turbine	AT	1543	Cessna 550 Citation II	1PW036	1181

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275060012	Air Taxi, Turbine	AT	1544	Cessna 551 Citation IISP	1PW036	18
2011	HOU	2275060012	Air Taxi, Turbine	AT	1549	Cessna 560 Citation V	1PW037	1578
2011	HOU	2275060012	Air Taxi, Turbine	AT	1553	Cessna 650 Citation III	1AS002	474
2011	HOU	2275060012	Air Taxi, Turbine	AT	1557	Cessna 750 Citation X	6AL022	978
2011	HOU	2275060012	Air Taxi, Turbine	AT	1589	Dassault Falcon 2000-EX	7PW080	669
2011	HOU	2275060012	Air Taxi, Turbine	AT	1590	Dassault Falcon 50	1AS002	364
2011	HOU	2275060012	Air Taxi, Turbine	AT	1592	Dassault Falcon 900	1AS002	174
2011	HOU	2275060012	Air Taxi, Turbine	AT	1608	DeHavilland DHC-8-100	PW120A	6
2011	HOU	2275060012	Air Taxi, Turbine	AT	1623	Dornier 328-100 Series	PW119B	342
2011	HOU	2275060012	Air Taxi, Turbine	AT	1632	EADS Socata TBM-700	PT6A64	46
2011	HOU	2275060012	Air Taxi, Turbine	AT	1654	Embraer ERJ140	6AL011	114
2011	HOU	2275060012	Air Taxi, Turbine	AT	1656	Embraer ERJ140	6AL012	342
2011	HOU	2275060012	Air Taxi, Turbine	AT	1662	Embraer ERJ140	6AL017	192
2011	HOU	2275060012	Air Taxi, Turbine	AT	1668	Embraer ERJ145	4AL003	2520

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HOU	2275060012	Air Taxi, Turbine	AT	1753	Fairchild SA-226-TC Metro II	TPE10N	4
2011	HOU	2275060012	Air Taxi, Turbine	AT	1777	Fairchild SA-227-AT Expeditor	TPE10N	80
2011	HOU	2275060012	Air Taxi, Turbine	AT	2052	Pilatus PC-12	PT67B	658
2011	HOU	2275060012	Air Taxi, Turbine	AT	2064	Piper PA-31T Cheyenne	PT6A28	108
2011	HOU	2275060012	Air Taxi, Turbine	AT	2087	Raytheon Beech 1900-C	PT67D	4
2011	HOU	2275060012	Air Taxi, Turbine	AT	2091	Raytheon Beech 99	PT6A20	132
2011	HOU	2275060012	Air Taxi, Turbine	AT	2099	Raytheon Beechjet 400	1PW037	865
2011	HOU	2275060012	Air Taxi, Turbine	AT	2107	Raytheon Hawker 4000 Horizon	7PW079	2
2011	HOU	2275060012	Air Taxi, Turbine	AT	2124	Raytheon Super King Air 200	PT6A41	1418
2011	HOU	2275060012	Air Taxi, Turbine	AT	2129	Raytheon Super King Air 300	P660AG	1229
2011	HOU	2275060012	Air Taxi, Turbine	AT	518	BAE Jetstream 31	TPE10	35
2011	HOU	2275060012	Air Taxi, Turbine	AT	543	Bell 206 JetRanger	250B17	4

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	HPY	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	1747.35449
2011	HPY	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	662.789634
2011	HQZ	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	1015
2011	HQZ	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	40581
2011	HQZ	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	1015
2011	HQZ	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	3044
2011	HQZ	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	5073
2011	IAH	2275001000	Military Aircraft, Total	MIL	2105	Raytheon Hawker 1000	TFE731	62
2011	IAH	2275001000	Military Aircraft, Total	MIL	475	Antonov 12 Cub	T56-1	9
2011	IAH	2275001000	Military Aircraft, Total	MIL	545	Bell AH-1S Cobra	T5311D	128
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1019	Boeing 767-300 Series	2GE055	56

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1052	Boeing 767-400 ER	3GE058	1986
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1055	Boeing 777-200 Series	7GE097	16
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1058	Boeing 777-200 Series	5GE086	37
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1066	Boeing 777-200 Series	6GE089	183
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1069	Boeing 777-200 Series	6GE090	110
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1071	Boeing 777-200 Series	3GE061	1525
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1073	Boeing 777-200 Series	6GE091	33

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1099	Boeing 777-200 Series	5RR040	245
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1148	Boeing 777-300 Series	7GE099	59
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1149	Boeing 777-300 Series	5GE086	18
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1157	Boeing 777-300 Series	6GE089	91
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1160	Boeing 777-300 Series	6GE090	55
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1188	Boeing 777-300 Series	5RR040	121
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	119	Airbus A300B4-600 Series	2GE039	2

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	120	Airbus A300B4-600 Series	3GE056	17
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1208	Boeing DC-10-10 Series	3GE078	76
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1216	Boeing DC-10-10 Series	1GE001	229
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1263	Boeing DC-8 Series 70	1CM003	193
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1277	Boeing DC-9-30 Series	1PW010	115
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1282	Boeing DC-9-30 Series	1PW005	276
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1284	Boeing DC-9-30 Series	1PW007	414

Baseyear	**State Facility Identifier**	**SCC**	**Mode**	**Category**	**Code**	**Airframe**	**Engine**	**LTO**
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1295	Boeing DC-9-50 Series	1PW013	12
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1335	Boeing MD-11	1GE031	1
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1341	Boeing MD-11	1PW052	1
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	135	Airbus A300B4-600 Series	1PW048	255
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1364	Boeing MD-82	4PW070	4104
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1369	Boeing MD-83	4PW070	964
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1377	Boeing MD-87	1PW019	468

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1395	Boeing MD-90	1IA002	80
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1404	Bombardier CRJ-200	5GE084	1753
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1411	Bombardier CRJ-700	5GE084	1417
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1412	Bombardier CRJ-700	5GE083	2830
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1414	Bombardier CRJ-700	6GE092	2824
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1424	Bombardier CRJ-900	6GE092	384
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1438	Bombardier Global Express	4BR009	166

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1676	Embraer ERJ145	6AL020	40978
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1713	Embraer ERJ170	6GE094	186
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1723	Embraer ERJ190	6GE094	2
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1852	Gulfstream G300	MK511	38
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1856	Gulfstream G400	1RR019	741
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1859	Gulfstream G500	4BR008	319
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	1870	Gulfstream II	MK511	9

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	191	Airbus A310-200 Series	1GE013	103
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	206	Airbus A310-200 Series	1PW028	51
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	208	Airbus A310-200 Series	1PW044	51
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	2163	Rockwell Sabreliner 40	CF700D	14
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	263	Airbus A318-100 Series	7CM048	237
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	271	Airbus A319-100 Series	4CM036	2803
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	277	Airbus A319-100 Series	3CM027	579

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	280	Airbus A319-100 Series	3CM028	193
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	285	Airbus A319-100 Series	3IA006	753
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	287	Airbus A319-100 Series	3IA007	42
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	291	Airbus A320-100 Series	1CM008	164
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	296	Airbus A320-100 Series	2CM014	38
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	303	Airbus A320-100 Series	1IA001	253
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	306	Airbus A320-100 Series	1IA003	1167

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	419	Airbus A330-300 Series	3RR030	1
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	446	Airbus A340-300 Series	1CM010	110
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	450	Airbus A340-300 Series	2CM015	445
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	476	Antonov 124 Ruslan	1ZM001	19
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	581	Boeing 727-200 Series	1PW010	71
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	582	Boeing 727-200 Series	1PW009	5
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	583	Boeing 727-200 Series	1PW011	7

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	584	Boeing 727-200 Series	1PW013	6
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	586	Boeing 727-200 Series	1PW014	65
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	588	Boeing 727-200 Series	1PW016	25
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	590	Boeing 727-200 Series	4PW070	2
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	593	Boeing 727-200 Series	1PW005	19
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	595	Boeing 727-200 Series	1PW007	21
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	608	Boeing 737-200 Series	1PW010	470

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	610	Boeing 737-200 Series	1PW011	270
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	611	Boeing 737-200 Series	1PW013	35
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	613	Boeing 737-200 Series	1PW014	35
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	620	Boeing 737-300 Series	1CM004	22525
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	622	Boeing 737-300 Series	CF563B	815
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	623	Boeing 737-300 Series	1CM005	294
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	624	Boeing 737-300 Series	1CM007	1017

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	631	Boeing 737-400 Series	1CM005	1
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	632	Boeing 737-400 Series	1CM007	46
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	635	Boeing 737-500 Series	1CM004	278
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	639	Boeing 737-500 Series	1CM007	19825
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	659	Boeing 737-700 Series	3CM031	890
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	661	Boeing 737-700 Series	3CM032	8908
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	676	Boeing 737-800 Series	3CM033	28062

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	678	Boeing 737-800 Series	3CM034	1798
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	700	Boeing 737-900 Series	3CM033	6039
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	722	Boeing 747-100 Series	1PW021	2
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	750	Boeing 747-200 Series	1GE009	10
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	771	Boeing 747-200 Series	1PW024	5
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	772	Boeing 747-200 Series	1PW025	4
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	818	Boeing 747-400 Series	1GE024	506

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	845	Boeing 747-400 Series	4RR037	79
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	861	Boeing 757-200 Series	4PW072	5
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	862	Boeing 757-200 Series	4PW073	185
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	867	Boeing 757-200 Series	3RR028	589
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	869	Boeing 757-200 Series	3RR034	7328
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	875	Boeing 757-300 Series	3RR034	3105
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	925	Boeing 767-200 Series	1GE010	232

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275020000	Commercial Aircraft, Total: All Types	AC	936	Boeing 767-200 Series	2GE047	565
2011	IAH	2275050011	General Aviation, Piston	GA	1527	Cessna 414	TIO540	24
2011	IAH	2275050011	General Aviation, Piston	GA	2032	Mooney M20-K	TSIO36	5
2011	IAH	2275050011	General Aviation, Piston	GA	2095	Raytheon Beech Baron 58	TIO540	19
2011	IAH	2275050011	General Aviation, Piston	GA	2148	Rockwell Commander 680	TIO540	5
2011	IAH	2275050011	General Aviation, Piston	GA	2149	Rockwell Commander 690	TPE10	57
2011	IAH	2275050012	General Aviation, Turbine	GA	1427	Bombardier Challenger 300	6AL006	76
2011	IAH	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	15
2011	IAH	2275050012	General Aviation, Turbine	GA	1449	Bombardier Learjet 25	CJ6106	9
2011	IAH	2275050012	General Aviation, Turbine	GA	1453	Bombardier Learjet 31	1AS001	38
2011	IAH	2275050012	General Aviation, Turbine	GA	1454	Bombardier Learjet 35	1AS001	271

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275050012	General Aviation, Turbine	GA	1457	Bombardier Learjet 40	1AS001	19
2011	IAH	2275050012	General Aviation, Turbine	GA	1458	Bombardier Learjet 45	1AS001	200
2011	IAH	2275050012	General Aviation, Turbine	GA	1460	Bombardier Learjet 55	1AS002	34
2011	IAH	2275050012	General Aviation, Turbine	GA	1462	Bombardier Learjet 60	TFE731	157
2011	IAH	2275050012	General Aviation, Turbine	GA	1529	Cessna 425 Conquest I	PT6A60	9
2011	IAH	2275050012	General Aviation, Turbine	GA	1538	Cessna 441 Conquest II	TPE8	5
2011	IAH	2275050012	General Aviation, Turbine	GA	1541	Cessna 501 Citation ISP	1PW035	204
2011	IAH	2275050012	General Aviation, Turbine	GA	1542	Cessna 525 CitationJet	1PW035	53
2011	IAH	2275050012	General Aviation, Turbine	GA	1548	Cessna 560 Citation Excel	1PW037	124
2011	IAH	2275050012	General Aviation, Turbine	GA	1554	Cessna 680 Citation Sovereign	7PW080	209
2011	IAH	2275050012	General Aviation, Turbine	GA	1575	Dassault Falcon 10	1RR020	38

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275050012	General Aviation, Turbine	GA	1579	Dassault Falcon 20-C	CF700D	6
2011	IAH	2275050012	General Aviation, Turbine	GA	1580	Dassault Falcon 20-C	1AS002	57
2011	IAH	2275050012	General Aviation, Turbine	GA	1848	Gulfstream G100	1AS002	14
2011	IAH	2275050012	General Aviation, Turbine	GA	1849	Gulfstream G150	1AS002	24
2011	IAH	2275050012	General Aviation, Turbine	GA	1850	Gulfstream G200	7PW077	34
2011	IAH	2275050012	General Aviation, Turbine	GA	1884	Hawker HS-125 Series 700	1AS002	556
2011	IAH	2275050012	General Aviation, Turbine	GA	1913	Israel IAI-1124 Westwind I	1AS002	85
2011	IAH	2275050012	General Aviation, Turbine	GA	2025	Mitsubishi MU-2	TPE10N	19
2011	IAH	2275050012	General Aviation, Turbine	GA	2031	Mitsubishi MU-300 Diamond	1PW037	9
2011	IAH	2275050012	General Aviation, Turbine	GA	2050	Piaggio P.180 Avanti	PT6A60	14
2011	IAH	2275050012	General Aviation, Turbine	GA	2075	Piper PA-42 Cheyenne Series	TPE10N	5

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275050012	General Aviation, Turbine	GA	2080	Piper PA46-TP Meridian	PT6A42	9
2011	IAH	2275050012	General Aviation, Turbine	GA	2111	Raytheon King Air 100	PT6A28	14
2011	IAH	2275050012	General Aviation, Turbine	GA	2114	Raytheon King Air 90	PT6A21	104
2011	IAH	2275050012	General Aviation, Turbine	GA	2119	Raytheon Premier I	1PW035	24
2011	IAH	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	19
2011	IAH	2275060011	Air Taxi, Piston	AT	1516	Cessna 182	IO360	5
2011	IAH	2275060011	Air Taxi, Piston	AT	1517	Cessna 206	IO360	5
2011	IAH	2275060011	Air Taxi, Piston	AT	1525	Cessna 402	TIO540	5
2011	IAH	2275060011	Air Taxi, Piston	AT	1528	Cessna 421 Golden Eagle	TIO540	14
2011	IAH	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	9
2011	IAH	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	14
2011	IAH	2275060012	Air Taxi, Turbine	AT	1403	Bombardier CRJ-200	1GE035	458
2011	IAH	2275060012	Air Taxi, Turbine	AT	1519	Cessna 208 Caravan	P6114A	176

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	28
2011	IAH	2275060012	Air Taxi, Turbine	AT	1543	Cessna 550 Citation II	1PW036	152
2011	IAH	2275060012	Air Taxi, Turbine	AT	1549	Cessna 560 Citation V	1PW037	637
2011	IAH	2275060012	Air Taxi, Turbine	AT	1553	Cessna 650 Citation III	1AS002	81
2011	IAH	2275060012	Air Taxi, Turbine	AT	1557	Cessna 750 Citation X	6AL022	257
2011	IAH	2275060012	Air Taxi, Turbine	AT	1589	Dassault Falcon 2000-EX	7PW080	337
2011	IAH	2275060012	Air Taxi, Turbine	AT	1590	Dassault Falcon 50	1AS002	228
2011	IAH	2275060012	Air Taxi, Turbine	AT	1592	Dassault Falcon 900	1AS002	71
2011	IAH	2275060012	Air Taxi, Turbine	AT	1639	Embraer EMB120 Brasilia	PW118A	1992
2011	IAH	2275060012	Air Taxi, Turbine	AT	1640	Embraer EMB120 Brasilia	PW118B	1992
2011	IAH	2275060012	Air Taxi, Turbine	AT	1656	Embraer ERJ140	6AL012	149
2011	IAH	2275060012	Air Taxi, Turbine	AT	1662	Embraer ERJ140	6AL017	10872
2011	IAH	2275060012	Air Taxi, Turbine	AT	1668	Embraer ERJ145	4AL003	55414
2011	IAH	2275060012	Air Taxi, Turbine	AT	1790	Fokker F27 Friendship	RDA7	5

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	IAH	2275060012	Air Taxi, Turbine	AT	2052	Pilatus PC-12	PT67B	57
2011	IAH	2275060012	Air Taxi, Turbine	AT	2064	Piper PA-31T Cheyenne	PT6A28	5
2011	IAH	2275060012	Air Taxi, Turbine	AT	2087	Raytheon Beech 1900-C	PT67D	5
2011	IAH	2275060012	Air Taxi, Turbine	AT	2091	Raytheon Beech 99	PT6A20	19
2011	IAH	2275060012	Air Taxi, Turbine	AT	2099	Raytheon Beechjet 400	1PW037	166
2011	IAH	2275060012	Air Taxi, Turbine	AT	2124	Raytheon Super King Air 200	PT6A41	271
2011	IAH	2275060012	Air Taxi, Turbine	AT	2129	Raytheon Super King Air 300	P660AG	138
2011	IAH	2275060012	Air Taxi, Turbine	AT	2181	Saab 340-B	CT7-5	8353
2011	IWS	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	37300.214
2011	IWS	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	14433.786
2011	IWS	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	109
2011	IWS	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	391
2011	JWY	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	373
2011	JWY	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	14920

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	JWY	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	560
2011	JWY	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	1492
2011	JWY	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	1306
2011	LA50	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	LA50	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	LBX	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	1666.66667
2011	LBX	2275020000	Commercial Aircraft, Total: All Types	AC	280	Airbus A319-100 Series	3CM028	215
2011	LBX	2275020000	Commercial Aircraft, Total: All Types	AC	601	Boeing 737-100 Series	1PW012	58
2011	LBX	2275020000	Commercial Aircraft, Total: All Types	AC	620	Boeing 737-300 Series	1CM004	21
2011	LBX	2275020000	Commercial Aircraft, Total: All Types	AC	999906	GENERIC	GENERIC	345.358

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	LBX	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	13324.1649
2011	LBX	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	34262.508
2011	LBX	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	780.3
2011	LBX	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	2003.73333
2011	LNC	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	680
2011	LNC	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	28570
2011	LNC	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	1360
2011	LNC	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	1701
2011	LNC	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	1701
2011	LUD	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	4758.6
2011	LUD	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	66
2011	LUD	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	1841.4
2011	LUD	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	4770

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	LUD	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	199
2011	LUD	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	596
2011	LUD	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	994
2011	LVJ	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	42981.5632
2011	LVJ	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	16715.0524
2011	LVJ	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	218.436784
2011	LVJ	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	84.9476381
2011	MWL	2275050012	General Aviation, Turbine	GA	1868	Gulfstream G550	3BR001	11
2011	MWL	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	8798
2011	MWL	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	202
2011	MWL	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	1305
2011	MWL	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	934
2011	NFW	2275001000	Military Aircraft, Total	MIL	1311	Boeing F/A-18 Hornet	F4044	2098

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	NFW	2275001000	Military Aircraft, Total	MIL	1314	Boeing KC-135 Stratotanker	1CM001	335
2011	NFW	2275001000	Military Aircraft, Total	MIL	1957	Lockheed C-130 Hercules	T56A15	3482
2011	NFW	2275001000	Military Aircraft, Total	MIL	1986	Lockheed Martin F-16 Fighting Falcon	F10010	5040
2011	NFW	2275001000	Military Aircraft, Total	MIL	1995	Lockheed Martin F-16 Fighting Falcon	F1101	379
2011	NFW	2275001000	Military Aircraft, Total	MIL	2215	T-38 Talon	J855HA	335
2011	NFW	2275020000	Commercial Aircraft, Total: All Types	AC	1285	Boeing DC-9-30 Series	1PW006	662
2011	NFW	2275020000	Commercial Aircraft, Total: All Types	AC	1967	Lockheed C-5 Galaxy	TF391	335
2011	NFW	2275020000	Commercial Aircraft, Total: All Types	AC	659	Boeing 737-700 Series	3CM031	460
2011	NFW	2275060011	Air Taxi, Piston	AT	2142	Robinson R22	O320	35
2011	NFW	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	1174

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	O07	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	2184.19311
2011	O07	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	828.487043
2011	RBD	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	1458
2011	RBD	2275050012	General Aviation, Turbine	GA	1877	Gulfstream V-SP	4BR008	292
2011	RBD	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	19827
2011	RBD	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	1166
2011	RBD	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	2916
2011	RBD	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	3499
2011	SGR	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	385.876256
2011	SGR	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	29911.1175
2011	SGR	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	11632.1012
2011	SGR	2275060011	Air Taxi, Piston	AT	999901	GENERIC	GENERIC	2211.05162
2011	SGR	2275060012	Air Taxi, Turbine	AT	999902	GENERIC	GENERIC	859.853409

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	T00	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	1081.5
2011	T00	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	418.5
2011	T13	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	150
2011	T31	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	4140
2011	T31	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	270
2011	T31	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	90
2011	T41	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	29303.9635
2011	T41	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	11339.5365
2011	T51	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	2839.45105
2011	T51	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	1077.03316
2011	T54	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	114.031442
2011	T57	2275060011	Air Taxi, Piston	AT	2142	Robinson R22	O320	18250
2011	T58	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	630

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	T58	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	630
2011	T58	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	840
2011	T67	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	15035
2011	T67	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	310
2011	T67	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	155
2011	T76	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	495
2011	T76	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	495
2011	T76	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	660
2011	T78	2275001000	Military Aircraft, Total	MIL	999905	GENERIC	GENERIC	12.5
2011	T78	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	2054.85
2011	T78	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	795.15
2011	T79	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	738.788651
2011	T79	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	331.394817

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	T80	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	300
2011	T87	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	150
2011	T90	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	1081.5
2011	T90	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	418.5
2011	T95	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	3.26273261
2011	T95	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	5.77530786
2011	TA02	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561
2011	TA03	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	70.1980111
2011	TA07	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	65.5153167
2011	TA14	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA14	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TA19	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	75
2011	TA20	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA20	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TA28	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	TA30	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	TA33	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	85.0148694
2011	TA45	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA45	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TA62	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA62	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TA74	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA74	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TA87	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	TA90	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	TA92	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA92	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TA95	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TA95	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TA96	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA96	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TA97	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	77.7607262
2011	TA98	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TA98	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TE09	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	TE11	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TE11	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TE28	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TE28	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TE41	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TE41	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TE44	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TE44	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TE49	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TE49	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TE53	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TE53	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TE69	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TE69	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TE70	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	155
2011	TE76	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	TE77	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	70.0318392
2011	TE85	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	73.598506
2011	TE88	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	62.2937868

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TKI	2275050012	General Aviation, Turbine	GA	1429	Bombardier Challenger 600	5GE084	2900
2011	TKI	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	16570
2011	TKI	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	3728
2011	TKI	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	7042
2011	TKI	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	11185
2011	TME	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	3276.28967
2011	TME	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	1242.73056
2011	TRL	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	10220
2011	TRL	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	383
2011	TRL	2275060012	Air Taxi, Turbine	AT	1539	Cessna 500 Citation I	1PW035	1022
2011	TRL	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	1150
2011	TS07	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	1248.61972

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TS07	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	662.789634
2011	TS16	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS16	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS17	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS17	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS19	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS19	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS24	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS24	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS26	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS26	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS31	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS31	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TS33	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS33	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS34	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS34	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS35	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	130.802605
2011	TS37	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS37	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS38	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS38	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS44	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	55.6897248
2011	TS45	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS45	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS50	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	70.6073647

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TS52	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS52	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS57	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561
2011	TS77	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS77	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS81	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS81	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS82	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS82	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS83	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS83	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS86	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS86	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TS88	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS88	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS90	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	84.5401256
2011	TS93	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS93	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TS95	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	179.318731
2011	TS99	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TS99	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TX28	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TX28	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	TX37	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561
2011	TX42	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	TX64	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561
2011	TX66	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	92.3697943

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	TX86	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	TX86	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	WEA	2275050011	General Aviation, Piston	GA	2059	Piper PA-28 Cherokee Series	IO320	1623
2011	WEA	2275060011	Air Taxi, Piston	AT	1514	Cessna 172 Skyhawk	O320	1623
2011	WEA	2275060011	Air Taxi, Piston	AT	2096	Raytheon Beech Bonanza 36	TIO540	2164
2011	X09	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	440.467886
2011	XA07	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	64.0501993
2011	XA13	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA13	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XA19	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA19	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XA20	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA20	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	XA34	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	64.0501993
2011	XA38	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA38	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XA57	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA57	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XA67	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA67	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XA73	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA73	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XA74	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA74	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XA76	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XA76	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	XA98	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	XA99	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	XBP	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	5731.95
2011	XBP	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	2218.05
2011	XBP	2275060011	Air Taxi, Piston	AT	1512	Cessna 172 Skyhawk	IO320	7314
2011	XBP	2275060011	Air Taxi, Piston	AT	2089	Raytheon Beech 55 Baron	TIO540	477
2011	XBP	2275060012	Air Taxi, Turbine	AT	2125	Raytheon Super King Air 200	PT6A42	159
2011	XS16	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XS16	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XS21	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	77.7607262
2011	XS25	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	XS26	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XS26	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231

Baseyear	State Facility Identifier	SCC	Mode	Category	Code	Airframe	Engine	LTO
2011	XS28	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	XS37	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XS37	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XS38	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	51.1161442
2011	XS38	2275050012	General Aviation, Turbine	GA	999904	GENERIC	GENERIC	90.4798231
2011	XS39	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	84.5401256
2011	XS58	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	72.7694599
2011	XS72	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	9.03804047
2011	XS77	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	106.878081
2011	XS92	2275050011	General Aviation, Piston	GA	999903	GENERIC	GENERIC	56.7960561

Appendix B
Projection Factors

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
00TX	AT	2011	2017	1	Airport/Aircraft Specific
00TX	AT	2011	2018	1	Airport/Aircraft Specific
00TX	AT	2011	2020	1	Airport/Aircraft Specific
00TX	AT	2011	2021	1	Airport/Aircraft Specific
01TE	AT	2011	2017	1	Airport/Aircraft Specific
01TE	AT	2011	2018	1	Airport/Aircraft Specific
01TE	AT	2011	2020	1	Airport/Aircraft Specific
01TE	AT	2011	2021	1	Airport/Aircraft Specific
01TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
01TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
01TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
01TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
03TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
03TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
03TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
03TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
04TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
04TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
04TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
04TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
06TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
06TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
06TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
06TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
06TX	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
06TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
06TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
06TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
07TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
07TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
07TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
07TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
08XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
08XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
08XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
08XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
09T	AT	2011	2017	1	Airport/Aircraft Specific
09T	AT	2011	2018	1	Airport/Aircraft Specific
09T	AT	2011	2020	1	Airport/Aircraft Specific
09T	AT	2011	2021	1	Airport/Aircraft Specific
09T	GA	2011	2017	1.408805	Airport/Aircraft Specific
09T	GA	2011	2018	1.408805	Airport/Aircraft Specific
09T	GA	2011	2020	1.408805	Airport/Aircraft Specific
09T	GA	2011	2021	1.408805	Airport/Aircraft Specific
0T7	AT	2011	2017	1	Airport/Aircraft Specific
0T7	AT	2011	2018	1	Airport/Aircraft Specific
0T7	AT	2011	2020	1	Airport/Aircraft Specific
0T7	AT	2011	2021	1	Airport/Aircraft Specific
0T7	GA	2011	2017	1.408805	Airport/Aircraft Specific
0T7	GA	2011	2018	1.408805	Airport/Aircraft Specific
0T7	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
0T7	GA	2011	2021	1.408805	Airport/Aircraft Specific
0TA0	GA	2011	2017	1.408805	Airport/Aircraft Specific
0TA0	GA	2011	2018	1.408805	Airport/Aircraft Specific
0TA0	GA	2011	2020	1.408805	Airport/Aircraft Specific
0TA0	GA	2011	2021	1.408805	Airport/Aircraft Specific
0TA5	GA	2011	2017	1.408805	Airport/Aircraft Specific
0TA5	GA	2011	2018	1.408805	Airport/Aircraft Specific
0TA5	GA	2011	2020	1.408805	Airport/Aircraft Specific
0TA5	GA	2011	2021	1.408805	Airport/Aircraft Specific
0TA9	GA	2011	2017	1.408805	Airport/Aircraft Specific
0TA9	GA	2011	2018	1.408805	Airport/Aircraft Specific
0TA9	GA	2011	2020	1.408805	Airport/Aircraft Specific
0TA9	GA	2011	2021	1.408805	Airport/Aircraft Specific
0TS3	GA	2011	2017	1.408805	Airport/Aircraft Specific
0TS3	GA	2011	2018	1.408805	Airport/Aircraft Specific
0TS3	GA	2011	2020	1.408805	Airport/Aircraft Specific
0TS3	GA	2011	2021	1.408805	Airport/Aircraft Specific
0TS6	GA	2011	2017	1.408805	Airport/Aircraft Specific
0TS6	GA	2011	2018	1.408805	Airport/Aircraft Specific
0TS6	GA	2011	2020	1.408805	Airport/Aircraft Specific
0TS6	GA	2011	2021	1.408805	Airport/Aircraft Specific
0XA3	GA	2011	2017	1.408805	Airport/Aircraft Specific
0XA3	GA	2011	2018	1.408805	Airport/Aircraft Specific
0XA3	GA	2011	2020	1.408805	Airport/Aircraft Specific
0XA3	GA	2011	2021	1.408805	Airport/Aircraft Specific
10TA	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
10TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
10TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
10TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
11TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
11TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
11TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
11TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
11TE	AT	2011	2017	1	Airport/Aircraft Specific
11TE	AT	2011	2018	1	Airport/Aircraft Specific
11TE	AT	2011	2020	1	Airport/Aircraft Specific
11TE	AT	2011	2021	1	Airport/Aircraft Specific
12TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
12TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
12TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
12TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
15XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
15XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
15XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
15XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
16X	AT	2011	2017	1	Airport/Aircraft Specific
16X	AT	2011	2018	1	Airport/Aircraft Specific
16X	AT	2011	2020	1	Airport/Aircraft Specific
16X	AT	2011	2021	1	Airport/Aircraft Specific
16XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
16XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
16XS	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
16XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
19TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
19TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
19TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
19TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
1F7	AT	2011	2017	1	Airport/Aircraft Specific
1F7	AT	2011	2018	1	Airport/Aircraft Specific
1F7	AT	2011	2020	1	Airport/Aircraft Specific
1F7	AT	2011	2021	1	Airport/Aircraft Specific
1F7	GA	2011	2017	1.408805	Airport/Aircraft Specific
1F7	GA	2011	2018	1.408805	Airport/Aircraft Specific
1F7	GA	2011	2020	1.408805	Airport/Aircraft Specific
1F7	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TA0	GA	2011	2017	1.408805	Airport/Aircraft Specific
1TA0	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TA0	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TA0	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TA3	GA	2011	2017	1.408805	Airport/Aircraft Specific
1TA3	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TA3	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TA3	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TA9	GA	2011	2017	1.408805	Airport/Aircraft Specific
1TA9	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TA9	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TA9	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TE2	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
1TE2	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TE2	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TE2	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TS0	GA	2011	2017	1.408805	Airport/Aircraft Specific
1TS0	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TS0	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TS0	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TS1	GA	2011	2017	1.408805	Airport/Aircraft Specific
1TS1	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TS1	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TS1	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TS3	GA	2011	2017	1.408805	Airport/Aircraft Specific
1TS3	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TS3	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TS3	GA	2011	2021	1.408805	Airport/Aircraft Specific
1TS5	GA	2011	2017	1.408805	Airport/Aircraft Specific
1TS5	GA	2011	2018	1.408805	Airport/Aircraft Specific
1TS5	GA	2011	2020	1.408805	Airport/Aircraft Specific
1TS5	GA	2011	2021	1.408805	Airport/Aircraft Specific
1XA4	GA	2011	2017	1.408805	Airport/Aircraft Specific
1XA4	GA	2011	2018	1.408805	Airport/Aircraft Specific
1XA4	GA	2011	2020	1.408805	Airport/Aircraft Specific
1XA4	GA	2011	2021	1.408805	Airport/Aircraft Specific
1XA9	GA	2011	2017	1.408805	Airport/Aircraft Specific
1XA9	GA	2011	2018	1.408805	Airport/Aircraft Specific
1XA9	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
1XA9	GA	2011	2021	1.408805	Airport/Aircraft Specific
1XS1	GA	2011	2017	1.408805	Airport/Aircraft Specific
1XS1	GA	2011	2018	1.408805	Airport/Aircraft Specific
1XS1	GA	2011	2020	1.408805	Airport/Aircraft Specific
1XS1	GA	2011	2021	1.408805	Airport/Aircraft Specific
21TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
21TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
21TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
21TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
21TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
21TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
21TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
21TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
21TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
21TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
21TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
21TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
21XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
21XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
21XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
21XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
22XA	GA	2011	2017	1.408805	Airport/Aircraft Specific
22XA	GA	2011	2018	1.408805	Airport/Aircraft Specific
22XA	GA	2011	2020	1.408805	Airport/Aircraft Specific
22XA	GA	2011	2021	1.408805	Airport/Aircraft Specific
24TE	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
24TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
24TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
24TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
25TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
25TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
25TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
25TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
25XS	AT	2011	2017	1	Airport/Aircraft Specific
25XS	AT	2011	2018	1	Airport/Aircraft Specific
25XS	AT	2011	2020	1	Airport/Aircraft Specific
25XS	AT	2011	2021	1	Airport/Aircraft Specific
25XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
25XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
25XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
25XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
26TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
26TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
26TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
26TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
26TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
26TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
26TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
26TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
26TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
26TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
26TS	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
26TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
27TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
27TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
27TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
27TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
27XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
27XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
27XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
27XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
29TE	AT	2011	2017	1	Airport/Aircraft Specific
29TE	AT	2011	2018	1	Airport/Aircraft Specific
29TE	AT	2011	2020	1	Airport/Aircraft Specific
29TE	AT	2011	2021	1	Airport/Aircraft Specific
29TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
29TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
29TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
29TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
29TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
29TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
29TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
29TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
2H5	GA	2011	2017	1.408805	Airport/Aircraft Specific
2H5	GA	2011	2018	1.408805	Airport/Aircraft Specific
2H5	GA	2011	2020	1.408805	Airport/Aircraft Specific
2H5	GA	2011	2021	1.408805	Airport/Aircraft Specific
2TA0	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
2TA0	GA	2011	2018	1.408805	Airport/Aircraft Specific
2TA0	GA	2011	2020	1.408805	Airport/Aircraft Specific
2TA0	GA	2011	2021	1.408805	Airport/Aircraft Specific
2TE0	GA	2011	2017	1.408805	Airport/Aircraft Specific
2TE0	GA	2011	2018	1.408805	Airport/Aircraft Specific
2TE0	GA	2011	2020	1.408805	Airport/Aircraft Specific
2TE0	GA	2011	2021	1.408805	Airport/Aircraft Specific
2TE1	GA	2011	2017	1.408805	Airport/Aircraft Specific
2TE1	GA	2011	2018	1.408805	Airport/Aircraft Specific
2TE1	GA	2011	2020	1.408805	Airport/Aircraft Specific
2TE1	GA	2011	2021	1.408805	Airport/Aircraft Specific
2TE2	AT	2011	2017	1	Airport/Aircraft Specific
2TE2	AT	2011	2018	1	Airport/Aircraft Specific
2TE2	AT	2011	2020	1	Airport/Aircraft Specific
2TE2	AT	2011	2021	1	Airport/Aircraft Specific
2TE2	GA	2011	2017	1.408805	Airport/Aircraft Specific
2TE2	GA	2011	2018	1.408805	Airport/Aircraft Specific
2TE2	GA	2011	2020	1.408805	Airport/Aircraft Specific
2TE2	GA	2011	2021	1.408805	Airport/Aircraft Specific
2TX7	GA	2011	2017	1.408805	Airport/Aircraft Specific
2TX7	GA	2011	2018	1.408805	Airport/Aircraft Specific
2TX7	GA	2011	2020	1.408805	Airport/Aircraft Specific
2TX7	GA	2011	2021	1.408805	Airport/Aircraft Specific
2TX9	GA	2011	2017	1.408805	Airport/Aircraft Specific
2TX9	GA	2011	2018	1.408805	Airport/Aircraft Specific
2TX9	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
2TX9	GA	2011	2021	1.408805	Airport/Aircraft Specific
2XA2	GA	2011	2017	1.408805	Airport/Aircraft Specific
2XA2	GA	2011	2018	1.408805	Airport/Aircraft Specific
2XA2	GA	2011	2020	1.408805	Airport/Aircraft Specific
2XA2	GA	2011	2021	1.408805	Airport/Aircraft Specific
2XA3	GA	2011	2017	1.408805	Airport/Aircraft Specific
2XA3	GA	2011	2018	1.408805	Airport/Aircraft Specific
2XA3	GA	2011	2020	1.408805	Airport/Aircraft Specific
2XA3	GA	2011	2021	1.408805	Airport/Aircraft Specific
30F	AT	2011	2017	1	Airport/Aircraft Specific
30F	AT	2011	2018	1	Airport/Aircraft Specific
30F	AT	2011	2020	1	Airport/Aircraft Specific
30F	AT	2011	2021	1	Airport/Aircraft Specific
30F	GA	2011	2017	1.408805	Airport/Aircraft Specific
30F	GA	2011	2018	1.408805	Airport/Aircraft Specific
30F	GA	2011	2020	1.408805	Airport/Aircraft Specific
30F	GA	2011	2021	1.408805	Airport/Aircraft Specific
31TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
31TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
31TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
31TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
33TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
33TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
33TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
33TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
33TE	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
33TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
33TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
33TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
34TE	AT	2011	2017	1	Airport/Aircraft Specific
34TE	AT	2011	2018	1	Airport/Aircraft Specific
34TE	AT	2011	2020	1	Airport/Aircraft Specific
34TE	AT	2011	2021	1	Airport/Aircraft Specific
35TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
35TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
35TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
35TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
35TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
35TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
35TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
35TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
36TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
36TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
36TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
36TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
37TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
37TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
37TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
37TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
37X	GA	2011	2017	1.408805	Airport/Aircraft Specific
37X	GA	2011	2018	1.408805	Airport/Aircraft Specific
37X	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
37X	GA	2011	2021	1.408805	Airport/Aircraft Specific
38TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
38TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
38TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
38TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
38TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
38TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
38TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
38TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
38TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
38TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
38TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
38TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
38TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
38TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
38TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
38TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
39R	GA	2011	2017	1.408805	Airport/Aircraft Specific
39R	GA	2011	2018	1.408805	Airport/Aircraft Specific
39R	GA	2011	2020	1.408805	Airport/Aircraft Specific
39R	GA	2011	2021	1.408805	Airport/Aircraft Specific
39TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
39TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
39TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
39TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
3T2	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
3T2	GA	2011	2018	1.408805	Airport/Aircraft Specific
3T2	GA	2011	2020	1.408805	Airport/Aircraft Specific
3T2	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TA7	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TA7	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TA7	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TA7	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TE1	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TE1	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TE1	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TE1	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TE2	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TE2	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TE2	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TE2	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TE9	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TE9	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TE9	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TE9	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TS3	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TS3	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TS3	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TS3	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TS4	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TS4	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TS4	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
3TS4	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TS5	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TS5	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TS5	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TS5	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TS6	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TS6	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TS6	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TS6	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TS7	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TS7	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TS7	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TS7	GA	2011	2021	1.408805	Airport/Aircraft Specific
3TS8	GA	2011	2017	1.408805	Airport/Aircraft Specific
3TS8	GA	2011	2018	1.408805	Airport/Aircraft Specific
3TS8	GA	2011	2020	1.408805	Airport/Aircraft Specific
3TS8	GA	2011	2021	1.408805	Airport/Aircraft Specific
3XA5	GA	2011	2017	1.408805	Airport/Aircraft Specific
3XA5	GA	2011	2018	1.408805	Airport/Aircraft Specific
3XA5	GA	2011	2020	1.408805	Airport/Aircraft Specific
3XA5	GA	2011	2021	1.408805	Airport/Aircraft Specific
3XS0	AT	2011	2017	1	Airport/Aircraft Specific
3XS0	AT	2011	2018	1	Airport/Aircraft Specific
3XS0	AT	2011	2020	1	Airport/Aircraft Specific
3XS0	AT	2011	2021	1	Airport/Aircraft Specific
3XS0	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
3XS0	GA	2011	2018	1.408805	Airport/Aircraft Specific
3XS0	GA	2011	2020	1.408805	Airport/Aircraft Specific
3XS0	GA	2011	2021	1.408805	Airport/Aircraft Specific
3XS8	GA	2011	2017	1.408805	Airport/Aircraft Specific
3XS8	GA	2011	2018	1.408805	Airport/Aircraft Specific
3XS8	GA	2011	2020	1.408805	Airport/Aircraft Specific
3XS8	GA	2011	2021	1.408805	Airport/Aircraft Specific
40TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
40TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
40TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
40TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
42TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
42TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
42TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
42TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
42TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
42TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
42TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
42TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
43TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
43TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
43TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
43TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
43XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
43XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
43XS	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
43XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
44XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
44XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
44XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
44XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
45TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
45TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
45TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
45TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
45TE	AT	2011	2017	1	Airport/Aircraft Specific
45TE	AT	2011	2018	1	Airport/Aircraft Specific
45TE	AT	2011	2020	1	Airport/Aircraft Specific
45TE	AT	2011	2021	1	Airport/Aircraft Specific
46TS	AT	2011	2017	1	Airport/Aircraft Specific
46TS	AT	2011	2018	1	Airport/Aircraft Specific
46TS	AT	2011	2020	1	Airport/Aircraft Specific
46TS	AT	2011	2021	1	Airport/Aircraft Specific
46TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
46TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
46TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
46TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
47TA	AT	2011	2017	1	Airport/Aircraft Specific
47TA	AT	2011	2018	1	Airport/Aircraft Specific
47TA	AT	2011	2020	1	Airport/Aircraft Specific
47TA	AT	2011	2021	1	Airport/Aircraft Specific
49T	AT	2011	2017	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
49T	AT	2011	2018	1	Airport/Aircraft Specific
49T	AT	2011	2020	1	Airport/Aircraft Specific
49T	AT	2011	2021	1	Airport/Aircraft Specific
49TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
49TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
49TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
49TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
4T2	AT	2011	2017	1	Airport/Aircraft Specific
4T2	AT	2011	2018	1	Airport/Aircraft Specific
4T2	AT	2011	2020	1	Airport/Aircraft Specific
4T2	AT	2011	2021	1	Airport/Aircraft Specific
4T2	GA	2011	2017	1.408805	Airport/Aircraft Specific
4T2	GA	2011	2018	1.408805	Airport/Aircraft Specific
4T2	GA	2011	2020	1.408805	Airport/Aircraft Specific
4T2	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TA0	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TA0	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TA0	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TA0	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TA4	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TA4	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TA4	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TA4	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TA9	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TA9	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TA9	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
4TA9	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TS0	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TS0	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TS0	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TS0	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TS1	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TS1	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TS1	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TS1	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TS2	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TS2	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TS2	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TS2	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TS4	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TS4	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TS4	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TS4	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TS6	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TS6	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TS6	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TS6	GA	2011	2021	1.408805	Airport/Aircraft Specific
4TX0	GA	2011	2017	1.408805	Airport/Aircraft Specific
4TX0	GA	2011	2018	1.408805	Airport/Aircraft Specific
4TX0	GA	2011	2020	1.408805	Airport/Aircraft Specific
4TX0	GA	2011	2021	1.408805	Airport/Aircraft Specific
4XS0	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
4XS0	GA	2011	2018	1.408805	Airport/Aircraft Specific
4XS0	GA	2011	2020	1.408805	Airport/Aircraft Specific
4XS0	GA	2011	2021	1.408805	Airport/Aircraft Specific
4XS2	GA	2011	2017	1.408805	Airport/Aircraft Specific
4XS2	GA	2011	2018	1.408805	Airport/Aircraft Specific
4XS2	GA	2011	2020	1.408805	Airport/Aircraft Specific
4XS2	GA	2011	2021	1.408805	Airport/Aircraft Specific
4XS3	GA	2011	2017	1.408805	Airport/Aircraft Specific
4XS3	GA	2011	2018	1.408805	Airport/Aircraft Specific
4XS3	GA	2011	2020	1.408805	Airport/Aircraft Specific
4XS3	GA	2011	2021	1.408805	Airport/Aircraft Specific
50F	AT	2011	2017	1	Airport/Aircraft Specific
50F	AT	2011	2018	1	Airport/Aircraft Specific
50F	AT	2011	2020	1	Airport/Aircraft Specific
50F	AT	2011	2021	1	Airport/Aircraft Specific
50F	GA	2011	2017	1.408805	Airport/Aircraft Specific
50F	GA	2011	2018	1.408805	Airport/Aircraft Specific
50F	GA	2011	2020	1.408805	Airport/Aircraft Specific
50F	GA	2011	2021	1.408805	Airport/Aircraft Specific
52F	AT	2011	2017	1	Airport/Aircraft Specific
52F	AT	2011	2018	1	Airport/Aircraft Specific
52F	AT	2011	2020	1	Airport/Aircraft Specific
52F	AT	2011	2021	1	Airport/Aircraft Specific
52TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
52TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
52TX	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
52TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
52XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
52XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
52XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
52XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
54T	GA	2011	2017	1.408805	Airport/Aircraft Specific
54T	GA	2011	2018	1.408805	Airport/Aircraft Specific
54T	GA	2011	2020	1.408805	Airport/Aircraft Specific
54T	GA	2011	2021	1.408805	Airport/Aircraft Specific
55TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
55TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
55TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
55TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
56TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
56TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
56TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
56TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
56XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
56XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
56XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
56XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
58F	AT	2011	2017	1	Airport/Aircraft Specific
58F	AT	2011	2018	1	Airport/Aircraft Specific
58F	AT	2011	2020	1	Airport/Aircraft Specific
58F	AT	2011	2021	1	Airport/Aircraft Specific
58T	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
58T	GA	2011	2018	1.408805	Airport/Aircraft Specific
58T	GA	2011	2020	1.408805	Airport/Aircraft Specific
58T	GA	2011	2021	1.408805	Airport/Aircraft Specific
59TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
59TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
59TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
59TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
59TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
59TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
59TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
59TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
5T0	GA	2011	2017	1.408805	Airport/Aircraft Specific
5T0	GA	2011	2018	1.408805	Airport/Aircraft Specific
5T0	GA	2011	2020	1.408805	Airport/Aircraft Specific
5T0	GA	2011	2021	1.408805	Airport/Aircraft Specific
5TA5	GA	2011	2017	1.408805	Airport/Aircraft Specific
5TA5	GA	2011	2018	1.408805	Airport/Aircraft Specific
5TA5	GA	2011	2020	1.408805	Airport/Aircraft Specific
5TA5	GA	2011	2021	1.408805	Airport/Aircraft Specific
5TA7	GA	2011	2017	1.408805	Airport/Aircraft Specific
5TA7	GA	2011	2018	1.408805	Airport/Aircraft Specific
5TA7	GA	2011	2020	1.408805	Airport/Aircraft Specific
5TA7	GA	2011	2021	1.408805	Airport/Aircraft Specific
5TA9	AT	2011	2017	1	Airport/Aircraft Specific
5TA9	AT	2011	2018	1	Airport/Aircraft Specific
5TA9	AT	2011	2020	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
5TA9	AT	2011	2021	1	Airport/Aircraft Specific
5TS4	GA	2011	2017	1.408805	Airport/Aircraft Specific
5TS4	GA	2011	2018	1.408805	Airport/Aircraft Specific
5TS4	GA	2011	2020	1.408805	Airport/Aircraft Specific
5TS4	GA	2011	2021	1.408805	Airport/Aircraft Specific
5TS6	GA	2011	2017	1.408805	Airport/Aircraft Specific
5TS6	GA	2011	2018	1.408805	Airport/Aircraft Specific
5TS6	GA	2011	2020	1.408805	Airport/Aircraft Specific
5TS6	GA	2011	2021	1.408805	Airport/Aircraft Specific
5TX3	GA	2011	2017	1.408805	Airport/Aircraft Specific
5TX3	GA	2011	2018	1.408805	Airport/Aircraft Specific
5TX3	GA	2011	2020	1.408805	Airport/Aircraft Specific
5TX3	GA	2011	2021	1.408805	Airport/Aircraft Specific
61TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
61TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
61TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
61TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
62TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
62TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
62TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
62TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
63TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
63TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
63TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
63TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
64TA	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
64TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
64TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
64TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
64TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
64TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
64TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
64TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
65TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
65TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
65TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
65TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
66TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
66TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
66TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
66TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
66TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
66TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
66TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
66TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
67TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
67TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
67TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
67TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
68TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
68TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
68TA	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
68TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
6R3	GA	2011	2017	1	Airport/Aircraft Specific
6R3	GA	2011	2018	1	Airport/Aircraft Specific
6R3	GA	2011	2020	1	Airport/Aircraft Specific
6R3	GA	2011	2021	1	Airport/Aircraft Specific
6R3	MIL	2011	2017	1	Airport/Aircraft Specific
6R3	MIL	2011	2018	1	Airport/Aircraft Specific
6R3	MIL	2011	2020	1	Airport/Aircraft Specific
6R3	MIL	2011	2021	1	Airport/Aircraft Specific
6R5	GA	2011	2017	1.408805	Airport/Aircraft Specific
6R5	GA	2011	2018	1.408805	Airport/Aircraft Specific
6R5	GA	2011	2020	1.408805	Airport/Aircraft Specific
6R5	GA	2011	2021	1.408805	Airport/Aircraft Specific
6TA5	AT	2011	2017	1	Airport/Aircraft Specific
6TA5	AT	2011	2018	1	Airport/Aircraft Specific
6TA5	AT	2011	2020	1	Airport/Aircraft Specific
6TA5	AT	2011	2021	1	Airport/Aircraft Specific
6TA5	GA	2011	2017	1.408805	Airport/Aircraft Specific
6TA5	GA	2011	2018	1.408805	Airport/Aircraft Specific
6TA5	GA	2011	2020	1.408805	Airport/Aircraft Specific
6TA5	GA	2011	2021	1.408805	Airport/Aircraft Specific
6TA6	GA	2011	2017	1.408805	Airport/Aircraft Specific
6TA6	GA	2011	2018	1.408805	Airport/Aircraft Specific
6TA6	GA	2011	2020	1.408805	Airport/Aircraft Specific
6TA6	GA	2011	2021	1.408805	Airport/Aircraft Specific
6X8	AT	2011	2017	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
6X8	AT	2011	2018	1	Airport/Aircraft Specific
6X8	AT	2011	2020	1	Airport/Aircraft Specific
6X8	AT	2011	2021	1	Airport/Aircraft Specific
6XS0	GA	2011	2017	1.408805	Airport/Aircraft Specific
6XS0	GA	2011	2018	1.408805	Airport/Aircraft Specific
6XS0	GA	2011	2020	1.408805	Airport/Aircraft Specific
6XS0	GA	2011	2021	1.408805	Airport/Aircraft Specific
6XS1	GA	2011	2017	1.408805	Airport/Aircraft Specific
6XS1	GA	2011	2018	1.408805	Airport/Aircraft Specific
6XS1	GA	2011	2020	1.408805	Airport/Aircraft Specific
6XS1	GA	2011	2021	1.408805	Airport/Aircraft Specific
6XS6	GA	2011	2017	1.408805	Airport/Aircraft Specific
6XS6	GA	2011	2018	1.408805	Airport/Aircraft Specific
6XS6	GA	2011	2020	1.408805	Airport/Aircraft Specific
6XS6	GA	2011	2021	1.408805	Airport/Aircraft Specific
6XS7	GA	2011	2017	1.408805	Airport/Aircraft Specific
6XS7	GA	2011	2018	1.408805	Airport/Aircraft Specific
6XS7	GA	2011	2020	1.408805	Airport/Aircraft Specific
6XS7	GA	2011	2021	1.408805	Airport/Aircraft Specific
72TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
72TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
72TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
72TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
76T	AT	2011	2017	1	Airport/Aircraft Specific
76T	AT	2011	2018	1	Airport/Aircraft Specific
76T	AT	2011	2020	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
76T	AT	2011	2021	1	Airport/Aircraft Specific
76TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
76TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
76TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
76TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
77TX	GA	2011	2017	1.408805	Airport/Aircraft Specific
77TX	GA	2011	2018	1.408805	Airport/Aircraft Specific
77TX	GA	2011	2020	1.408805	Airport/Aircraft Specific
77TX	GA	2011	2021	1.408805	Airport/Aircraft Specific
77XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
77XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
77XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
77XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
7R9	GA	2011	2017	1.408805	Airport/Aircraft Specific
7R9	GA	2011	2018	1.408805	Airport/Aircraft Specific
7R9	GA	2011	2020	1.408805	Airport/Aircraft Specific
7R9	GA	2011	2021	1.408805	Airport/Aircraft Specific
7TA0	GA	2011	2017	1.408805	Airport/Aircraft Specific
7TA0	GA	2011	2018	1.408805	Airport/Aircraft Specific
7TA0	GA	2011	2020	1.408805	Airport/Aircraft Specific
7TA0	GA	2011	2021	1.408805	Airport/Aircraft Specific
7TA2	GA	2011	2017	1.408805	Airport/Aircraft Specific
7TA2	GA	2011	2018	1.408805	Airport/Aircraft Specific
7TA2	GA	2011	2020	1.408805	Airport/Aircraft Specific
7TA2	GA	2011	2021	1.408805	Airport/Aircraft Specific
7TS0	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
7TS0	GA	2011	2018	1.408805	Airport/Aircraft Specific
7TS0	GA	2011	2020	1.408805	Airport/Aircraft Specific
7TS0	GA	2011	2021	1.408805	Airport/Aircraft Specific
7TS6	GA	2011	2017	1.408805	Airport/Aircraft Specific
7TS6	GA	2011	2018	1.408805	Airport/Aircraft Specific
7TS6	GA	2011	2020	1.408805	Airport/Aircraft Specific
7TS6	GA	2011	2021	1.408805	Airport/Aircraft Specific
7TX6	GA	2011	2017	1.408805	Airport/Aircraft Specific
7TX6	GA	2011	2018	1.408805	Airport/Aircraft Specific
7TX6	GA	2011	2020	1.408805	Airport/Aircraft Specific
7TX6	GA	2011	2021	1.408805	Airport/Aircraft Specific
7XS0	GA	2011	2017	1.408805	Airport/Aircraft Specific
7XS0	GA	2011	2018	1.408805	Airport/Aircraft Specific
7XS0	GA	2011	2020	1.408805	Airport/Aircraft Specific
7XS0	GA	2011	2021	1.408805	Airport/Aircraft Specific
7XS4	GA	2011	2017	1.408805	Airport/Aircraft Specific
7XS4	GA	2011	2018	1.408805	Airport/Aircraft Specific
7XS4	GA	2011	2020	1.408805	Airport/Aircraft Specific
7XS4	GA	2011	2021	1.408805	Airport/Aircraft Specific
7XS8	GA	2011	2017	1.408805	Airport/Aircraft Specific
7XS8	GA	2011	2018	1.408805	Airport/Aircraft Specific
7XS8	GA	2011	2020	1.408805	Airport/Aircraft Specific
7XS8	GA	2011	2021	1.408805	Airport/Aircraft Specific
7XS9	GA	2011	2017	1.408805	Airport/Aircraft Specific
7XS9	GA	2011	2018	1.408805	Airport/Aircraft Specific
7XS9	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
7XS9	GA	2011	2021	1.408805	Airport/Aircraft Specific
80TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
80TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
80TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
80TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
81D	GA	2011	2017	1.408805	Airport/Aircraft Specific
81D	GA	2011	2018	1.408805	Airport/Aircraft Specific
81D	GA	2011	2020	1.408805	Airport/Aircraft Specific
81D	GA	2011	2021	1.408805	Airport/Aircraft Specific
81XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
81XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
81XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
81XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
82TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
82TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
82TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
82TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
83XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
83XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
83XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
83XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
84TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
84TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
84TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
84TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
84TS	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
84TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
84TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
84TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
85XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
85XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
85XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
85XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
87TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
87TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
87TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
87TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
87TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
87TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
87TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
87TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
89TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
89TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
89TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
89TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
89XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
89XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
89XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
89XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
8TA4	GA	2011	2017	1.408805	Airport/Aircraft Specific
8TA4	GA	2011	2018	1.408805	Airport/Aircraft Specific
8TA4	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
8TA4	GA	2011	2021	1.408805	Airport/Aircraft Specific
8TE9	GA	2011	2017	1.408805	Airport/Aircraft Specific
8TE9	GA	2011	2018	1.408805	Airport/Aircraft Specific
8TE9	GA	2011	2020	1.408805	Airport/Aircraft Specific
8TE9	GA	2011	2021	1.408805	Airport/Aircraft Specific
8TS4	GA	2011	2017	1.408805	Airport/Aircraft Specific
8TS4	GA	2011	2018	1.408805	Airport/Aircraft Specific
8TS4	GA	2011	2020	1.408805	Airport/Aircraft Specific
8TS4	GA	2011	2021	1.408805	Airport/Aircraft Specific
8TX4	GA	2011	2017	1.408805	Airport/Aircraft Specific
8TX4	GA	2011	2018	1.408805	Airport/Aircraft Specific
8TX4	GA	2011	2020	1.408805	Airport/Aircraft Specific
8TX4	GA	2011	2021	1.408805	Airport/Aircraft Specific
8TX7	GA	2011	2017	1.408805	Airport/Aircraft Specific
8TX7	GA	2011	2018	1.408805	Airport/Aircraft Specific
8TX7	GA	2011	2020	1.408805	Airport/Aircraft Specific
8TX7	GA	2011	2021	1.408805	Airport/Aircraft Specific
8XS5	GA	2011	2017	1.408805	Airport/Aircraft Specific
8XS5	GA	2011	2018	1.408805	Airport/Aircraft Specific
8XS5	GA	2011	2020	1.408805	Airport/Aircraft Specific
8XS5	GA	2011	2021	1.408805	Airport/Aircraft Specific
90XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
90XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
90XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
90XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
91TS	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
91TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
91TS	GA	2011	2020	1.408805	Airport/Aircraft Specific
91TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
93XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
93XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
93XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
93XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
94XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
94XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
94XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
94XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
96XS	GA	2011	2017	1.408805	Airport/Aircraft Specific
96XS	GA	2011	2018	1.408805	Airport/Aircraft Specific
96XS	GA	2011	2020	1.408805	Airport/Aircraft Specific
96XS	GA	2011	2021	1.408805	Airport/Aircraft Specific
97TA	GA	2011	2017	1.408805	Airport/Aircraft Specific
97TA	GA	2011	2018	1.408805	Airport/Aircraft Specific
97TA	GA	2011	2020	1.408805	Airport/Aircraft Specific
97TA	GA	2011	2021	1.408805	Airport/Aircraft Specific
97TE	GA	2011	2017	1.408805	Airport/Aircraft Specific
97TE	GA	2011	2018	1.408805	Airport/Aircraft Specific
97TE	GA	2011	2020	1.408805	Airport/Aircraft Specific
97TE	GA	2011	2021	1.408805	Airport/Aircraft Specific
97TS	GA	2011	2017	1.408805	Airport/Aircraft Specific
97TS	GA	2011	2018	1.408805	Airport/Aircraft Specific
97TS	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
97TS	GA	2011	2021	1.408805	Airport/Aircraft Specific
9F9	AT	2011	2017	1	Airport/Aircraft Specific
9F9	AT	2011	2018	1	Airport/Aircraft Specific
9F9	AT	2011	2020	1	Airport/Aircraft Specific
9F9	AT	2011	2021	1	Airport/Aircraft Specific
9F9	GA	2011	2017	1.408805	Airport/Aircraft Specific
9F9	GA	2011	2018	1.408805	Airport/Aircraft Specific
9F9	GA	2011	2020	1.408805	Airport/Aircraft Specific
9F9	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TA3	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TA3	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TA3	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TA3	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TA6	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TA6	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TA6	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TA6	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TA7	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TA7	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TA7	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TA7	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TA9	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TA9	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TA9	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TA9	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TE1	GA	2011	2017	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
9TE1	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TE1	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TE1	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TE8	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TE8	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TE8	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TE8	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TE9	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TE9	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TE9	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TE9	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TS2	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TS2	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TS2	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TS2	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TS3	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TS3	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TS3	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TS3	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TS7	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TS7	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TS7	GA	2011	2020	1.408805	Airport/Aircraft Specific
9TS7	GA	2011	2021	1.408805	Airport/Aircraft Specific
9TX0	GA	2011	2017	1.408805	Airport/Aircraft Specific
9TX0	GA	2011	2018	1.408805	Airport/Aircraft Specific
9TX0	GA	2011	2020	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
9TX0	GA	2011	2021	1.408805	Airport/Aircraft Specific
9X1	GA	2011	2017	1.408805	Airport/Aircraft Specific
9X1	GA	2011	2018	1.408805	Airport/Aircraft Specific
9X1	GA	2011	2020	1.408805	Airport/Aircraft Specific
9X1	GA	2011	2021	1.408805	Airport/Aircraft Specific
9X9	GA	2011	2017	1.408805	Airport/Aircraft Specific
9X9	GA	2011	2018	1.408805	Airport/Aircraft Specific
9X9	GA	2011	2020	1.408805	Airport/Aircraft Specific
9X9	GA	2011	2021	1.408805	Airport/Aircraft Specific
9XS8	GA	2011	2017	1.408805	Airport/Aircraft Specific
9XS8	GA	2011	2018	1.408805	Airport/Aircraft Specific
9XS8	GA	2011	2020	1.408805	Airport/Aircraft Specific
9XS8	GA	2011	2021	1.408805	Airport/Aircraft Specific
ADS	AT	2011	2017	0.6551501	Airport/Aircraft Specific
ADS	AT	2011	2018	0.6551501	Airport/Aircraft Specific
ADS	AT	2011	2020	0.6551501	Airport/Aircraft Specific
ADS	AT	2011	2021	0.6551501	Airport/Aircraft Specific
ADS	GA	2011	2017	1.1011577	Airport/Aircraft Specific
ADS	GA	2011	2018	1.0718774	Airport/Aircraft Specific
ADS	GA	2011	2020	1.0803243	Airport/Aircraft Specific
ADS	GA	2011	2021	1.0845659	Airport/Aircraft Specific
AFW	AC	2011	2017	1.0347871	Airport/Aircraft Specific
AFW	AC	2011	2018	1.0503634	Airport/Aircraft Specific
AFW	AC	2011	2020	1.0821651	Airport/Aircraft Specific
AFW	AC	2011	2021	1.0983904	Airport/Aircraft Specific
AFW	AT	2011	2017	1.0712456	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
AFW	AT	2011	2018	1.0826542	Airport/Aircraft Specific
AFW	AT	2011	2020	1.1057043	Airport/Aircraft Specific
AFW	AT	2011	2021	1.1173458	Airport/Aircraft Specific
AFW	GA	2011	2017	0.9808732	Airport/Aircraft Specific
AFW	GA	2011	2018	0.9830009	Airport/Aircraft Specific
AFW	GA	2011	2020	0.9960665	Airport/Aircraft Specific
AFW	GA	2011	2021	1.0026913	Airport/Aircraft Specific
AXH	AT	2011	2017	1	Airport/Aircraft Specific
AXH	AT	2011	2018	1	Airport/Aircraft Specific
AXH	AT	2011	2020	1	Airport/Aircraft Specific
AXH	AT	2011	2021	1	Airport/Aircraft Specific
AXH	GA	2011	2017	1.025872	Airport/Aircraft Specific
AXH	GA	2011	2018	1.0523841	Airport/Aircraft Specific
AXH	GA	2011	2020	1.1075276	Airport/Aircraft Specific
AXH	GA	2011	2021	1.136181	Airport/Aircraft Specific
AXH	MIL	2011	2017	1	Airport/Aircraft Specific
AXH	MIL	2011	2018	1	Airport/Aircraft Specific
AXH	MIL	2011	2020	1	Airport/Aircraft Specific
AXH	MIL	2011	2021	1	Airport/Aircraft Specific
CPT	AT	2011	2017	1	Airport/Aircraft Specific
CPT	AT	2011	2018	1	Airport/Aircraft Specific
CPT	AT	2011	2020	1	Airport/Aircraft Specific
CPT	AT	2011	2021	1	Airport/Aircraft Specific
CPT	GA	2011	2017	1.0030909	Airport/Aircraft Specific
CPT	GA	2011	2018	1.0123636	Airport/Aircraft Specific
CPT	GA	2011	2020	1.0311212	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
CPT	GA	2011	2021	1.0406364	Airport/Aircraft Specific
CXO	AC	2011	2017	1	Airport/Aircraft Specific
CXO	AC	2011	2018	1	Airport/Aircraft Specific
CXO	AC	2011	2020	1	Airport/Aircraft Specific
CXO	AC	2011	2021	1	Airport/Aircraft Specific
CXO	AT	2011	2017	3.1596386	Airport/Aircraft Specific
CXO	AT	2011	2018	3.2304217	Airport/Aircraft Specific
CXO	AT	2011	2020	3.3569277	Airport/Aircraft Specific
CXO	AT	2011	2021	3.4277108	Airport/Aircraft Specific
CXO	GA	2011	2017	0.9409798	Airport/Aircraft Specific
CXO	GA	2011	2018	0.9044878	Airport/Aircraft Specific
CXO	GA	2011	2020	0.9044878	Airport/Aircraft Specific
CXO	GA	2011	2021	0.9044878	Airport/Aircraft Specific
CXO	MIL	2011	2017	1.2416529	Airport/Aircraft Specific
CXO	MIL	2011	2018	1.2416529	Airport/Aircraft Specific
CXO	MIL	2011	2020	1.2416529	Airport/Aircraft Specific
CXO	MIL	2011	2021	1.2416529	Airport/Aircraft Specific
DAL	AC	2011	2017	1.5957232	Airport/Aircraft Specific
DAL	AC	2011	2018	1.6309691	Airport/Aircraft Specific
DAL	AC	2011	2020	1.6755633	Airport/Aircraft Specific
DAL	AC	2011	2021	1.6758619	Airport/Aircraft Specific
DAL	AT	2011	2017	0.9414133	Airport/Aircraft Specific
DAL	AT	2011	2018	0.9508423	Airport/Aircraft Specific
DAL	AT	2011	2020	0.9699474	Airport/Aircraft Specific
DAL	AT	2011	2021	0.9796235	Airport/Aircraft Specific
DAL	GA	2011	2017	0.9591737	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
DAL	GA	2011	2018	0.956884	Airport/Aircraft Specific
DAL	GA	2011	2020	0.9613011	Airport/Aircraft Specific
DAL	GA	2011	2021	0.9635259	Airport/Aircraft Specific
DAL	MIL	2011	2017	0.99908	Airport/Aircraft Specific
DAL	MIL	2011	2018	0.99908	Airport/Aircraft Specific
DAL	MIL	2011	2020	0.99908	Airport/Aircraft Specific
DAL	MIL	2011	2021	0.99908	Airport/Aircraft Specific
DFW	AC	2011	2017	1.179732	Airport/Aircraft Specific
DFW	AC	2011	2018	1.2682229	Airport/Aircraft Specific
DFW	AC	2011	2020	1.3740907	Airport/Aircraft Specific
DFW	AC	2011	2021	1.4333791	Airport/Aircraft Specific
DFW	AT	2011	2017	0.5369969	Airport/Aircraft Specific
DFW	AT	2011	2018	0.353638	Airport/Aircraft Specific
DFW	AT	2011	2020	0.2596816	Airport/Aircraft Specific
DFW	AT	2011	2021	0.1882588	Airport/Aircraft Specific
DFW	GA	2011	2017	1.1084278	Airport/Aircraft Specific
DFW	GA	2011	2018	1.157056	Airport/Aircraft Specific
DFW	GA	2011	2020	1.1619846	Airport/Aircraft Specific
DFW	GA	2011	2021	1.1644488	Airport/Aircraft Specific
DTO	AT	2011	2017	2.8493353	Airport/Aircraft Specific
DTO	AT	2011	2018	2.8493353	Airport/Aircraft Specific
DTO	AT	2011	2020	2.8493353	Airport/Aircraft Specific
DTO	AT	2011	2021	2.8493353	Airport/Aircraft Specific
DTO	GA	2011	2017	0.8411119	Airport/Aircraft Specific
DTO	GA	2011	2018	0.8414064	Airport/Aircraft Specific
DTO	GA	2011	2020	0.8542401	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
DTO	GA	2011	2021	0.8608008	Airport/Aircraft Specific
DWH	AC	2011	2017	1	Airport/Aircraft Specific
DWH	AC	2011	2018	1	Airport/Aircraft Specific
DWH	AC	2011	2020	1	Airport/Aircraft Specific
DWH	AC	2011	2021	1	Airport/Aircraft Specific
DWH	AT	2011	2017	0.740564	Airport/Aircraft Specific
DWH	AT	2011	2018	0.740564	Airport/Aircraft Specific
DWH	AT	2011	2020	0.740564	Airport/Aircraft Specific
DWH	AT	2011	2021	0.740564	Airport/Aircraft Specific
DWH	GA	2011	2017	0.5492121	Airport/Aircraft Specific
DWH	GA	2011	2018	0.5766936	Airport/Aircraft Specific
DWH	GA	2011	2020	0.5774986	Airport/Aircraft Specific
DWH	GA	2011	2021	0.5779012	Airport/Aircraft Specific
DWH	MIL	2011	2017	0.4461679	Airport/Aircraft Specific
DWH	MIL	2011	2018	0.4461679	Airport/Aircraft Specific
DWH	MIL	2011	2020	0.4461679	Airport/Aircraft Specific
DWH	MIL	2011	2021	0.4461679	Airport/Aircraft Specific
E58	AT	2011	2017	1	Airport/Aircraft Specific
E58	AT	2011	2018	1	Airport/Aircraft Specific
E58	AT	2011	2020	1	Airport/Aircraft Specific
E58	AT	2011	2021	1	Airport/Aircraft Specific
EFD	AC	2011	2017	1.0782937	Airport/Aircraft Specific
EFD	AC	2011	2018	1.0782937	Airport/Aircraft Specific
EFD	AC	2011	2020	1.0782937	Airport/Aircraft Specific
EFD	AC	2011	2021	1.0782937	Airport/Aircraft Specific
EFD	AT	2011	2017	1.0778875	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
EFD	AT	2011	2018	1.0778875	Airport/Aircraft Specific
EFD	AT	2011	2020	1.0778875	Airport/Aircraft Specific
EFD	AT	2011	2021	1.0778875	Airport/Aircraft Specific
EFD	GA	2011	2017	0.6504806	Airport/Aircraft Specific
EFD	GA	2011	2018	0.6504806	Airport/Aircraft Specific
EFD	GA	2011	2020	0.6504806	Airport/Aircraft Specific
EFD	GA	2011	2021	0.6504806	Airport/Aircraft Specific
EFD	MIL	2011	2017	0.531559	Airport/Aircraft Specific
EFD	MIL	2011	2018	0.531559	Airport/Aircraft Specific
EFD	MIL	2011	2020	0.531559	Airport/Aircraft Specific
EFD	MIL	2011	2021	0.531559	Airport/Aircraft Specific
EYQ	GA	2011	2017	1.408805	Airport/Aircraft Specific
EYQ	GA	2011	2018	1.408805	Airport/Aircraft Specific
EYQ	GA	2011	2020	1.408805	Airport/Aircraft Specific
EYQ	GA	2011	2021	1.408805	Airport/Aircraft Specific
F41	AT	2011	2017	1	Airport/Aircraft Specific
F41	AT	2011	2018	1	Airport/Aircraft Specific
F41	AT	2011	2020	1	Airport/Aircraft Specific
F41	AT	2011	2021	1	Airport/Aircraft Specific
F46	AT	2011	2017	1	Airport/Aircraft Specific
F46	AT	2011	2018	1	Airport/Aircraft Specific
F46	AT	2011	2020	1	Airport/Aircraft Specific
F46	AT	2011	2021	1	Airport/Aircraft Specific
F69	AT	2011	2017	1	Airport/Aircraft Specific
F69	AT	2011	2018	1	Airport/Aircraft Specific
F69	AT	2011	2020	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
F69	AT	2011	2021	1	Airport/Aircraft Specific
F78	AT	2011	2017	1	Airport/Aircraft Specific
F78	AT	2011	2018	1	Airport/Aircraft Specific
F78	AT	2011	2020	1	Airport/Aircraft Specific
F78	AT	2011	2021	1	Airport/Aircraft Specific
FTW	AT	2011	2017	1.4755226	Airport/Aircraft Specific
FTW	AT	2011	2018	1.4900767	Airport/Aircraft Specific
FTW	AT	2011	2020	1.5194496	Airport/Aircraft Specific
FTW	AT	2011	2021	1.5345329	Airport/Aircraft Specific
FTW	GA	2011	2017	2.2398395	Airport/Aircraft Specific
FTW	GA	2011	2018	2.3526413	Airport/Aircraft Specific
FTW	GA	2011	2020	2.3822895	Airport/Aircraft Specific
FTW	GA	2011	2021	2.3972946	Airport/Aircraft Specific
FWS	AT	2011	2017	2.4175258	Airport/Aircraft Specific
FWS	AT	2011	2018	2.4793814	Airport/Aircraft Specific
FWS	AT	2011	2020	2.6030928	Airport/Aircraft Specific
FWS	AT	2011	2021	2.6649485	Airport/Aircraft Specific
FWS	GA	2011	2017	1.0750428	Airport/Aircraft Specific
FWS	GA	2011	2018	1.1091843	Airport/Aircraft Specific
FWS	GA	2011	2020	1.111059	Airport/Aircraft Specific
FWS	GA	2011	2021	1.1119964	Airport/Aircraft Specific
GKY	AT	2011	2017	1.6404293	Airport/Aircraft Specific
GKY	AT	2011	2018	1.6404293	Airport/Aircraft Specific
GKY	AT	2011	2020	1.6404293	Airport/Aircraft Specific
GKY	AT	2011	2021	1.6404293	Airport/Aircraft Specific
GKY	GA	2011	2017	1.1135878	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
GKY	GA	2011	2018	1.1009266	Airport/Aircraft Specific
GKY	GA	2011	2020	1.1044256	Airport/Aircraft Specific
GKY	GA	2011	2021	1.1061751	Airport/Aircraft Specific
GLS	AC	2011	2017	0.1111111	Airport/Aircraft Specific
GLS	AC	2011	2018	0.1111111	Airport/Aircraft Specific
GLS	AC	2011	2020	0.1111111	Airport/Aircraft Specific
GLS	AC	2011	2021	0.1111111	Airport/Aircraft Specific
GLS	AT	2011	2017	0.6223051	Airport/Aircraft Specific
GLS	AT	2011	2018	0.6284411	Airport/Aircraft Specific
GLS	AT	2011	2020	0.6412106	Airport/Aircraft Specific
GLS	AT	2011	2021	0.6476783	Airport/Aircraft Specific
GLS	GA	2011	2017	1.3593868	Airport/Aircraft Specific
GLS	GA	2011	2018	1.3665494	Airport/Aircraft Specific
GLS	GA	2011	2020	1.3776703	Airport/Aircraft Specific
GLS	GA	2011	2021	1.3832621	Airport/Aircraft Specific
GLS	MIL	2011	2017	5.9513274	Airport/Aircraft Specific
GLS	MIL	2011	2018	5.9513274	Airport/Aircraft Specific
GLS	MIL	2011	2020	5.9513274	Airport/Aircraft Specific
GLS	MIL	2011	2021	5.9513274	Airport/Aircraft Specific
GPM	AT	2011	2017	2.1527778	Airport/Aircraft Specific
GPM	AT	2011	2018	2.1527778	Airport/Aircraft Specific
GPM	AT	2011	2020	2.1527778	Airport/Aircraft Specific
GPM	AT	2011	2021	2.1527778	Airport/Aircraft Specific
HOU	AC	2011	2017	1.1581389	Airport/Aircraft Specific
HOU	AC	2011	2018	1.1903337	Airport/Aircraft Specific
HOU	AC	2011	2020	1.2646897	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
HOU	AC	2011	2021	1.2985031	Airport/Aircraft Specific
HOU	AT	2011	2017	0.6647026	Airport/Aircraft Specific
HOU	AT	2011	2018	0.6481774	Airport/Aircraft Specific
HOU	AT	2011	2020	0.6606851	Airport/Aircraft Specific
HOU	AT	2011	2021	0.6668988	Airport/Aircraft Specific
HOU	GA	2011	2017	0.9810127	Airport/Aircraft Specific
HOU	GA	2011	2018	1.0047257	Airport/Aircraft Specific
HOU	GA	2011	2020	1.0107511	Airport/Aircraft Specific
HOU	GA	2011	2021	1.0137722	Airport/Aircraft Specific
HOU	MIL	2011	2017	0.3225694	Airport/Aircraft Specific
HOU	MIL	2011	2018	0.3225694	Airport/Aircraft Specific
HOU	MIL	2011	2020	0.3225694	Airport/Aircraft Specific
HOU	MIL	2011	2021	0.3225694	Airport/Aircraft Specific
HPY	GA	2011	2017	1.408805	Airport/Aircraft Specific
HPY	GA	2011	2018	1.408805	Airport/Aircraft Specific
HPY	GA	2011	2020	1.408805	Airport/Aircraft Specific
HPY	GA	2011	2021	1.408805	Airport/Aircraft Specific
HQZ	AT	2011	2017	1	Airport/Aircraft Specific
HQZ	AT	2011	2018	1	Airport/Aircraft Specific
HQZ	AT	2011	2020	1	Airport/Aircraft Specific
HQZ	AT	2011	2021	1	Airport/Aircraft Specific
HQZ	GA	2011	2017	0.64061	Airport/Aircraft Specific
HQZ	GA	2011	2018	0.71226	Airport/Aircraft Specific
HQZ	GA	2011	2020	0.72957	Airport/Aircraft Specific
HQZ	GA	2011	2021	0.73839	Airport/Aircraft Specific
IAH	AC	2011	2017	1.1836457	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
IAH	AC	2011	2018	1.2181385	Airport/Aircraft Specific
IAH	AC	2011	2020	1.3308767	Airport/Aircraft Specific
IAH	AC	2011	2021	1.3950538	Airport/Aircraft Specific
IAH	AT	2011	2017	0.4430512	Airport/Aircraft Specific
IAH	AT	2011	2018	0.3956619	Airport/Aircraft Specific
IAH	AT	2011	2020	0.2778451	Airport/Aircraft Specific
IAH	AT	2011	2021	0.1901403	Airport/Aircraft Specific
IAH	GA	2011	2017	0.9765722	Airport/Aircraft Specific
IAH	GA	2011	2018	1.0045692	Airport/Aircraft Specific
IAH	GA	2011	2020	1.00756	Airport/Aircraft Specific
IAH	GA	2011	2021	1.0090554	Airport/Aircraft Specific
IAH	MIL	2011	2017	1.8398438	Airport/Aircraft Specific
IAH	MIL	2011	2018	1.8398438	Airport/Aircraft Specific
IAH	MIL	2011	2020	1.8398438	Airport/Aircraft Specific
IAH	MIL	2011	2021	1.8398438	Airport/Aircraft Specific
IWS	AT	2011	2017	1	Airport/Aircraft Specific
IWS	AT	2011	2018	1	Airport/Aircraft Specific
IWS	AT	2011	2020	1	Airport/Aircraft Specific
IWS	AT	2011	2021	1	Airport/Aircraft Specific
IWS	GA	2011	2017	1.014402	Airport/Aircraft Specific
IWS	GA	2011	2018	1.0290392	Airport/Aircraft Specific
IWS	GA	2011	2020	1.0589314	Airport/Aircraft Specific
IWS	GA	2011	2021	1.0741961	Airport/Aircraft Specific
JWY	AT	2011	2017	1	Airport/Aircraft Specific
JWY	AT	2011	2018	1	Airport/Aircraft Specific
JWY	AT	2011	2020	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
JWY	AT	2011	2021	1	Airport/Aircraft Specific
JWY	GA	2011	2017	0.8579088	Airport/Aircraft Specific
JWY	GA	2011	2018	0.8579088	Airport/Aircraft Specific
JWY	GA	2011	2020	0.8579088	Airport/Aircraft Specific
JWY	GA	2011	2021	0.8579088	Airport/Aircraft Specific
LA50	GA	2011	2017	1.408805	Airport/Aircraft Specific
LA50	GA	2011	2018	1.408805	Airport/Aircraft Specific
LA50	GA	2011	2020	1.408805	Airport/Aircraft Specific
LA50	GA	2011	2021	1.408805	Airport/Aircraft Specific
LBX	AC	2011	2017	1	Airport/Aircraft Specific
LBX	AC	2011	2018	1	Airport/Aircraft Specific
LBX	AC	2011	2020	1	Airport/Aircraft Specific
LBX	AC	2011	2021	1	Airport/Aircraft Specific
LBX	AT	2011	2017	1	Airport/Aircraft Specific
LBX	AT	2011	2018	1	Airport/Aircraft Specific
LBX	AT	2011	2020	1	Airport/Aircraft Specific
LBX	AT	2011	2021	1	Airport/Aircraft Specific
LBX	GA	2011	2017	1.0233244	Airport/Aircraft Specific
LBX	GA	2011	2018	1.0471925	Airport/Aircraft Specific
LBX	GA	2011	2020	1.0965734	Airport/Aircraft Specific
LBX	GA	2011	2021	1.1221677	Airport/Aircraft Specific
LBX	MIL	2011	2017	1	Airport/Aircraft Specific
LBX	MIL	2011	2018	1	Airport/Aircraft Specific
LBX	MIL	2011	2020	1	Airport/Aircraft Specific
LBX	MIL	2011	2021	1	Airport/Aircraft Specific
LNC	AT	2011	2017	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
LNC	AT	2011	2018	1	Airport/Aircraft Specific
LNC	AT	2011	2020	1	Airport/Aircraft Specific
LNC	AT	2011	2021	1	Airport/Aircraft Specific
LNC	GA	2011	2017	1.0145414	Airport/Aircraft Specific
LNC	GA	2011	2018	1.0293065	Airport/Aircraft Specific
LNC	GA	2011	2020	1.0594482	Airport/Aircraft Specific
LNC	GA	2011	2021	1.0748397	Airport/Aircraft Specific
LUD	AT	2011	2017	1	Airport/Aircraft Specific
LUD	AT	2011	2018	1	Airport/Aircraft Specific
LUD	AT	2011	2020	1	Airport/Aircraft Specific
LUD	AT	2011	2021	1	Airport/Aircraft Specific
LUD	GA	2011	2017	1.3636364	Airport/Aircraft Specific
LUD	GA	2011	2018	1.3636364	Airport/Aircraft Specific
LUD	GA	2011	2020	1.3636364	Airport/Aircraft Specific
LUD	GA	2011	2021	1.3636364	Airport/Aircraft Specific
LVJ	AT	2011	2017	1	Airport/Aircraft Specific
LVJ	AT	2011	2018	1	Airport/Aircraft Specific
LVJ	AT	2011	2020	1	Airport/Aircraft Specific
LVJ	AT	2011	2021	1	Airport/Aircraft Specific
LVJ	GA	2011	2017	1.0189413	Airport/Aircraft Specific
LVJ	GA	2011	2018	1.0382278	Airport/Aircraft Specific
LVJ	GA	2011	2020	1.0779171	Airport/Aircraft Specific
LVJ	GA	2011	2021	1.0983314	Airport/Aircraft Specific
MWL	AT	2011	2017	1	Airport/Aircraft Specific
MWL	AT	2011	2018	1	Airport/Aircraft Specific
MWL	AT	2011	2020	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
MWL	AT	2011	2021	1	Airport/Aircraft Specific
MWL	GA	2011	2017	1.4222222	Airport/Aircraft Specific
MWL	GA	2011	2018	1.4222222	Airport/Aircraft Specific
MWL	GA	2011	2020	1.4222222	Airport/Aircraft Specific
MWL	GA	2011	2021	1.4222222	Airport/Aircraft Specific
NFW	AC	2011	2017	1.1659737	Aircraft Specific
NFW	AC	2011	2018	1	Airport/Aircraft Specific
NFW	AC	2011	2020	1	Airport/Aircraft Specific
NFW	AC	2011	2021	1	Airport/Aircraft Specific
NFW	AT	2011	2017	1	Airport/Aircraft Specific
NFW	AT	2011	2018	1	Airport/Aircraft Specific
NFW	AT	2011	2020	1	Airport/Aircraft Specific
NFW	AT	2011	2021	1	Airport/Aircraft Specific
NFW	MIL	2011	2017	1	Airport/Aircraft Specific
NFW	MIL	2011	2018	1	Airport/Aircraft Specific
NFW	MIL	2011	2020	1	Airport/Aircraft Specific
NFW	MIL	2011	2021	1	Airport/Aircraft Specific
O07	GA	2011	2017	1.408805	Airport/Aircraft Specific
O07	GA	2011	2018	1.408805	Airport/Aircraft Specific
O07	GA	2011	2020	1.408805	Airport/Aircraft Specific
O07	GA	2011	2021	1.408805	Airport/Aircraft Specific
RBD	AT	2011	2017	0.1295938	Airport/Aircraft Specific
RBD	AT	2011	2018	0.1295938	Airport/Aircraft Specific
RBD	AT	2011	2020	0.1295938	Airport/Aircraft Specific
RBD	AT	2011	2021	0.1295938	Airport/Aircraft Specific
RBD	GA	2011	2017	0.7389834	Airport/Aircraft Specific
RBD	GA	2011	2018	0.751886	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
RBD	GA	2011	2020	0.7571059	Airport/Aircraft Specific
RBD	GA	2011	2021	0.7597419	Airport/Aircraft Specific
SGR	AT	2011	2017	1.3033354	Airport/Aircraft Specific
SGR	AT	2011	2018	1.3163415	Airport/Aircraft Specific
SGR	AT	2011	2020	1.3427732	Airport/Aircraft Specific
SGR	AT	2011	2021	1.3561989	Airport/Aircraft Specific
SGR	GA	2011	2017	1.0056445	Airport/Aircraft Specific
SGR	GA	2011	2018	0.9923242	Airport/Aircraft Specific
SGR	GA	2011	2020	0.9961543	Airport/Aircraft Specific
SGR	GA	2011	2021	0.9980772	Airport/Aircraft Specific
SGR	MIL	2011	2017	1.4156928	Airport/Aircraft Specific
SGR	MIL	2011	2018	1.4156928	Airport/Aircraft Specific
SGR	MIL	2011	2020	1.4156928	Airport/Aircraft Specific
SGR	MIL	2011	2021	1.4156928	Airport/Aircraft Specific
T00	GA	2011	2017	1.5	Airport/Aircraft Specific
T00	GA	2011	2018	1.5	Airport/Aircraft Specific
T00	GA	2011	2020	1.5	Airport/Aircraft Specific
T00	GA	2011	2021	1.5	Airport/Aircraft Specific
T13	AT	2011	2017	1	Airport/Aircraft Specific
T13	AT	2011	2018	1	Airport/Aircraft Specific
T13	AT	2011	2020	1	Airport/Aircraft Specific
T13	AT	2011	2021	1	Airport/Aircraft Specific
T31	AT	2011	2017	1	Airport/Aircraft Specific
T31	AT	2011	2018	1	Airport/Aircraft Specific
T31	AT	2011	2020	1	Airport/Aircraft Specific
T31	AT	2011	2021	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
T41	GA	2011	2017	0.3742399	Airport/Aircraft Specific
T41	GA	2011	2018	0.3829768	Airport/Aircraft Specific
T41	GA	2011	2020	0.4010298	Airport/Aircraft Specific
T41	GA	2011	2021	0.4103836	Airport/Aircraft Specific
T51	GA	2011	2017	1.408805	Airport/Aircraft Specific
T51	GA	2011	2018	1.408805	Airport/Aircraft Specific
T51	GA	2011	2020	1.408805	Airport/Aircraft Specific
T51	GA	2011	2021	1.408805	Airport/Aircraft Specific
T54	GA	2011	2017	1.408805	Airport/Aircraft Specific
T54	GA	2011	2018	1.408805	Airport/Aircraft Specific
T54	GA	2011	2020	1.408805	Airport/Aircraft Specific
T54	GA	2011	2021	1.408805	Airport/Aircraft Specific
T57	AT	2011	2017	1	Airport/Aircraft Specific
T57	AT	2011	2018	1	Airport/Aircraft Specific
T57	AT	2011	2020	1	Airport/Aircraft Specific
T57	AT	2011	2021	1	Airport/Aircraft Specific
T58	AT	2011	2017	1	Airport/Aircraft Specific
T58	AT	2011	2018	1	Airport/Aircraft Specific
T58	AT	2011	2020	1	Airport/Aircraft Specific
T58	AT	2011	2021	1	Airport/Aircraft Specific
T58	GA	2011	2017	1.408805	Airport/Aircraft Specific
T58	GA	2011	2018	1.408805	Airport/Aircraft Specific
T58	GA	2011	2020	1.408805	Airport/Aircraft Specific
T58	GA	2011	2021	1.408805	Airport/Aircraft Specific
T67	AT	2011	2017	1	Airport/Aircraft Specific
T67	AT	2011	2018	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
T67	AT	2011	2020	1	Airport/Aircraft Specific
T67	AT	2011	2021	1	Airport/Aircraft Specific
T76	AT	2011	2017	1	Airport/Aircraft Specific
T76	AT	2011	2018	1	Airport/Aircraft Specific
T76	AT	2011	2020	1	Airport/Aircraft Specific
T76	AT	2011	2021	1	Airport/Aircraft Specific
T76	GA	2011	2017	1.408805	Airport/Aircraft Specific
T76	GA	2011	2018	1.408805	Airport/Aircraft Specific
T76	GA	2011	2020	1.408805	Airport/Aircraft Specific
T76	GA	2011	2021	1.408805	Airport/Aircraft Specific
T78	GA	2011	2017	1.0868421	Airport/Aircraft Specific
T78	GA	2011	2018	1.0868421	Airport/Aircraft Specific
T78	GA	2011	2020	1.0868421	Airport/Aircraft Specific
T78	GA	2011	2021	1.0868421	Airport/Aircraft Specific
T78	MIL	2011	2017	1.92	Airport/Aircraft Specific
T78	MIL	2011	2018	1.92	Airport/Aircraft Specific
T78	MIL	2011	2020	1.92	Airport/Aircraft Specific
T78	MIL	2011	2021	1.92	Airport/Aircraft Specific
T79	GA	2011	2017	1.408805	Airport/Aircraft Specific
T79	GA	2011	2018	1.408805	Airport/Aircraft Specific
T79	GA	2011	2020	1.408805	Airport/Aircraft Specific
T79	GA	2011	2021	1.408805	Airport/Aircraft Specific
T80	AT	2011	2017	1	Airport/Aircraft Specific
T80	AT	2011	2018	1	Airport/Aircraft Specific
T80	AT	2011	2020	1	Airport/Aircraft Specific
T80	AT	2011	2021	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
T87	AT	2011	2017	1	Airport/Aircraft Specific
T87	AT	2011	2018	1	Airport/Aircraft Specific
T87	AT	2011	2020	1	Airport/Aircraft Specific
T87	AT	2011	2021	1	Airport/Aircraft Specific
T90	GA	2011	2017	2	Airport/Aircraft Specific
T90	GA	2011	2018	2	Airport/Aircraft Specific
T90	GA	2011	2020	2	Airport/Aircraft Specific
T90	GA	2011	2021	2	Airport/Aircraft Specific
T95	GA	2011	2017	1.408805	Airport/Aircraft Specific
T95	GA	2011	2018	1.408805	Airport/Aircraft Specific
T95	GA	2011	2020	1.408805	Airport/Aircraft Specific
T95	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA02	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA02	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA02	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA02	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA03	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA03	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA03	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA03	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA07	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA07	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA07	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA07	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA14	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA14	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TA14	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA14	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA19	AT	2011	2017	1	Airport/Aircraft Specific
TA19	AT	2011	2018	1	Airport/Aircraft Specific
TA19	AT	2011	2020	1	Airport/Aircraft Specific
TA19	AT	2011	2021	1	Airport/Aircraft Specific
TA20	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA20	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA20	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA20	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA28	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA28	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA28	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA28	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA30	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA30	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA30	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA30	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA33	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA33	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA33	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA33	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA45	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA45	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA45	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA45	GA	2011	2021	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TA62	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA62	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA62	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA62	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA74	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA74	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA74	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA74	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA87	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA87	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA87	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA87	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA90	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA90	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA90	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA90	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA92	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA92	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA92	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA92	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA95	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA95	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA95	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA95	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA96	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA96	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TA96	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA96	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA97	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA97	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA97	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA97	GA	2011	2021	1.408805	Airport/Aircraft Specific
TA98	GA	2011	2017	1.408805	Airport/Aircraft Specific
TA98	GA	2011	2018	1.408805	Airport/Aircraft Specific
TA98	GA	2011	2020	1.408805	Airport/Aircraft Specific
TA98	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE09	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE09	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE09	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE09	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE11	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE11	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE11	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE11	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE28	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE28	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE28	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE28	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE41	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE41	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE41	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE41	GA	2011	2021	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TE44	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE44	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE44	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE44	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE49	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE49	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE49	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE49	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE53	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE53	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE53	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE53	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE69	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE69	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE69	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE69	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE70	AT	2011	2017	1	Airport/Aircraft Specific
TE70	AT	2011	2018	1	Airport/Aircraft Specific
TE70	AT	2011	2020	1	Airport/Aircraft Specific
TE70	AT	2011	2021	1	Airport/Aircraft Specific
TE76	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE76	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE76	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE76	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE77	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE77	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TE77	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE77	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE85	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE85	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE85	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE85	GA	2011	2021	1.408805	Airport/Aircraft Specific
TE88	GA	2011	2017	1.408805	Airport/Aircraft Specific
TE88	GA	2011	2018	1.408805	Airport/Aircraft Specific
TE88	GA	2011	2020	1.408805	Airport/Aircraft Specific
TE88	GA	2011	2021	1.408805	Airport/Aircraft Specific
TKI	AT	2011	2017	2.5037159	Airport/Aircraft Specific
TKI	AT	2011	2018	2.5037159	Airport/Aircraft Specific
TKI	AT	2011	2020	2.5037159	Airport/Aircraft Specific
TKI	AT	2011	2021	2.5037159	Airport/Aircraft Specific
TKI	GA	2011	2017	1.5711034	Airport/Aircraft Specific
TKI	GA	2011	2018	1.6687963	Airport/Aircraft Specific
TKI	GA	2011	2020	1.6807784	Airport/Aircraft Specific
TKI	GA	2011	2021	1.6868001	Airport/Aircraft Specific
TME	GA	2011	2017	1.408805	Airport/Aircraft Specific
TME	GA	2011	2018	1.408805	Airport/Aircraft Specific
TME	GA	2011	2020	1.408805	Airport/Aircraft Specific
TME	GA	2011	2021	1.408805	Airport/Aircraft Specific
TRL	AT	2011	2017	1	Airport/Aircraft Specific
TRL	AT	2011	2018	1	Airport/Aircraft Specific
TRL	AT	2011	2020	1	Airport/Aircraft Specific
TRL	AT	2011	2021	1	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TS07	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS07	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS07	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS07	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS16	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS16	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS16	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS16	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS17	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS17	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS17	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS17	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS19	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS19	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS19	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS19	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS24	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS24	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS24	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS24	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS26	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS26	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS26	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS26	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS31	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS31	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TS31	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS31	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS33	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS33	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS33	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS33	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS34	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS34	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS34	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS34	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS35	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS35	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS35	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS35	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS37	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS37	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS37	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS37	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS38	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS38	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS38	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS38	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS44	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS44	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS44	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS44	GA	2011	2021	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TS45	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS45	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS45	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS45	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS50	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS50	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS50	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS50	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS52	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS52	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS52	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS52	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS57	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS57	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS57	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS57	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS77	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS77	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS77	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS77	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS81	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS81	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS81	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS81	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS82	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS82	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TS82	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS82	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS83	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS83	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS83	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS83	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS86	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS86	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS86	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS86	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS88	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS88	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS88	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS88	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS90	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS90	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS90	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS90	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS93	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS93	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS93	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS93	GA	2011	2021	1.408805	Airport/Aircraft Specific
TS95	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS95	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS95	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS95	GA	2011	2021	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TS99	GA	2011	2017	1.408805	Airport/Aircraft Specific
TS99	GA	2011	2018	1.408805	Airport/Aircraft Specific
TS99	GA	2011	2020	1.408805	Airport/Aircraft Specific
TS99	GA	2011	2021	1.408805	Airport/Aircraft Specific
TX28	GA	2011	2017	1.408805	Airport/Aircraft Specific
TX28	GA	2011	2018	1.408805	Airport/Aircraft Specific
TX28	GA	2011	2020	1.408805	Airport/Aircraft Specific
TX28	GA	2011	2021	1.408805	Airport/Aircraft Specific
TX37	GA	2011	2017	1.408805	Airport/Aircraft Specific
TX37	GA	2011	2018	1.408805	Airport/Aircraft Specific
TX37	GA	2011	2020	1.408805	Airport/Aircraft Specific
TX37	GA	2011	2021	1.408805	Airport/Aircraft Specific
TX42	GA	2011	2017	1.408805	Airport/Aircraft Specific
TX42	GA	2011	2018	1.408805	Airport/Aircraft Specific
TX42	GA	2011	2020	1.408805	Airport/Aircraft Specific
TX42	GA	2011	2021	1.408805	Airport/Aircraft Specific
TX64	GA	2011	2017	1.408805	Airport/Aircraft Specific
TX64	GA	2011	2018	1.408805	Airport/Aircraft Specific
TX64	GA	2011	2020	1.408805	Airport/Aircraft Specific
TX64	GA	2011	2021	1.408805	Airport/Aircraft Specific
TX66	GA	2011	2017	1.408805	Airport/Aircraft Specific
TX66	GA	2011	2018	1.408805	Airport/Aircraft Specific
TX66	GA	2011	2020	1.408805	Airport/Aircraft Specific
TX66	GA	2011	2021	1.408805	Airport/Aircraft Specific
TX86	GA	2011	2017	1.408805	Airport/Aircraft Specific
TX86	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
TX86	GA	2011	2020	1.408805	Airport/Aircraft Specific
TX86	GA	2011	2021	1.408805	Airport/Aircraft Specific
WEA	AT	2011	2017	1	Airport/Aircraft Specific
WEA	AT	2011	2018	1	Airport/Aircraft Specific
WEA	AT	2011	2020	1	Airport/Aircraft Specific
WEA	AT	2011	2021	1	Airport/Aircraft Specific
WEA	GA	2011	2017	1.408805	Airport/Aircraft Specific
WEA	GA	2011	2018	1.408805	Airport/Aircraft Specific
WEA	GA	2011	2020	1.408805	Airport/Aircraft Specific
WEA	GA	2011	2021	1.408805	Airport/Aircraft Specific
X09	GA	2011	2017	1.408805	Airport/Aircraft Specific
X09	GA	2011	2018	1.408805	Airport/Aircraft Specific
X09	GA	2011	2020	1.408805	Airport/Aircraft Specific
X09	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA07	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA07	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA07	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA07	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA13	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA13	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA13	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA13	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA19	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA19	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA19	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA19	GA	2011	2021	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
XA20	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA20	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA20	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA20	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA34	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA34	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA34	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA34	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA38	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA38	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA38	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA38	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA57	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA57	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA57	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA57	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA67	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA67	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA67	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA67	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA73	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA73	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA73	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA73	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA74	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA74	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
XA74	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA74	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA76	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA76	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA76	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA76	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA98	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA98	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA98	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA98	GA	2011	2021	1.408805	Airport/Aircraft Specific
XA99	GA	2011	2017	1.408805	Airport/Aircraft Specific
XA99	GA	2011	2018	1.408805	Airport/Aircraft Specific
XA99	GA	2011	2020	1.408805	Airport/Aircraft Specific
XA99	GA	2011	2021	1.408805	Airport/Aircraft Specific
XBP	AT	2011	2017	1	Airport/Aircraft Specific
XBP	AT	2011	2018	1	Airport/Aircraft Specific
XBP	AT	2011	2020	1	Airport/Aircraft Specific
XBP	AT	2011	2021	1	Airport/Aircraft Specific
XBP	GA	2011	2017	1.408805	Airport/Aircraft Specific
XBP	GA	2011	2018	1.408805	Airport/Aircraft Specific
XBP	GA	2011	2020	1.408805	Airport/Aircraft Specific
XBP	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS16	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS16	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS16	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS16	GA	2011	2021	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
XS21	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS21	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS21	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS21	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS25	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS25	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS25	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS25	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS26	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS26	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS26	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS26	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS28	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS28	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS28	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS28	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS37	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS37	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS37	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS37	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS38	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS38	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS38	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS38	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS39	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS39	GA	2011	2018	1.408805	Airport/Aircraft Specific

State Facility Identifier	Category	Base Year	Projection Year	Growth Factor	Note
XS39	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS39	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS58	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS58	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS58	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS58	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS72	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS72	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS72	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS72	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS77	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS77	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS77	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS77	GA	2011	2021	1.408805	Airport/Aircraft Specific
XS92	GA	2011	2017	1.408805	Airport/Aircraft Specific
XS92	GA	2011	2018	1.408805	Airport/Aircraft Specific
XS92	GA	2011	2020	1.408805	Airport/Aircraft Specific
XS92	GA	2011	2021	1.408805	Airport/Aircraft Specific

Appendix C
Full County Controlled Emissions

Appendix C. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NOx	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
Anderson	9.03E-02	1.88E-03	1.92E-03	1.50E-03	2.98E-04	2.81E-03
Andrews	2.79E-02	3.38E-04	5.84E-04	4.49E-04	6.84E-05	7.42E-04
Angelina	1.55E-01	9.44E-03	3.53E-03	2.82E-03	1.09E-03	7.65E-03
Aransas	9.65E-01	5.02E-01	3.91E-02	3.65E-02	4.79E-02	2.52E-01
Archer	3.07E-02	3.98E-04	6.46E-04	5.03E-04	8.14E-05	8.69E-04
Armstrong	2.77E-03	1.50E-05	5.45E-05	3.76E-05	2.30E-06	3.46E-05
Atascosa	2.63E-01	4.52E-03	4.89E-04	4.64E-04	9.81E-04	2.28E-02
Austin	3.16E-02	3.44E-04	6.54E-04	4.94E-04	6.80E-05	7.58E-04
Bailey	5.16E-02	6.87E-04	1.09E-03	8.53E-04	1.41E-04	1.50E-03
Bandera	1.10E-02	9.30E-05	2.22E-04	1.61E-04	1.72E-05	2.08E-04
Bastrop	7.73E-02	9.02E-04	1.61E-03	1.23E-03	1.81E-04	1.98E-03
Baylor	2.48E-03	2.90E-05	5.16E-05	3.95E-05	5.82E-06	6.37E-05
Bee	3.80E-02	4.73E-04	7.96E-04	6.16E-04	9.62E-05	1.04E-03
Bell	1.02E+00	3.24E-01	2.89E-02	2.59E-02	3.30E-02	1.47E-01
Bexar	8.83E+00	1.18E+00	3.08E-02	2.94E-02	1.49E-01	8.96E-01
Blanco	9.02E-03	4.88E-05	1.78E-04	1.23E-04	7.51E-06	1.13E-04
Bosque	5.40E-02	6.56E-04	1.13E-03	8.68E-04	1.33E-04	1.44E-03
Bowie	3.16E-03	1.71E-05	6.22E-05	4.29E-05	2.63E-06	3.96E-05
Brazoria	2.01E+00	1.05E-01	4.78E-02	4.02E-02	1.43E-02	1.06E-01
Brazos	6.90E-01	1.86E-01	1.95E-02	1.72E-02	1.93E-02	9.97E-02
Brewster	8.06E-02	1.72E-03	1.71E-03	1.32E-03	2.65E-04	2.47E-03
Briscoe	1.49E-04	8.05E-07	2.93E-06	2.02E-06	1.24E-07	1.86E-06
Brooks	4.36E-02	5.35E-04	9.12E-04	7.04E-04	1.08E-04	1.17E-03
Brown	4.91E-02	5.43E-03	1.23E-03	1.02E-03	5.99E-04	3.62E-03
Burleson	2.40E-02	3.02E-04	5.03E-04	3.90E-04	6.16E-05	6.62E-04
Burnet	3.57E-01	1.34E-02	7.81E-03	6.13E-03	1.71E-03	1.37E-02
Caldwell	3.85E-01	9.70E-03	8.28E-03	6.44E-03	1.41E-03	1.25E-02
Calhoun	9.85E-02	2.40E-02	2.95E-03	2.60E-03	2.38E-03	1.34E-02
Callahan	3.19E-03	1.98E-05	6.33E-05	4.43E-05	3.28E-06	4.53E-05
Cameron	1.26E+00	5.68E-01	3.61E-02	3.35E-02	5.78E-02	2.50E-01
Camp	3.16E-03	5.08E-05	6.82E-05	5.55E-05	1.08E-05	1.10E-04
Carson	3.68E-02	4.72E-04	7.73E-04	6.01E-04	9.64E-05	1.03E-03
Cass	1.23E-01	1.48E-03	2.57E-03	1.97E-03	2.98E-04	3.24E-03
Castro	2.23E-02	2.56E-04	4.64E-04	3.54E-04	5.12E-05	5.63E-04
Chambers	1.25E-01	1.54E-03	2.62E-03	2.02E-03	3.11E-04	3.37E-03
Cherokee	1.13E-01	2.14E-03	2.39E-03	1.86E-03	3.51E-04	3.38E-03
Childress	2.36E-02	3.15E-04	4.97E-04	3.90E-04	6.50E-05	6.89E-04
Clay	3.17E-02	4.59E-04	6.75E-04	5.37E-04	9.58E-05	1.00E-03
Cochran	2.56E-02	3.10E-04	5.35E-04	4.12E-04	6.27E-05	6.80E-04

Appendix C. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC
Coke	2.15E-03	2.71E-05	4.51E-05	3.50E-05	5.51E-06	5.93E-05
Coleman	5.84E-02	7.06E-04	1.22E-03	9.38E-04	1.43E-04	1.55E-03
Collin	2.89E+00	7.49E-02	5.31E-03	5.27E-03	1.73E-02	3.10E-01
Collingsworth	1.89E-02	1.13E-03	4.30E-04	3.43E-04	1.30E-04	9.20E-04
Colorado	1.30E-01	1.60E-03	2.73E-03	2.11E-03	3.25E-04	3.51E-03
Comal	8.59E-01	1.59E-03	9.49E-04	8.49E-04	8.39E-04	2.09E-02
Comanche	5.41E-02	6.54E-04	1.13E-03	8.69E-04	1.32E-04	1.43E-03
Cooke	1.79E-01	3.62E-03	3.79E-03	2.92E-03	5.64E-04	5.32E-03
Coryell	3.71E-02	4.53E-04	7.75E-04	5.98E-04	9.17E-05	9.92E-04
Cottle	7.89E-03	9.93E-05	1.65E-04	1.28E-04	2.02E-05	2.17E-04
Crane	9.00E-03	1.13E-04	1.89E-04	1.46E-04	2.30E-05	2.47E-04
Crockett	4.89E-02	1.72E-03	1.06E-03	8.32E-04	2.23E-04	1.81E-03
Crosby	4.24E-02	6.10E-04	9.03E-04	7.18E-04	1.27E-04	1.33E-03
Culberson	7.28E-03	3.10E-03	2.67E-04	2.43E-04	2.96E-04	1.57E-03
Dallam	2.11E-02	2.58E-04	4.42E-04	3.41E-04	5.23E-05	5.66E-04
Dallas	1.20E+01	1.70E+00	4.13E-02	4.10E-02	2.28E-01	1.32E+00
Dawson	7.18E-02	8.77E-04	1.50E-03	1.16E-03	1.78E-04	1.92E-03
Deaf Smith	1.06E-01	1.88E-03	2.23E-03	1.73E-03	3.14E-04	3.08E-03
Delta	1.49E-04	8.05E-07	2.93E-06	2.02E-06	1.24E-07	1.86E-06
Denton	6.57E+00	1.07E-01	9.46E-03	9.41E-03	2.59E-02	3.51E-01
DeWitt	1.70E-02	2.19E-04	3.58E-04	2.79E-04	4.49E-05	4.80E-04
Dickens	1.03E-03	5.58E-06	2.03E-05	1.40E-05	8.59E-07	1.29E-05
Dimmit	1.64E-02	1.82E-04	3.39E-04	2.57E-04	3.62E-05	4.01E-04
Donley	2.68E-04	4.02E-06	5.74E-06	4.60E-06	8.44E-07	8.75E-06
Duval	1.65E-02	1.61E-04	3.38E-04	2.51E-04	3.11E-05	3.58E-04
Eastland	6.87E-02	8.22E-04	1.43E-03	1.10E-03	1.66E-04	1.80E-03
Ector	4.00E-01	4.86E-03	8.35E-03	6.43E-03	9.83E-04	1.07E-02
Edwards	7.46E-03	7.12E-05	1.53E-04	1.13E-04	1.37E-05	1.58E-04
El Paso	2.29E+00	7.94E-01	3.27E-02	2.89E-02	8.80E-02	1.96E-01
Ellis	9.44E-01	1.48E-02	1.48E-03	1.48E-03	3.70E-03	5.76E-02
Erath	9.30E-02	1.09E-03	1.94E-03	1.48E-03	2.20E-04	2.40E-03
Falls	3.24E-03	3.30E-05	6.66E-05	4.98E-05	6.42E-06	7.29E-05
Fannin	5.37E-02	5.87E-04	1.11E-03	8.40E-04	1.16E-04	1.29E-03
Fayette	9.02E-02	1.04E-03	1.87E-03	1.43E-03	2.09E-04	2.29E-03
Fisher	2.60E-02	3.26E-04	5.45E-04	4.22E-04	6.63E-05	7.13E-04
Floyd	5.13E-02	6.05E-04	1.07E-03	8.19E-04	1.22E-04	1.33E-03
Foard	3.62E-03	4.53E-05	7.58E-05	5.87E-05	9.22E-06	9.92E-05
Fort Bend	1.21E+00	4.06E-02	2.71E-02	2.12E-02	5.38E-03	4.35E-02
Franklin	3.74E-02	4.93E-04	7.89E-04	6.17E-04	1.01E-04	1.08E-03

Appendix C. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC
Freestone	1.27E-02	1.64E-04	2.67E-04	2.08E-04	3.36E-05	3.59E-04
Frio	3.95E-02	4.79E-04	8.25E-04	6.35E-04	9.68E-05	1.05E-03
Gaines	1.28E-01	1.60E-03	2.71E-03	2.10E-03	3.24E-04	3.45E-03
Galveston	2.77E-01	1.20E-02	9.68E-03	8.37E-03	2.07E-03	1.51E-02
Garza	5.81E-03	6.52E-05	1.20E-04	9.15E-05	1.30E-05	1.43E-04
Gillespie	8.13E-02	1.52E-03	3.04E-04	2.49E-04	4.04E-04	1.08E-02
Glasscock	1.72E-03	9.29E-06	3.38E-05	2.33E-05	1.43E-06	2.15E-05
Goliad	1.00E-03	5.42E-06	1.98E-05	1.36E-05	8.35E-07	1.26E-05
Gonzales	1.58E-02	1.94E-04	3.31E-04	2.55E-04	3.92E-05	4.25E-04
Gray	5.17E-02	6.28E-04	1.08E-03	8.32E-04	1.27E-04	1.38E-03
Grayson	3.82E-01	6.90E-03	8.09E-03	6.26E-03	1.15E-03	1.11E-02
Gregg	7.97E-01	1.09E-01	2.02E-02	1.68E-02	1.11E-02	6.43E-02
Grimes	3.82E-02	4.72E-04	7.99E-04	6.18E-04	9.58E-05	1.03E-03
Guadalupe	1.00E+00	2.68E-02	3.01E-03	2.68E-03	6.28E-03	1.68E-01
Hale	2.40E-01	3.62E-03	5.04E-03	3.88E-03	6.49E-04	6.64E-03
Hall	1.79E-02	2.16E-04	3.73E-04	2.87E-04	4.37E-05	4.74E-04
Hamilton	4.13E-02	8.73E-04	8.82E-04	6.82E-04	1.35E-04	1.25E-03
Hansford	2.58E-02	3.12E-04	5.38E-04	4.14E-04	6.31E-05	6.84E-04
Hardeman	4.44E-02	5.36E-04	9.27E-04	7.13E-04	1.08E-04	1.18E-03
Hardin	2.77E-02	3.57E-04	5.83E-04	4.54E-04	7.31E-05	7.79E-04
Harris	2.53E+01	8.88E+00	2.16E-01	1.98E-01	8.76E-01	2.31E+00
Harrison	1.39E-01	1.74E-03	2.91E-03	2.25E-03	3.55E-04	3.81E-03
Hartley	1.78E-01	4.42E-03	3.81E-03	2.96E-03	6.46E-04	5.77E-03
Haskell	1.86E-02	2.26E-04	3.89E-04	3.00E-04	4.56E-05	4.95E-04
Hays	8.96E-03	4.85E-05	1.77E-04	1.22E-04	7.46E-06	1.12E-04
Hemphill	2.05E-02	2.36E-04	4.26E-04	3.25E-04	4.72E-05	5.18E-04
Henderson	1.03E-01	3.42E-04	6.97E-05	6.96E-05	1.18E-04	1.86E-03
Hidalgo	1.16E+00	2.30E-01	2.49E-02	2.11E-02	2.84E-02	9.10E-02
Hill	6.30E-02	7.15E-04	1.31E-03	9.95E-04	1.43E-04	1.57E-03
Hockley	1.38E-01	1.68E-03	2.89E-03	2.23E-03	3.41E-04	3.68E-03
Hood	5.38E-01	6.26E-03	6.33E-04	6.30E-04	1.51E-03	2.26E-02
Hopkins	1.47E-01	8.60E-03	3.35E-03	2.67E-03	9.97E-04	7.08E-03
Houston	5.94E-02	7.32E-04	1.24E-03	9.60E-04	1.48E-04	1.60E-03
Howard	1.06E-01	1.82E-02	2.86E-03	2.42E-03	1.83E-03	1.06E-02
Hudspeth	2.31E-02	3.21E-04	4.91E-04	3.87E-04	6.66E-05	7.00E-04
Hunt	7.59E-01	1.38E-02	1.38E-03	1.37E-03	3.51E-03	6.97E-02
Hutchinson	4.37E-02	6.79E-04	9.17E-04	7.08E-04	1.21E-04	1.23E-03
Irion	1.03E-03	5.57E-06	2.03E-05	1.40E-05	8.58E-07	1.29E-05
Jack	5.48E-03	4.52E-05	1.11E-04	8.02E-05	8.32E-06	1.01E-04

Appendix C. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_x	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
Jackson	1.52E-01	3.89E-03	3.28E-03	2.60E-03	5.98E-04	5.37E-03
Jasper	8.93E-02	1.09E-03	1.87E-03	1.44E-03	2.21E-04	2.39E-03
Jeff Davis	1.49E-04	8.05E-07	2.93E-06	2.02E-06	1.24E-07	1.86E-06
Jefferson	3.39E-01	2.75E-02	8.12E-03	6.71E-03	3.41E-03	2.38E-02
Jim Hogg	2.76E-02	3.26E-04	5.75E-04	4.40E-04	6.56E-05	7.15E-04
Jim Wells	8.93E-02	3.13E-02	3.04E-03	2.74E-03	3.03E-03	1.64E-02
Johnson	6.01E-01	1.67E-02	9.12E-04	9.08E-04	3.47E-03	3.83E-02
Jones	5.49E-02	6.97E-04	1.15E-03	8.95E-04	1.42E-04	1.53E-03
Karnes	6.68E-02	5.76E-04	1.54E-04	1.34E-04	1.56E-04	3.43E-03
Kaufman	5.49E-01	7.54E-03	8.69E-04	8.66E-04	2.04E-03	3.36E-02
Kendall	4.63E-03	2.50E-05	9.12E-05	6.29E-05	3.85E-06	5.80E-05
Kenedy	8.80E-04	4.76E-06	1.73E-05	1.20E-05	7.33E-07	1.10E-05
Kent	4.34E-02	5.43E-04	9.09E-04	7.04E-04	1.11E-04	1.19E-03
Kerr	1.75E-01	4.64E-03	5.68E-04	5.00E-04	9.86E-04	2.43E-02
Kimble	4.07E-02	2.00E-03	9.09E-04	7.19E-04	2.40E-04	1.78E-03
King	1.91E-03	1.03E-05	3.76E-05	2.59E-05	1.59E-06	2.39E-05
Kinney	6.79E-03	3.67E-05	1.34E-04	9.23E-05	5.65E-06	8.50E-05
Kleberg	7.25E-02	2.05E-02	2.30E-03	2.04E-03	2.01E-03	1.11E-02
Knox	3.68E-02	4.54E-04	7.71E-04	5.95E-04	9.22E-05	9.96E-04
La Salle	8.41E-02	3.13E-02	3.03E-03	2.75E-03	3.03E-03	1.63E-02
Lamar	1.26E-01	5.59E-03	2.91E-03	2.35E-03	7.26E-04	5.57E-03
Lamb	7.12E-02	1.26E-03	1.50E-03	1.17E-03	2.15E-04	2.11E-03
Lampasas	4.51E-02	5.28E-04	9.39E-04	7.18E-04	1.06E-04	1.16E-03
Lavaca	2.40E-02	2.87E-04	5.01E-04	3.85E-04	5.79E-05	6.30E-04
Lee	3.91E-02	4.45E-04	8.12E-04	6.19E-04	8.90E-05	9.80E-04
Leon	9.50E-03	8.51E-05	1.93E-04	1.42E-04	1.60E-05	1.90E-04
Liberty	1.72E-01	8.47E-03	3.84E-03	3.03E-03	1.01E-03	7.49E-03
Limestone	5.46E-02	6.54E-04	1.14E-03	8.75E-04	1.32E-04	1.43E-03
Lipscomb	4.85E-03	3.86E-05	9.77E-05	7.05E-05	7.01E-06	8.66E-05
Live Oak	1.62E-02	1.85E-04	3.36E-04	2.56E-04	3.70E-05	4.07E-04
Llano	2.24E-01	3.05E-03	4.75E-03	3.73E-03	6.29E-04	6.65E-03
Lubbock	1.30E+00	3.55E-01	2.71E-02	2.41E-02	3.77E-02	1.42E-01
Lynn	1.98E-02	2.42E-04	4.14E-04	3.19E-04	4.91E-05	5.31E-04
Madison	5.70E-03	6.17E-05	1.18E-04	8.89E-05	1.22E-05	1.36E-04
Marion	1.38E-02	1.73E-04	2.88E-04	2.24E-04	3.53E-05	3.79E-04
Martin	1.31E-02	1.48E-04	2.71E-04	2.06E-04	2.95E-05	3.25E-04
Mason	1.53E-02	1.76E-04	3.19E-04	2.43E-04	3.51E-05	3.86E-04
Matagorda	1.52E-01	2.47E-02	4.06E-03	3.45E-03	2.51E-03	1.48E-02
Maverick	7.43E-03	1.05E-04	1.58E-04	1.25E-04	2.18E-05	2.29E-04

Appendix C. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	$PM_{10\text{-}PRI}$	$PM_{25\text{-}PRI}$	SO_2	VOC
McCulloch	2.43E-01	9.34E-02	8.57E-03	7.78E-03	9.00E-03	4.83E-02
McLennan	9.61E-01	2.67E-01	2.91E-02	2.58E-02	2.69E-02	1.43E-01
McMullen	1.03E-03	5.57E-06	2.03E-05	1.40E-05	8.57E-07	1.29E-05
Medina	7.00E+00	2.10E-01	1.49E-01	1.45E-01	4.81E-02	4.78E-01
Menard	6.59E-03	6.65E-05	1.35E-04	1.01E-04	1.29E-05	1.47E-04
Midland	1.48E+00	5.70E-01	4.29E-02	3.94E-02	5.81E-02	2.59E-01
Milam	3.16E-02	3.73E-04	6.59E-04	5.05E-04	7.49E-05	8.18E-04
Mills	3.69E-03	2.00E-05	7.27E-05	5.02E-05	3.07E-06	4.62E-05
Mitchell	3.06E-02	4.02E-04	6.44E-04	5.03E-04	8.25E-05	8.79E-04
Montague	5.64E-02	1.45E-03	1.22E-03	9.49E-04	2.12E-04	1.87E-03
Montgomery	7.12E-01	5.07E-02	1.40E-02	1.14E-02	5.67E-03	4.24E-02
Moore	1.15E-01	1.87E-03	2.41E-03	1.87E-03	3.29E-04	3.31E-03
Morris	2.54E-03	5.00E-05	5.64E-05	4.79E-05	1.09E-05	1.08E-04
Motley	1.56E-03	1.87E-05	3.26E-05	2.50E-05	3.78E-06	4.11E-05
Nacogdoches	1.82E-01	6.72E-03	3.97E-03	3.11E-03	8.63E-04	6.90E-03
Navarro	6.89E-02	7.78E-04	1.43E-03	1.09E-03	1.55E-04	1.71E-03
Newton	4.83E-03	5.70E-05	1.01E-04	7.71E-05	1.15E-05	1.25E-04
Nolan	3.83E-02	4.75E-04	8.01E-04	6.20E-04	9.64E-05	1.04E-03
Nueces	1.78E+00	1.02E+00	6.78E-02	6.45E-02	1.01E-01	4.90E-01
Ochiltree	7.76E-02	9.40E-04	1.62E-03	1.25E-03	1.90E-04	2.06E-03
Oldham	3.12E-02	3.77E-04	6.51E-04	5.01E-04	7.61E-05	8.26E-04
Orange	8.88E-02	1.36E-03	2.09E-03	1.65E-03	2.76E-04	2.66E-03
Palo Pinto	4.29E-02	5.68E-04	9.04E-04	7.08E-04	1.17E-04	1.24E-03
Panola	1.62E-01	9.53E-03	3.68E-03	2.94E-03	1.10E-03	7.84E-03
Parker	1.43E+00	7.49E-03	1.18E-03	1.18E-03	2.49E-03	6.67E-02
Parmer	5.24E-02	6.51E-04	1.10E-03	8.49E-04	1.32E-04	1.43E-03
Pecos	8.02E-02	3.27E-03	1.79E-03	1.41E-03	4.14E-04	3.21E-03
Polk	6.16E-02	7.39E-04	1.29E-03	9.88E-04	1.49E-04	1.62E-03
Potter	9.92E-01	5.93E-01	3.61E-02	3.43E-02	5.65E-02	2.53E-01
Presidio	1.21E-01	1.46E-03	2.53E-03	1.95E-03	2.95E-04	3.20E-03
Rains	3.28E-03	5.14E-05	7.05E-05	5.70E-05	1.09E-05	1.12E-04
Randall	2.95E-01	3.68E-03	6.17E-03	4.78E-03	7.49E-04	8.07E-03
Reagan	1.59E-02	1.99E-04	3.34E-04	2.59E-04	4.06E-05	4.37E-04
Real	9.62E-03	1.15E-04	2.01E-04	1.54E-04	2.32E-05	2.52E-04
Red River	2.87E-02	3.60E-04	6.01E-04	4.66E-04	7.34E-05	7.89E-04
Reeves	2.16E-01	9.08E-02	7.91E-03	7.24E-03	8.72E-03	4.65E-02
Refugio	3.84E-02	4.76E-04	8.05E-04	6.22E-04	9.65E-05	1.04E-03
Roberts	4.62E-03	5.07E-05	9.55E-05	7.23E-05	1.00E-05	1.12E-04
Robertson	4.83E-02	5.57E-04	1.00E-03	7.66E-04	1.12E-04	1.22E-03

Appendix C. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
Rockwall	1.01E+00	4.15E-03	1.06E-03	1.06E-03	1.68E-03	2.27E-02
Runnels	2.30E-02	2.99E-04	4.94E-04	3.84E-04	6.05E-05	6.35E-04
Rusk	8.16E-02	7.02E-03	1.94E-03	1.57E-03	7.60E-04	4.96E-03
Sabine	9.36E-03	1.12E-04	1.95E-04	1.50E-04	2.27E-05	2.47E-04
San Augustine	5.89E-03	7.30E-05	1.23E-04	9.53E-05	1.48E-05	1.60E-04
San Jacinto	1.29E-03	6.99E-06	2.55E-05	1.76E-05	1.08E-06	1.62E-05
San Patricio	1.15E-01	1.47E-03	2.41E-03	1.88E-03	3.01E-04	3.22E-03
San Saba	1.51E-02	1.74E-04	3.13E-04	2.39E-04	3.49E-05	3.83E-04
Schleicher	7.34E-03	8.60E-05	1.53E-04	1.17E-04	1.73E-05	1.89E-04
Scurry	7.45E-02	9.02E-04	1.56E-03	1.20E-03	1.82E-04	1.98E-03
Shackelford	2.75E-02	3.55E-04	5.78E-04	4.50E-04	7.25E-05	7.75E-04
Shelby	5.95E-02	1.17E-03	1.26E-03	9.76E-04	1.88E-04	1.79E-03
Sherman	2.16E-03	2.51E-05	4.50E-05	3.44E-05	5.03E-06	5.51E-05
Smith	3.99E-01	2.92E-02	7.92E-03	6.31E-03	4.14E-03	2.20E-02
Somervell	5.97E-03	6.60E-05	1.24E-04	9.37E-05	1.31E-05	1.45E-04
Starr	5.31E-03	5.96E-05	1.10E-04	8.36E-05	1.19E-05	1.31E-04
Stephens	1.25E-01	1.50E-03	2.61E-03	2.01E-03	3.04E-04	3.30E-03
Sterling	1.31E-03	7.61E-06	2.59E-05	1.80E-05	1.22E-06	1.75E-05
Stonewall	8.47E-03	1.18E-04	1.80E-04	1.42E-04	2.45E-05	2.57E-04
Sutton	1.07E-02	1.30E-04	2.23E-04	1.72E-04	2.62E-05	2.84E-04
Swisher	1.51E-01	1.81E-03	3.14E-03	2.42E-03	3.66E-04	3.98E-03
Tarrant	2.99E+01	1.27E+01	2.06E-01	2.05E-01	1.45E+00	3.36E+00
Taylor	8.56E-01	3.63E-01	2.90E-02	2.66E-02	3.59E-02	1.76E-01
Terrell	5.33E-03	5.97E-05	1.11E-04	8.40E-05	1.19E-05	1.31E-04
Terry	6.96E-02	8.62E-04	1.46E-03	1.13E-03	1.75E-04	1.89E-03
Throckmorton	4.66E-04	5.87E-06	9.78E-06	7.58E-06	1.19E-06	1.28E-05
Titus	1.06E-01	1.29E-03	2.21E-03	1.70E-03	2.62E-04	2.83E-03
Tom Green	1.38E+00	8.28E-01	6.03E-02	5.72E-02	7.93E-02	4.03E-01
Travis	5.03E+00	1.39E+00	3.18E-02	3.02E-02	1.41E-01	4.78E-01
Trinity	1.33E-02	1.67E-04	2.79E-04	2.16E-04	3.41E-05	3.66E-04
Tyler	1.37E-02	1.85E-04	2.90E-04	2.28E-04	3.82E-05	4.04E-04
Upshur	8.42E-02	1.06E-03	1.77E-03	1.37E-03	2.17E-04	2.33E-03
Upton	5.74E-03	7.22E-05	1.20E-04	9.33E-05	1.47E-05	1.58E-04
Uvalde	1.05E-01	5.89E-03	2.44E-03	1.95E-03	6.97E-04	4.98E-03
Val Verde	1.46E-01	2.26E-02	3.41E-03	2.87E-03	2.67E-03	1.48E-02
Van Zandt	3.10E-02	3.59E-04	6.45E-04	4.93E-04	7.19E-05	7.89E-04
Victoria	8.23E-01	5.82E-01	3.92E-02	3.76E-02	5.54E-02	2.89E-01
Walker	1.28E-01	3.93E-02	4.17E-03	3.71E-03	3.83E-03	2.09E-02
Waller	1.93E-01	2.44E-03	4.05E-03	3.14E-03	4.96E-04	5.33E-03

Appendix C. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NOx	PM10-PRI	PM25-PRI	SO2	VOC
Ward	6.75E-02	8.18E-04	1.41E-03	1.09E-03	1.65E-04	1.79E-03
Washington	1.22E-01	2.20E-03	2.57E-03	1.98E-03	3.61E-04	3.52E-03
Webb	1.05E+00	5.01E-01	3.22E-02	3.03E-02	5.30E-02	2.47E-01
Wharton	1.69E-01	3.57E-03	3.60E-03	2.79E-03	5.57E-04	5.22E-03
Wheeler	8.68E-03	1.09E-04	1.82E-04	1.41E-04	2.22E-05	2.39E-04
Wichita	6.02E+00	4.82E+00	3.08E-01	2.99E-01	4.57E-01	2.35E+00
Wilbarger	7.59E-02	2.43E-03	1.64E-03	1.29E-03	3.27E-04	2.72E-03
Willacy	1.05E-02	1.13E-04	2.17E-04	1.64E-04	2.24E-05	2.50E-04
Williamson	9.44E-01	2.20E-02	2.01E-02	1.56E-02	3.28E-03	2.97E-02
Wilson	5.92E-03	3.20E-05	1.17E-04	8.05E-05	4.93E-06	7.42E-05
Winkler	2.94E-02	1.88E-03	6.76E-04	5.45E-04	2.17E-04	1.52E-03
Wise	8.38E-01	1.03E-02	5.88E-03	4.66E-03	2.37E-03	3.25E-02
Wood	1.77E-01	2.18E-03	3.70E-03	2.86E-03	4.43E-04	4.79E-03
Yoakum	7.02E-02	8.69E-04	1.47E-03	1.14E-03	1.76E-04	1.90E-03
Young	1.44E-01	1.74E-03	3.01E-03	2.32E-03	3.52E-04	3.82E-03
Zapata	2.47E-02	2.88E-04	5.13E-04	3.92E-04	5.78E-05	6.32E-04
Zavala	7.34E-03	5.52E-05	1.47E-04	1.06E-04	9.83E-06	1.24E-04

Appendix D
Full County Uncontrolled Emissions

Appendix D. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	$PM_{10\text{-PRI}}$	$PM_{25\text{-PRI}}$	SO_2	VOC
Anderson	9.03E-02	1.88E-03	1.92E-03	1.50E-03	2.98E-04	2.81E-03
Andrews	2.79E-02	3.38E-04	5.84E-04	4.49E-04	6.84E-05	7.42E-04
Angelina	1.55E-01	9.44E-03	3.53E-03	2.82E-03	1.09E-03	7.65E-03
Aransas	9.65E-01	5.02E-01	3.91E-02	3.65E-02	4.79E-02	2.52E-01
Archer	3.07E-02	3.98E-04	6.46E-04	5.03E-04	8.14E-05	8.69E-04
Armstrong	2.77E-03	1.50E-05	5.45E-05	3.76E-05	2.30E-06	3.46E-05
Atascosa	2.63E-01	4.52E-03	4.89E-04	4.64E-04	9.81E-04	2.28E-02
Austin	3.16E-02	3.44E-04	6.54E-04	4.94E-04	6.80E-05	7.58E-04
Bailey	5.16E-02	6.87E-04	1.09E-03	8.53E-04	1.41E-04	1.50E-03
Bandera	1.10E-02	9.30E-05	2.22E-04	1.61E-04	1.72E-05	2.08E-04
Bastrop	7.73E-02	9.02E-04	1.61E-03	1.23E-03	1.81E-04	1.98E-03
Baylor	2.48E-03	2.90E-05	5.16E-05	3.95E-05	5.82E-06	6.37E-05
Bee	3.80E-02	4.73E-04	7.96E-04	6.16E-04	9.62E-05	1.04E-03
Bell	1.02E+00	3.24E-01	2.89E-02	2.59E-02	3.30E-02	1.47E-01
Bexar	8.77E+00	1.15E+00	2.54E-02	2.39E-02	1.44E-01	8.92E-01
Blanco	9.02E-03	4.88E-05	1.78E-04	1.23E-04	7.51E-06	1.13E-04
Bosque	5.40E-02	6.56E-04	1.13E-03	8.68E-04	1.33E-04	1.44E-03
Bowie	3.16E-03	1.71E-05	6.22E-05	4.29E-05	2.63E-06	3.96E-05
Brazoria	2.01E+00	1.05E-01	4.78E-02	4.02E-02	1.43E-02	1.06E-01
Brazos	6.90E-01	1.86E-01	1.95E-02	1.72E-02	1.93E-02	9.97E-02
Brewster	8.06E-02	1.72E-03	1.71E-03	1.32E-03	2.65E-04	2.47E-03
Briscoe	1.49E-04	8.05E-07	2.93E-06	2.02E-06	1.24E-07	1.86E-06
Brooks	4.36E-02	5.35E-04	9.12E-04	7.04E-04	1.08E-04	1.17E-03
Brown	4.91E-02	5.43E-03	1.23E-03	1.02E-03	5.99E-04	3.62E-03
Burleson	2.40E-02	3.02E-04	5.03E-04	3.90E-04	6.16E-05	6.62E-04
Burnet	3.57E-01	1.34E-02	7.81E-03	6.13E-03	1.71E-03	1.37E-02
Caldwell	3.85E-01	9.70E-03	8.28E-03	6.44E-03	1.41E-03	1.25E-02
Calhoun	9.85E-02	2.40E-02	2.95E-03	2.60E-03	2.38E-03	1.34E-02
Callahan	3.19E-03	1.98E-05	6.33E-05	4.43E-05	3.28E-06	4.53E-05
Cameron	1.26E+00	5.64E-01	3.54E-02	3.29E-02	5.72E-02	2.49E-01
Camp	3.16E-03	5.08E-05	6.82E-05	5.55E-05	1.08E-05	1.10E-04
Carson	3.68E-02	4.72E-04	7.73E-04	6.01E-04	9.64E-05	1.03E-03
Cass	1.23E-01	1.48E-03	2.57E-03	1.97E-03	2.98E-04	3.24E-03
Castro	2.23E-02	2.56E-04	4.64E-04	3.54E-04	5.12E-05	5.63E-04
Chambers	1.25E-01	1.54E-03	2.62E-03	2.02E-03	3.11E-04	3.37E-03
Cherokee	1.13E-01	2.14E-03	2.39E-03	1.86E-03	3.51E-04	3.38E-03
Childress	2.36E-02	3.15E-04	4.97E-04	3.90E-04	6.50E-05	6.89E-04
Clay	3.17E-02	4.59E-04	6.75E-04	5.37E-04	9.58E-05	1.00E-03
Cochran	2.56E-02	3.10E-04	5.35E-04	4.12E-04	6.27E-05	6.80E-04

Appendix D. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC
Coke	2.15E-03	2.71E-05	4.51E-05	3.50E-05	5.51E-06	5.93E-05
Coleman	5.84E-02	7.06E-04	1.22E-03	9.38E-04	1.43E-04	1.55E-03
Collin	2.89E+00	7.49E-02	5.31E-03	5.27E-03	1.73E-02	3.10E-01
Collingsworth	1.89E-02	1.13E-03	4.30E-04	3.43E-04	1.30E-04	9.20E-04
Colorado	1.30E-01	1.60E-03	2.73E-03	2.11E-03	3.25E-04	3.51E-03
Comal	8.59E-01	1.59E-03	9.49E-04	8.49E-04	8.39E-04	2.09E-02
Comanche	5.41E-02	6.54E-04	1.13E-03	8.69E-04	1.32E-04	1.43E-03
Cooke	1.79E-01	3.62E-03	3.79E-03	2.92E-03	5.64E-04	5.32E-03
Coryell	3.71E-02	4.53E-04	7.75E-04	5.98E-04	9.17E-05	9.92E-04
Cottle	7.89E-03	9.93E-05	1.65E-04	1.28E-04	2.02E-05	2.17E-04
Crane	9.00E-03	1.13E-04	1.89E-04	1.46E-04	2.30E-05	2.47E-04
Crockett	4.89E-02	1.72E-03	1.06E-03	8.32E-04	2.23E-04	1.81E-03
Crosby	4.24E-02	6.10E-04	9.03E-04	7.18E-04	1.27E-04	1.33E-03
Culberson	7.28E-03	3.10E-03	2.67E-04	2.43E-04	2.96E-04	1.57E-03
Dallam	2.11E-02	2.58E-04	4.42E-04	3.41E-04	5.23E-05	5.66E-04
Dallas	1.20E+01	1.70E+00	4.13E-02	4.10E-02	2.28E-01	1.32E+00
Dawson	7.18E-02	8.77E-04	1.50E-03	1.16E-03	1.78E-04	1.92E-03
Deaf Smith	1.06E-01	1.88E-03	2.23E-03	1.73E-03	3.14E-04	3.08E-03
Delta	1.49E-04	8.05E-07	2.93E-06	2.02E-06	1.24E-07	1.86E-06
Denton	6.57E+00	1.07E-01	9.46E-03	9.41E-03	2.59E-02	3.51E-01
DeWitt	1.70E-02	2.19E-04	3.58E-04	2.79E-04	4.49E-05	4.80E-04
Dickens	1.03E-03	5.58E-06	2.03E-05	1.40E-05	8.59E-07	1.29E-05
Dimmit	1.64E-02	1.82E-04	3.39E-04	2.57E-04	3.62E-05	4.01E-04
Donley	2.68E-04	4.02E-06	5.74E-06	4.60E-06	8.44E-07	8.75E-06
Duval	1.65E-02	1.61E-04	3.38E-04	2.51E-04	3.11E-05	3.58E-04
Eastland	6.87E-02	8.22E-04	1.43E-03	1.10E-03	1.66E-04	1.80E-03
Ector	4.00E-01	4.86E-03	8.35E-03	6.43E-03	9.83E-04	1.07E-02
Edwards	7.46E-03	7.12E-05	1.53E-04	1.13E-04	1.37E-05	1.58E-04
El Paso	2.25E+00	7.77E-01	2.92E-02	2.54E-02	8.50E-02	1.93E-01
Ellis	9.44E-01	1.48E-02	1.48E-03	1.48E-03	3.70E-03	5.76E-02
Erath	9.30E-02	1.09E-03	1.94E-03	1.48E-03	2.20E-04	2.40E-03
Falls	3.24E-03	3.30E-05	6.66E-05	4.98E-05	6.42E-06	7.29E-05
Fannin	5.37E-02	5.87E-04	1.11E-03	8.40E-04	1.16E-04	1.29E-03
Fayette	9.02E-02	1.04E-03	1.87E-03	1.43E-03	2.09E-04	2.29E-03
Fisher	2.60E-02	3.26E-04	5.45E-04	4.22E-04	6.63E-05	7.13E-04
Floyd	5.13E-02	6.05E-04	1.07E-03	8.19E-04	1.22E-04	1.33E-03
Foard	3.62E-03	4.53E-05	7.58E-05	5.87E-05	9.22E-06	9.92E-05
Fort Bend	1.21E+00	4.06E-02	2.71E-02	2.12E-02	5.38E-03	4.35E-02
Franklin	3.74E-02	4.93E-04	7.89E-04	6.17E-04	1.01E-04	1.08E-03

Appendix D. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC
Freestone	1.27E-02	1.64E-04	2.67E-04	2.08E-04	3.36E-05	3.59E-04
Frio	3.95E-02	4.79E-04	8.25E-04	6.35E-04	9.68E-05	1.05E-03
Gaines	1.28E-01	1.60E-03	2.71E-03	2.10E-03	3.24E-04	3.45E-03
Galveston	2.77E-01	1.20E-02	9.68E-03	8.37E-03	2.07E-03	1.51E-02
Garza	5.81E-03	6.52E-05	1.20E-04	9.15E-05	1.30E-05	1.43E-04
Gillespie	8.13E-02	1.52E-03	3.04E-04	2.49E-04	4.04E-04	1.08E-02
Glasscock	1.72E-03	9.29E-06	3.38E-05	2.33E-05	1.43E-06	2.15E-05
Goliad	1.00E-03	5.42E-06	1.98E-05	1.36E-05	8.35E-07	1.26E-05
Gonzales	1.58E-02	1.94E-04	3.31E-04	2.55E-04	3.92E-05	4.25E-04
Gray	5.17E-02	6.28E-04	1.08E-03	8.32E-04	1.27E-04	1.38E-03
Grayson	3.82E-01	6.90E-03	8.09E-03	6.26E-03	1.15E-03	1.11E-02
Gregg	7.97E-01	1.09E-01	2.02E-02	1.68E-02	1.11E-02	6.43E-02
Grimes	3.82E-02	4.72E-04	7.99E-04	6.18E-04	9.58E-05	1.03E-03
Guadalupe	1.00E+00	2.68E-02	3.01E-03	2.68E-03	6.28E-03	1.68E-01
Hale	2.40E-01	3.62E-03	5.04E-03	3.88E-03	6.49E-04	6.64E-03
Hall	1.79E-02	2.16E-04	3.73E-04	2.87E-04	4.37E-05	4.74E-04
Hamilton	4.13E-02	8.73E-04	8.82E-04	6.82E-04	1.35E-04	1.25E-03
Hansford	2.58E-02	3.12E-04	5.38E-04	4.14E-04	6.31E-05	6.84E-04
Hardeman	4.44E-02	5.36E-04	9.27E-04	7.13E-04	1.08E-04	1.18E-03
Hardin	2.77E-02	3.57E-04	5.83E-04	4.54E-04	7.31E-05	7.79E-04
Harris	2.49E+01	8.66E+00	1.75E-01	1.57E-01	8.38E-01	2.28E+00
Harrison	1.39E-01	1.74E-03	2.91E-03	2.25E-03	3.55E-04	3.81E-03
Hartley	1.78E-01	4.42E-03	3.81E-03	2.96E-03	6.46E-04	5.77E-03
Haskell	1.86E-02	2.26E-04	3.89E-04	3.00E-04	4.56E-05	4.95E-04
Hays	8.96E-03	4.85E-05	1.77E-04	1.22E-04	7.46E-06	1.12E-04
Hemphill	2.05E-02	2.36E-04	4.26E-04	3.25E-04	4.72E-05	5.18E-04
Henderson	1.03E-01	3.42E-04	6.97E-05	6.96E-05	1.18E-04	1.86E-03
Hidalgo	1.16E+00	2.30E-01	2.49E-02	2.11E-02	2.84E-02	9.10E-02
Hill	6.30E-02	7.15E-04	1.31E-03	9.95E-04	1.43E-04	1.57E-03
Hockley	1.38E-01	1.68E-03	2.89E-03	2.23E-03	3.41E-04	3.68E-03
Hood	5.38E-01	6.26E-03	6.33E-04	6.30E-04	1.51E-03	2.26E-02
Hopkins	1.47E-01	8.60E-03	3.35E-03	2.67E-03	9.97E-04	7.08E-03
Houston	5.94E-02	7.32E-04	1.24E-03	9.60E-04	1.48E-04	1.60E-03
Howard	1.06E-01	1.82E-02	2.86E-03	2.42E-03	1.83E-03	1.06E-02
Hudspeth	2.31E-02	3.21E-04	4.91E-04	3.87E-04	6.66E-05	7.00E-04
Hunt	7.59E-01	1.38E-02	1.38E-03	1.37E-03	3.51E-03	6.97E-02
Hutchinson	4.37E-02	6.79E-04	9.17E-04	7.08E-04	1.21E-04	1.23E-03
Irion	1.03E-03	5.57E-06	2.03E-05	1.40E-05	8.58E-07	1.29E-05
Jack	5.48E-03	4.52E-05	1.11E-04	8.02E-05	8.32E-06	1.01E-04

Appendix D. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC
Jackson	1.52E-01	3.89E-03	3.28E-03	2.60E-03	5.98E-04	5.37E-03
Jasper	8.93E-02	1.09E-03	1.87E-03	1.44E-03	2.21E-04	2.39E-03
Jeff Davis	1.49E-04	8.05E-07	2.93E-06	2.02E-06	1.24E-07	1.86E-06
Jefferson	3.39E-01	2.75E-02	8.12E-03	6.71E-03	3.41E-03	2.38E-02
Jim Hogg	2.76E-02	3.26E-04	5.75E-04	4.40E-04	6.56E-05	7.15E-04
Jim Wells	8.93E-02	3.13E-02	3.04E-03	2.74E-03	3.03E-03	1.64E-02
Johnson	6.01E-01	1.67E-02	9.12E-04	9.08E-04	3.47E-03	3.83E-02
Jones	5.49E-02	6.97E-04	1.15E-03	8.95E-04	1.42E-04	1.53E-03
Karnes	6.68E-02	5.76E-04	1.54E-04	1.34E-04	1.56E-04	3.43E-03
Kaufman	5.49E-01	7.54E-03	8.69E-04	8.66E-04	2.04E-03	3.36E-02
Kendall	4.63E-03	2.50E-05	9.12E-05	6.29E-05	3.85E-06	5.80E-05
Kenedy	8.80E-04	4.76E-06	1.73E-05	1.20E-05	7.33E-07	1.10E-05
Kent	4.34E-02	5.43E-04	9.09E-04	7.04E-04	1.11E-04	1.19E-03
Kerr	1.75E-01	4.64E-03	5.68E-04	5.00E-04	9.86E-04	2.43E-02
Kimble	4.07E-02	2.00E-03	9.09E-04	7.19E-04	2.40E-04	1.78E-03
King	1.91E-03	1.03E-05	3.76E-05	2.59E-05	1.59E-06	2.39E-05
Kinney	6.79E-03	3.67E-05	1.34E-04	9.23E-05	5.65E-06	8.50E-05
Kleberg	7.25E-02	2.05E-02	2.30E-03	2.04E-03	2.01E-03	1.11E-02
Knox	3.68E-02	4.54E-04	7.71E-04	5.95E-04	9.22E-05	9.96E-04
La Salle	8.41E-02	3.13E-02	3.03E-03	2.75E-03	3.03E-03	1.63E-02
Lamar	1.26E-01	5.59E-03	2.91E-03	2.35E-03	7.26E-04	5.57E-03
Lamb	7.12E-02	1.26E-03	1.50E-03	1.17E-03	2.15E-04	2.11E-03
Lampasas	4.51E-02	5.28E-04	9.39E-04	7.18E-04	1.06E-04	1.16E-03
Lavaca	2.40E-02	2.87E-04	5.01E-04	3.85E-04	5.79E-05	6.30E-04
Lee	3.91E-02	4.45E-04	8.12E-04	6.19E-04	8.90E-05	9.80E-04
Leon	9.50E-03	8.51E-05	1.93E-04	1.42E-04	1.60E-05	1.90E-04
Liberty	1.72E-01	8.47E-03	3.84E-03	3.03E-03	1.01E-03	7.49E-03
Limestone	5.46E-02	6.54E-04	1.14E-03	8.75E-04	1.32E-04	1.43E-03
Lipscomb	4.85E-03	3.86E-05	9.77E-05	7.05E-05	7.01E-06	8.66E-05
Live Oak	1.62E-02	1.85E-04	3.36E-04	2.56E-04	3.70E-05	4.07E-04
Llano	2.24E-01	3.05E-03	4.75E-03	3.73E-03	6.29E-04	6.65E-03
Lubbock	1.29E+00	3.49E-01	2.62E-02	2.31E-02	3.68E-02	1.42E-01
Lynn	1.98E-02	2.42E-04	4.14E-04	3.19E-04	4.91E-05	5.31E-04
Madison	5.70E-03	6.17E-05	1.18E-04	8.89E-05	1.22E-05	1.36E-04
Marion	1.38E-02	1.73E-04	2.88E-04	2.24E-04	3.53E-05	3.79E-04
Martin	1.31E-02	1.48E-04	2.71E-04	2.06E-04	2.95E-05	3.25E-04
Mason	1.53E-02	1.76E-04	3.19E-04	2.43E-04	3.51E-05	3.86E-04
Matagorda	1.52E-01	2.47E-02	4.06E-03	3.45E-03	2.51E-03	1.48E-02
Maverick	7.43E-03	1.05E-04	1.58E-04	1.25E-04	2.18E-05	2.29E-04

Appendix D. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	$PM_{10\text{-}PRI}$	$PM_{25\text{-}PRI}$	SO_2	VOC
McCulloch	2.43E-01	9.34E-02	8.57E-03	7.78E-03	9.00E-03	4.83E-02
McLennan	9.61E-01	2.67E-01	2.91E-02	2.58E-02	2.69E-02	1.43E-01
McMullen	1.03E-03	5.57E-06	2.03E-05	1.40E-05	8.57E-07	1.29E-05
Medina	7.00E+00	2.10E-01	1.49E-01	1.45E-01	4.81E-02	4.78E-01
Menard	6.59E-03	6.65E-05	1.35E-04	1.01E-04	1.29E-05	1.47E-04
Midland	1.48E+00	5.70E-01	4.29E-02	3.94E-02	5.81E-02	2.59E-01
Milam	3.16E-02	3.73E-04	6.59E-04	5.05E-04	7.49E-05	8.18E-04
Mills	3.69E-03	2.00E-05	7.27E-05	5.02E-05	3.07E-06	4.62E-05
Mitchell	3.06E-02	4.02E-04	6.44E-04	5.03E-04	8.25E-05	8.79E-04
Montague	5.64E-02	1.45E-03	1.22E-03	9.49E-04	2.12E-04	1.87E-03
Montgomery	7.12E-01	5.07E-02	1.40E-02	1.14E-02	5.67E-03	4.24E-02
Moore	1.15E-01	1.87E-03	2.41E-03	1.87E-03	3.29E-04	3.31E-03
Morris	2.54E-03	5.00E-05	5.64E-05	4.79E-05	1.09E-05	1.08E-04
Motley	1.56E-03	1.87E-05	3.26E-05	2.50E-05	3.78E-06	4.11E-05
Nacogdoches	1.82E-01	6.72E-03	3.97E-03	3.11E-03	8.63E-04	6.90E-03
Navarro	6.89E-02	7.78E-04	1.43E-03	1.09E-03	1.55E-04	1.71E-03
Newton	4.83E-03	5.70E-05	1.01E-04	7.71E-05	1.15E-05	1.25E-04
Nolan	3.83E-02	4.75E-04	8.01E-04	6.20E-04	9.64E-05	1.04E-03
Nueces	1.78E+00	1.02E+00	6.78E-02	6.45E-02	1.01E-01	4.90E-01
Ochiltree	7.76E-02	9.40E-04	1.62E-03	1.25E-03	1.90E-04	2.06E-03
Oldham	3.12E-02	3.77E-04	6.51E-04	5.01E-04	7.61E-05	8.26E-04
Orange	8.88E-02	1.36E-03	2.09E-03	1.65E-03	2.76E-04	2.66E-03
Palo Pinto	4.29E-02	5.68E-04	9.04E-04	7.08E-04	1.17E-04	1.24E-03
Panola	1.62E-01	9.53E-03	3.68E-03	2.94E-03	1.10E-03	7.84E-03
Parker	1.43E+00	7.49E-03	1.18E-03	1.18E-03	2.49E-03	6.67E-02
Parmer	5.24E-02	6.51E-04	1.10E-03	8.49E-04	1.32E-04	1.43E-03
Pecos	8.02E-02	3.27E-03	1.79E-03	1.41E-03	4.14E-04	3.21E-03
Polk	6.16E-02	7.39E-04	1.29E-03	9.88E-04	1.49E-04	1.62E-03
Potter	9.92E-01	5.93E-01	3.61E-02	3.43E-02	5.65E-02	2.53E-01
Presidio	1.21E-01	1.46E-03	2.53E-03	1.95E-03	2.95E-04	3.20E-03
Rains	3.28E-03	5.14E-05	7.05E-05	5.70E-05	1.09E-05	1.12E-04
Randall	2.95E-01	3.68E-03	6.17E-03	4.78E-03	7.49E-04	8.07E-03
Reagan	1.59E-02	1.99E-04	3.34E-04	2.59E-04	4.06E-05	4.37E-04
Real	9.62E-03	1.15E-04	2.01E-04	1.54E-04	2.32E-05	2.52E-04
Red River	2.87E-02	3.60E-04	6.01E-04	4.66E-04	7.34E-05	7.89E-04
Reeves	2.16E-01	9.08E-02	7.91E-03	7.24E-03	8.72E-03	4.65E-02
Refugio	3.84E-02	4.76E-04	8.05E-04	6.22E-04	9.65E-05	1.04E-03
Roberts	4.62E-03	5.07E-05	9.55E-05	7.23E-05	1.00E-05	1.12E-04
Robertson	4.83E-02	5.57E-04	1.00E-03	7.66E-04	1.12E-04	1.22E-03

Appendix D. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM$_{10\text{-PRI}}$	PM$_{25\text{-PRI}}$	SO$_2$	VOC
Rockwall	1.01E+00	4.15E-03	1.06E-03	1.06E-03	1.68E-03	2.27E-02
Runnels	2.30E-02	2.99E-04	4.94E-04	3.84E-04	6.05E-05	6.35E-04
Rusk	8.16E-02	7.02E-03	1.94E-03	1.57E-03	7.60E-04	4.96E-03
Sabine	9.36E-03	1.12E-04	1.95E-04	1.50E-04	2.27E-05	2.47E-04
San Augustine	5.89E-03	7.30E-05	1.23E-04	9.53E-05	1.48E-05	1.60E-04
San Jacinto	1.29E-03	6.99E-06	2.55E-05	1.76E-05	1.08E-06	1.62E-05
San Patricio	1.15E-01	1.47E-03	2.41E-03	1.88E-03	3.01E-04	3.22E-03
San Saba	1.51E-02	1.74E-04	3.13E-04	2.39E-04	3.49E-05	3.83E-04
Schleicher	7.34E-03	8.60E-05	1.53E-04	1.17E-04	1.73E-05	1.89E-04
Scurry	7.45E-02	9.02E-04	1.56E-03	1.20E-03	1.82E-04	1.98E-03
Shackelford	2.75E-02	3.55E-04	5.78E-04	4.50E-04	7.25E-05	7.75E-04
Shelby	5.95E-02	1.17E-03	1.26E-03	9.76E-04	1.88E-04	1.79E-03
Sherman	2.16E-03	2.51E-05	4.50E-05	3.44E-05	5.03E-06	5.51E-05
Smith	3.99E-01	2.92E-02	7.92E-03	6.31E-03	4.14E-03	2.20E-02
Somervell	5.97E-03	6.60E-05	1.24E-04	9.37E-05	1.31E-05	1.45E-04
Starr	5.31E-03	5.96E-05	1.10E-04	8.36E-05	1.19E-05	1.31E-04
Stephens	1.25E-01	1.50E-03	2.61E-03	2.01E-03	3.04E-04	3.30E-03
Sterling	1.31E-03	7.61E-06	2.59E-05	1.80E-05	1.22E-06	1.75E-05
Stonewall	8.47E-03	1.18E-04	1.80E-04	1.42E-04	2.45E-05	2.57E-04
Sutton	1.07E-02	1.30E-04	2.23E-04	1.72E-04	2.62E-05	2.84E-04
Swisher	1.51E-01	1.81E-03	3.14E-03	2.42E-03	3.66E-04	3.98E-03
Tarrant	2.99E+01	1.27E+01	2.06E-01	2.05E-01	1.45E+00	3.36E+00
Taylor	8.56E-01	3.63E-01	2.90E-02	2.66E-02	3.59E-02	1.76E-01
Terrell	5.33E-03	5.97E-05	1.11E-04	8.40E-05	1.19E-05	1.31E-04
Terry	6.96E-02	8.62E-04	1.46E-03	1.13E-03	1.75E-04	1.89E-03
Throckmorton	4.66E-04	5.87E-06	9.78E-06	7.58E-06	1.19E-06	1.28E-05
Titus	1.06E-01	1.29E-03	2.21E-03	1.70E-03	2.62E-04	2.83E-03
Tom Green	1.38E+00	8.28E-01	6.03E-02	5.72E-02	7.93E-02	4.03E-01
Travis	4.94E+00	1.36E+00	2.35E-02	2.19E-02	1.34E-01	4.72E-01
Trinity	1.33E-02	1.67E-04	2.79E-04	2.16E-04	3.41E-05	3.66E-04
Tyler	1.37E-02	1.85E-04	2.90E-04	2.28E-04	3.82E-05	4.04E-04
Upshur	8.42E-02	1.06E-03	1.77E-03	1.37E-03	2.17E-04	2.33E-03
Upton	5.74E-03	7.22E-05	1.20E-04	9.33E-05	1.47E-05	1.58E-04
Uvalde	1.05E-01	5.89E-03	2.44E-03	1.95E-03	6.97E-04	4.98E-03
Val Verde	1.46E-01	2.26E-02	3.41E-03	2.87E-03	2.67E-03	1.48E-02
Van Zandt	3.10E-02	3.59E-04	6.45E-04	4.93E-04	7.19E-05	7.89E-04
Victoria	8.23E-01	5.82E-01	3.92E-02	3.76E-02	5.54E-02	2.89E-01
Walker	1.28E-01	3.93E-02	4.17E-03	3.71E-03	3.83E-03	2.09E-02
Waller	1.93E-01	2.44E-03	4.05E-03	3.14E-03	4.96E-04	5.33E-03

Appendix D. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	$PM_{10\text{-}PRI}$	$PM_{25\text{-}PRI}$	SO_2	VOC
Ward	6.75E-02	8.18E-04	1.41E-03	1.09E-03	1.65E-04	1.79E-03
Washington	1.22E-01	2.20E-03	2.57E-03	1.98E-03	3.61E-04	3.52E-03
Webb	1.05E+00	5.01E-01	3.22E-02	3.03E-02	5.30E-02	2.47E-01
Wharton	1.69E-01	3.57E-03	3.60E-03	2.79E-03	5.57E-04	5.22E-03
Wheeler	8.68E-03	1.09E-04	1.82E-04	1.41E-04	2.22E-05	2.39E-04
Wichita	6.02E+00	4.82E+00	3.08E-01	2.99E-01	4.57E-01	2.35E+00
Wilbarger	7.59E-02	2.43E-03	1.64E-03	1.29E-03	3.27E-04	2.72E-03
Willacy	1.05E-02	1.13E-04	2.17E-04	1.64E-04	2.24E-05	2.50E-04
Williamson	9.44E-01	2.20E-02	2.01E-02	1.56E-02	3.28E-03	2.97E-02
Wilson	5.92E-03	3.20E-05	1.17E-04	8.05E-05	4.93E-06	7.42E-05
Winkler	2.94E-02	1.88E-03	6.76E-04	5.45E-04	2.17E-04	1.52E-03
Wise	8.38E-01	1.03E-02	5.88E-03	4.66E-03	2.37E-03	3.25E-02
Wood	1.77E-01	2.18E-03	3.70E-03	2.86E-03	4.43E-04	4.79E-03
Yoakum	7.02E-02	8.69E-04	1.47E-03	1.14E-03	1.76E-04	1.90E-03
Young	1.44E-01	1.74E-03	3.01E-03	2.32E-03	3.52E-04	3.82E-03
Zapata	2.47E-02	2.88E-04	5.13E-04	3.92E-04	5.78E-05	6.32E-04
Zavala	7.34E-03	5.52E-05	1.47E-04	1.06E-04	9.83E-06	1.24E-04

Appendix E
Quality Assurance

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Quality Assurance

QUALITY ASSURANCE

All resulting emission inventories were subjected to internal review and QA/QC procedures outlined in the Quality Assurance Project Plan (QAPP) for Development of 2017 Statewide Emissions Inventories for Air Emissions Reporting Requirements and Reasonable Further Progress for Airport Sources Work Order No. 582-18-82508-19, as per the requirements of a Category III QAPP for Data Evaluation or Use for a Secondary Purpose.

The Category III QAPP establishes requirements for projects involving data use for secondary purposes. The internal review and QA/QC procedures were consistent with the NRML QAPP requirements. These procedures are outlined below.

A. Project Management

Project Staff: The project included a team of technical specialists who are well trained to address each project objective. These staff and their primary responsibility area are delineated as follows.

Rick Baker: Mr. Baker is the overall ERG contract manager for this TCEQ contract. He ensures the project implementation follows all contract requirements and that project quality standards are met on all deliverables. He assists in interactions with the TCEQ as required.

Donna Tedder: Ms. Tedder provided peer review for the QAPP and oversaw the QA/QC procedures, ensuring Mr. Billings reviews were all in line with the QAPP and ERG's corporate QA guidelines.

Roger Chang: Project manager for this study, Mr. Chang was recommended to the FAA by the US EPA to be a beta tester for the FAA's Aviation Environmental Design Tool (AEDT) used for this project. Additionally, he has been involved with the development of airport inventories for the US EPA and other federal agencies as well as the TCEQ for over a decade.

Richard Billings: Mr. Billings has extensive knowledge and expertise on aircraft and worked as peer reviewer for the project, ensuring that following checks were made:

- Reviewed at least ten percent of project data files to check for data transfer issues and to ensure that database queries were implemented correctly.
- Project staff used appropriate methodologies and documented data quality activities and the deliverable review process.
- The preliminary data and draft/final reports were reviewed by technical staff to ensure that the project objectives and data quality objectives (DQOs) expressed for this study.
- The report was reviewed by the project's editing staff prior to delivery of the draft version to the TCEQ.

Jennifer Sellers: Ms. Sellers is an experienced environmental scientist who served as the Task Lead for 4 and 5 and Task support for 2, 3, and 6. She is experienced in aircraft emission inventories.

Heather Perez: Ms. Perez is an experienced environmental scientist and database manager who served as technical support and QA reviewer for Tasks 3, 4, 5 and 6. She is experienced in aircraft emission inventories.

Marty Wolf: Mr. Wolf is an experienced environmental engineer who served as technical support for Task 3, 4, and 5. He is experienced in data collection and formatting.

Steve Mendenhall: Mr. Mendenhall is an experienced programmer who served as technical support for tasks 2, 3, 4, and 5. He is experienced with SQL, Access, XML, and various programming languages.

Lindsay Dayton: Ms. Dayton is an experienced environmental scientist who served as the Task support for 3, 4 and 5. She is experienced in aircraft emission inventories.

Jody Tisano: Ms. Tisano is an administrative assistant who provided administrative and clerical support, mainly on Tasks 5 and 6. She has performed similar work on previous TCEQ projects.

Background: The purpose of this project was to develop a set of Statewide and Area-specific emissions inventories (EI) and activity data for all airport sources including aircraft, Auxiliary Power Units (APU), and Ground Support Equipment (GSE). These Els are needed to fulfill the Federal Air Emissions Reporting Requirements (AERR) and support State Implementation Plan (SIP) development. For this project, ERG developed the annual (tons per year) and average summer weekday (tons per day) emissions inventory estimates of Criteria Air Pollutants (CAP), CAP precursors, and Hazardous Air Pollutants (HAP) using the Federal Aviation Agency (FAA) Aviation Environmental Design Tool (AEDT) model.

The overall objective of this project was to provide the aircraft mobile sources 2017 evaluation year activity and annual emissions inventory estimates required for the State of Texas for inclusion in the EPA's 2017 NEI and emissions inventories for SIP development. The previous trend inventory for 2017 was used for every Texas county including estimates for controlled and uncontrolled emissions in both annual (tons per year) and average weekday (tons per day) emissions.

The secondary purpose of this project was to develop area-specific emissions inventories necessary to support both an attainment demonstration and a rate of further progress (RFP) analysis for the Houston-Galveston-Brazoria (HGB) eight-county and the Dallas-Fort Worth (DFW) ten-county non-attainment areas to develop the SIP revision(s) for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS). These inventories were based off previously collected data for 2011 and the 2020 inventory was developed by projecting data from the 2017 activity data.

Project/Task Description:

To meet the project objectives, the following tasks were completed:

- Provided an emissions inventory development plan
- Recompiled the 2011 calendar year data from Work Order 582-11-99776-FY12- 09
- Developed Summer weekday emissions for 2017, 2018, 2020, and 2021 for the HGB Eight-County and the DFW Ten-County areas using the previous 2011 data
- Developed a revised statewide 2011 EI and provided the AEDT files
- Collected new 2017 national data and local data
- Developed 2017 statewide inventory and formatted the data into XML for TexAER and EPA EIS
- Projected the 2017 statewide inventory to 2020 and provided the 2017 AEDT files
- Provided the final report

The project included producing XML files and Excel summary files which were shared with the TCEQ Work Assignment Manager and used in our quality checks.

Quality Objectives and Criteria: ERG provided the TCEQ with comprehensive and accurate emission inventories based on the FAA's latest emission estimating model. Typically, the quality of such inventories was measured by the degree to which local rather than default data were used in their development. ERG documented all the airports from which we solicited data including documentation of repeated calls and emails. Only when there were data gaps in the local data did ERG use national FAA data to gap fill. The FAA data used was obtained from the T-100 dataset that provides aircraft make and model specific data for the 49 airports in Texas that provide commercial air services from a regulated airline. These T-100 data were supplemented with FAA Terminal Area Facility (TAF) data and the FAA's airport Master Plan data (5010) to quantify aircraft activities in the remaining Texas airports. Note that the 5010 and TAF datasets provide activity data in terms of generic aircraft types. Adjustments were made to the generic LTO counts to avoid double counting with the local data and the T-100 aircraft specific data. The resulting TCEQ airport inventory includes locally provided data, T-100 aircraft specific data, and TAF/5010 generic data to ensure that all Texas airports have representative activity data.

The 2011, 2017, and 2020 inventories developed for this project were compared to previous inventory efforts. The 2011 inventory was compared to the 2011 inventory created for the TCEQ's 2011 NEI submittal (Work Order 582-11-99776-FY12- 09). The 2017 and 2020 inventories were compared to the applicable trend inventories developed from the 2014 inventory submitted to the EPA for the NEI. These comparisons were implemented at the state level to evaluate whether the overall state trend was reasonable; at the county level to see if there were any counties that indicated an unexpected increase or decrease in emissions; and at the airport and aircraft level to identify outliers.

When outliers were identified, ERG investigated further to ensure that the data were correct and there were no errors in data handling, in creating the input files for AEDT or for generic aircraft data, and the emission queries were evaluated to ensure they were linking the data correctly.

Under Task 4, the final emissions inventory and activity data were formatted to meet the TCEQ's TexAER and EPA's CERS XML requirements.

Special Training/Certification: No special training or certification is required.

Documents and Records: The process used to collect data and develop the inventories was documented from start to finish. All procedures and data sources used to create the inventories were presented such that the TCEQ or any third party have sufficient information to independently replicate any part of the process if needed.

The process of providing interim products for each work task and obtaining TCEQ review comments enhanced the completeness and quality of the documentation in the final project report. The final report includes this document in the QA section, discussion of any problems encountered, corrective actions taken, and limitation of the data identified in the process of developing the emission inventories.

B. Data Generation and Acquisition

ERG recompiled the 2011 data originally obtained from Work Order 582-11-99776-FY12- 09. ERG conducted no additional data acquisition for 2011.

ERG obtained various aircraft activity data for 2017. There are two general sources of airport data. The preferred sources are from the local airports. The other data are from the publicly available national information from the FAA.

ERG contacted 213 local Texas airports by telephone and email to request 2017 activity data and to identify and characterize control strategies used or planned at each airport. Of the 213 airports contacted, 26 provided data that could be used in the 2017 inventory.

To develop the most accurate aircraft emission inventory possible, ERG took two approaches. First, if aircraft-specific make and model data were available, ERG used the FAA's AEDT model in conjunction with the detailed aircraft activity data either provided by the airport or obtained from T-100. If such detailed data were not available, then ERG applied a more general approach for different aircraft types (i.e., air taxis, general aviation, and military aircraft) using available generic activity data from the local airports, or from the FAA's TAF dataset and FAA's 5010 dataset in conjunction with EPA emission estimating methods noted in the National Emission Inventory documentation.

a. Data Management

No hard copy data were received during the project. For this project all data obtained were electronic. Working copies of the original data files were shared with the team, such that the integrity of the original files was maintained. The original files were never checked out, and only viewed a couple of times to confirm that the data in the working files were correctly transferred.

The electronic working files were stored in a specific project directory on ERG's network drive in Morrisville, North Carolina. The original data files were kept in a separate folder on the same network. All files on the Morrisville server are backed up daily.

Only project team members were granted access to the directories where the working files were stored, such that all members of the team had access to all project data and could perform their work using these files. Once the project was completed, all project electronic files were moved into an archive directory on the network for permanent storage.

C. Assessment and Oversight

Data collection efforts were coordinated so that all ERG team members understood the project goals. Following the kickoff discussions with TCEQ staff and submittal of the work plan, the ERG Project Manager and task leads had internal team meetings to discuss and verify data collection efforts for each project task. Each team member had a clear understanding of all project objectives and deliverables and the data that will be needed to support those deliverables. This coordinated process is seen as essential to efficient and productive data collection.

When data were received from airports, federal agencies or the TCEQ, the staff receiving the data put the original data files directly on the Morrisville server and sent a working copy to the appropriate staff responsible for that task. These staff members reviewed and briefly summarized the findings in the data submittal and informed the ERG project manager. The ERG project manager informed the TCEQ project manager of the data submittal noting any issues with the data based on the initial summary. Once the TCEQ project manager approved the data, ERG team members started working with the submitted data. The TCEQ project manager did not direct ERG to exclude any of the compiled data.

After the aviation data had been compiled and adjustments were made to avoid double counting, the data were stored in a file format appropriate for inclusion into the AEDT. Peer reviewers knowledgeable about the source category but not directly involved in conducting day to day activities of the project reviewed all data handling methods and results of the work. ERG's peer reviewers were included in the initial planning stages of this project to ensure the planned approaches were technically sound and that quality checks were planned for critical points in the process. This included review of AEDT input files and output files as well as the generic aircraft type calculations.

ERG peer reviewers did not find any issues with data handling for the AEDT input files nor did they have any problem reproducing the generic emission estimates using the project access database and associated queries.

All final products were reviewed by senior team members prior to submittal to the TCEQ to ensure the project procedures were properly implemented. The ERG Project Manager and task leads signed off on all deliverables to the TCEQ documenting that all quality checks were implemented and where problems were identified corrections were made in the preliminary or final dataset, and the draft or final report.

The ERG editor worked directly with task leads, making changes to the draft report to make the document clear and easy to follow. The ERG Project Manager also ensured that the final report included all recommended changes suggested by the TCEQ Project Manager.

Reports to Management: The ERG project manager reported to the TCEQ project manager on a biweekly schedule or sooner if something urgent was raised.

D. Data Validation and Usability and Verification and Validation Methods

All information used to develop the emission inventories were checked and reviewed for reasonableness to the extent possible. This included checking activity data and emission factors against the reference source, such as the FAA T-100 and TAF datasets and the EPA's Documentation for the National Emission Inventory to ensure that the values used were correct (e.g., decimal location is correct, units are converted correctly). A minimum of 10% of the data were audited by an independent reviewer not involved with the inventory development. 100 percent of all calculation queries were checked by having a second staff member replicate the result by independently applying the input data and assumptions to see if the same data were produced.

The ERG data review did not find any formatting issues with the data used for the AEDT model input file or issues with the generic emission calculations.

Activity and emissions data were reviewed by the Project Manager to ensure they were reasonable and consistent (i.e., extremely low or high values that are usually indicative of errors were flagged for further investigation). ERG highlighted NO_x emissions as it is a critical pollutant for the nonattainment areas. Any data that were found to be questionable were examined in greater detail to determine what was causing the issue and what adjustments, if any, were required. If data were revised, the procedures and assumptions used were documented. The Project Manager and task leads reviewed and approve all data adjustments, as documented in this QA summary.

2011 to Previous 2011 Inventory Comparison

The 2011 inventory including the DFW and HGB SIP areas was initially analyzed at the county level to see if there were any outliers. Table E-1 summarizes the counties with an absolute difference of 1000% percent or greater from the original 2011 inventory. Because the LTO data matched between the original 2011 data from Work Order 582-11-99776-FY12- 09, and the new inventory using AEDT and new EPA generic emission factors, ERG then looked at the data at the airport level within those counties to see where the underlying sources of the differences were. These airports are summarized in Table E-2.

Table E-1. Counties with the Highest Absolute Percent Changes in Emissions

County	2011 NO_X Emissions w/AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)*	Current 2011 w/ AEDT + Revised Emission Factors LTO	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Wichita	1,759.76	20.59	8,448.63	183,745	183,745	0
Victoria	212.05	2.75	7,619.11	28,709	28,709	0
Aransas	183.19	3.02	5,967.93	41,181	41,181	0
Culberson	1.13	0.02	5,296.46	334	334	0
Reeves	33.15	0.72	4,500.71	10,101	10,101	0
McCulloch	34.10	0.84	3,967.95	11,771	11,771	0
Jim Wells	11.41	0.32	3,420.48	4,474	4,474	0
La Salle	11.43	0.34	3,276.16	4,157	4,157	0
Walker	14.35	0.49	2,822.20	6,633	6,633	0
Kleberg	7.50	0.29	2,487.25	3,851	3,851	0
Calhoun	8.74	0.43	1,951.45	5,449	5,449	0
Howard	6.63	0.42	1,464.47	6,096	6,096	0
Tom Green	301.37	19.46	1,448.91	54,373	54,373	0
Matagorda	9.02	0.65	1,294.69	8,846	8,846	0

* Percent change greater than 1,000%

a. Previous Inventory was based on the same LTO data but used EDMS and previous EPA generic emission factors.

Table E-2. Airports with the Highest Absolute Percent Changes in Emissions Within the Previously Identified Counties

County	Airport	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)*	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Wichita	Sheppard AFB/Wichita Falls Muni	1,758.23	19.06	9,126.00	161,654	161,654	0
Victoria	Victoria Rgnl	211.83	2.52	8,294.44	26,070	26,070	0
Matagorda	Palacios Muni	8.20	0.11	7,417.74	1,480	1,480	0
Culberson	Culberson County	1.13	0.02	6,095.70	250	250	0
Aransas	Aransas Co	183.19	3.02	5,972.51	41,110	41,110	0
Reeves	Pecos Muni	33.15	0.72	4,516.27	10,025	10,025	0
McCulloch	Curtis Field	34.10	0.84	3,969.34	11,762	11,762	0
Calhoun	Calhoun County	8.53	0.21	3,893.33	3,000	3,000	0
Jim Wells	Alice Intl	11.39	0.31	3,612.01	4,305	4,305	0
La Salle	Cotulla-La Salle County	11.42	0.33	3,342.53	3,950	3,950	0
Walker	Huntsville Muni	14.33	0.47	2,932.53	6,425	6,425	0
Kleberg	Kleberg County	7.48	0.27	2,638.42	3,700	3,700	0
Howard	Big Spring Mc Mahon-Wrinkle	6.63	0.42	1,464.47	6,096	6,096	0
Tom Green	San Angelo Rgnl/Mathis Field	301.27	19.36	1,456.45	52,983	52,983	0

* Percent change greater than 1,000%

a. Previous Inventory was based on the same LTO data but used EDMS and older EPA generic emission factors.

The data from Table E-2 showed that the LTO data matched, whereas the emissions were higher in the new 2011 inventory developed using AEDT. Table E-2 also compares the new generic emission factors from the EPA to the emissions factors used in the prior inventory that was developed using the FAA's older EDMS software and the EPA's older generic emission factors. It is recognized by the FAA that AEDT emissions differ from EDMS emissions. Factors that contribute to these differences include the use of different fuel consumption methods (AEDT data are considered more accurate as they are based on aircraft flight recorder data). Also, AEDT uses different methods to determine aircraft weight, flap and power settings. EDMS uses more generic default values for these aircraft operating perimeters (see https://aedt.faa.gov/Documents/Comparison_AEDT_Legacy_Summary.pdf).

Overall, AEDT is believed to provide more accurate emissions estimates than EDMS. Based on ERG's analysis, the AEDT model generated results consistent with the FAA's findings that overall emissions from the resulting model outputs are typically higher than corresponding results from EDMS when analyzing aggregate emissions estimates.

Comparing the two models can be very complicated, as the two models use different methodologies to account for airport factors (e.g., runway length, relative elevation, time in mode and local meteorology) and aircraft factors (e.g., aircraft rate of climbout/descent, engine specific fuel consumption, aircraft weight, engine mode operations). Table E-3 provides a simple comparison where the emissions for a BOEING 737 200 series equipped with Pratt and Whitney 1PW011 engines are normalized on a per LTO basis.[1] As Table E-3 indicates, EDMS and AEDT emission estimates can differ for different airports and pollutants.

Variance in the AEDT output appears reasonable when considering the variance typically associated with the EDMS output, based on ERG's experience working with EDMS outputs.

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[1] This is just one example for the 737 200 series, most aircraft models have multiple engine options, and this series has five different low-bypass turbonfan variants as part of their JT8D product line.

Table E-3. Example Comparison for 2011 Inventory between AEDT and EDMS at the Airport, Aircraft, Engine, and Pollutant Level

Airport	Airframe	Engine	Pollutant Code	AEDT Emissions (Ton per LTO)	EDMS Emissions (Tons per LTO)	Percent Change
Dallas Love Field	Boeing 737-200 Series	1PW011	CO	1.93E-02	8.32E-03	132
San Antonio Intl	Boeing 737-200 Series	1PW011	CO	2.53E-02	1.50E-02	68
William P Hobby	Boeing 737-200 Series	1PW011	CO	2.87E-02	1.75E-02	64
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	CO	1.41E-02	9.21E-03	53
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	CO	1.07E-02	7.23E-03	49
Dallas Love Field	Boeing 737-200 Series	1PW011	NO_X	2.14E-02	1.93E-02	11
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	NO_X	2.24E-02	2.03E-02	10
San Antonio Intl	Boeing 737-200 Series	1PW011	NO_X	2.01E-02	2.05E-02	-2
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	NO_X	2.02E-02	2.10E-02	-4
William P Hobby	Boeing 737-200 Series	1PW011	NO_X	2.15E-02	2.24E-02	-4
Dallas Love Field	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.56E-04	2.82E-04	-45
San Antonio Intl	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.86E-04	3.56E-04	-48
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.74E-04	4.01E-04	-57
William P Hobby	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.39E-04	3.30E-04	-58
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.28E-04	3.04E-04	-58
Dallas Love Field	Boeing 737-200 Series	1PW011	SO_2	1.71E-03	1.38E-03	24
San Antonio Intl	Boeing 737-200 Series	1PW011	SO_2	2.08E-03	1.78E-03	17
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	SO_2	1.93E-03	2.00E-03	-4
William P Hobby	Boeing 737-200 Series	1PW011	SO_2	1.51E-03	1.63E-03	-7
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	SO_2	1.37E-03	1.49E-03	-8
Dallas Love Field	Boeing 737-200 Series	1PW011	VOC	5.38E-03	2.57E-03	109
San Antonio Intl	Boeing 737-200 Series	1PW011	VOC	6.92E-03	4.26E-03	62
William P Hobby	Boeing 737-200 Series	1PW011	VOC	7.80E-03	4.92E-03	58
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	VOC	4.05E-03	2.77E-03	46
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	VOC	3.19E-03	2.27E-03	41

Additionally, ERG looked at the data at the airport and SCC level, summarized in Table E-4. This table clearly showed that the large difference (14,035% increase) in emissions were from military activity. ERG concluded the change in emissions were due to the revised generic military emission factors. ERG confirmed that in all the cases the military data with high emission differences were from generic activity. The percent difference between the older emission factor and the revised emission factor for NO_x is 14,035%. The smaller absolute percent changes, such as the -36% change at Austin Bergstrom International Airport, are due to the use of AEDT vs EDMS. Additional details can be found in Table E-5.

Additional checks were conducted by looking at the top 25 airports in Texas to see if there were any additional outliers of concern. The TCEQ noticed that Hondo Municipal Airport seemed to have an unusually high level of activity. The original 2011 data were based on data the airport provided in 2008 and were grown using the growth factors in the FAA's TAF dataset. Upon further investigation it was noted that Hondo Municipal Airport had unusually high LTO values in 2011 resulting in an unusually high calculated annual growth rate that, when applied to the airport-provided 2008 data, generated unrealistic 2011 values.

> **ERG replaced the elevated projected 2011 data with TAF data which was more consistent with the 2008 value. The correction was made to the data file and summary tables in the final report and included in this document as well.**

Table E-5 provides a revised list of the top 25 airports where the Hondo Municipal Airport data has been corrected. In this table, there are some emission differences, but these are attributed to the following:

- In comparing emission trends by airport with earlier inventory years, differences were noted that were attributed to the fact that the older 2011 emissions were based on the EDMS model, while other years were based on the FAA's new AEDT model.

  No changes were made since the FAA acknowledges the AEDT model provides notably different results than the EDMS model.

Table E-4. SCCs With the Highest Absolute Percent Change in Emissions Within the Previously Identified Airport/County Combinations

Airport	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)*	Current 2011 LTO w/ AEDT + Revised Emission Factors **	Previous 2011 LTO w/ EDMS + Previous Emission Factors[a]	LTO Percent Change (%)
Culberson County	2275001000	1.12	0.01	14,034.95	100	100	0
Alice Intl	2275001000	11.17	0.08	14,034.95	1,000	1,000	0
Cotulla-La Salle County	2275001000	11.17	0.08	14,034.95	1,000	1,000	0
Huntsville Muni	2275001000	13.96	0.10	14,034.95	1,250	1,250	0
Curtis Field	2275001000	33.50	0.24	14,034.95	3,000	3,000	0
Big Spring Mc Mahon-Wrinkle	2275001000	6.25	0.04	14,034.95	560	560	0
Calhoun County	2275001000	8.37	0.06	14,034.95	750	750	0
San Angelo Rgnl/Mathis Field	2275001000	283.67	2.01	14,034.95	25,404	25,404	0
Palacios Muni	2275001000	8.15	0.06	14,034.95	730	730	0
Kleberg County	2275001000	7.26	0.05	14,034.95	650	650	0
Victoria Rgnl	2275001000	210.76	1.49	14,034.95	18,875	18,875	0
Pecos Muni	2275001000	32.66	0.23	14,034.95	2,925	2,925	0
Sheppard AFB/Wichita Falls Muni	2275001000	1,751.34	12.39	14,034.95	156,837	156,837	0
Aransas Co	2275001000	181.46	1.28	14,034.95	16,250	16,250	0

*High percent change due to updates to Military EF update

**Military LTOs were all generic

a. Previous Inventory was based on the same LTO data but used EDMS and older EPA generic emission factors.

Table E-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Tarrant	Dallas/Fort Worth Intl	2275060012	38.74	26.76	45	21,405	21,405	0
Tarrant	Dallas/Fort Worth Intl	2275020000	3,638.95	2,898.22	26	296,412	296,412	0
Tarrant	Dallas/Fort Worth Intl	2275050012	12.18	6.17	97	5,427	5,427	0
Tarrant	Dallas/Fort Worth Intl	2275060011	0.01	0.01	14	157	157	0
Harris	George Bush Intercontinental/Houston	2275050011	0.05	0.03	43	110	110	0
Harris	George Bush Intercontinental/Houston	2275001000	0.16	0.23	-30	199	199	0
Harris	George Bush Intercontinental/Houston	2275020000	1,751.10	1,697.93	3	174,556	174,556	0
Harris	George Bush Intercontinental/Houston	2275060012	310.77	231.41	34	81,863	81,863	0
Harris	George Bush Intercontinental/Houston	2275050012	3.52	3.81	-7	2,435	2,435	0
Harris	George Bush Intercontinental/Houston	2275060011	0.00	0.00	-56	71	71	0
Harris	William P Hobby	2275060012	24.48	21.15	16	13,669	13,669	0
Harris	William P Hobby	2275060011	0.01	0.03	-59	774	774	0
Harris	William P Hobby	2275050012	15.55	17.48	-11	13,148	13,148	0
Harris	William P Hobby	2275050011	0.09	0.08	18	595	595	0
Harris	William P Hobby	2275020000	548.73	637.71	-14	80,192	80,192	0
Harris	William P Hobby	2275001000	1.16	0.68	71	2,256	2,256	0
Travis	Austin-Bergstrom Intl	2275001000	0.22	0.34	-36	220	220	0
Travis	Austin-Bergstrom Intl	2275020000	397.47	415.95	-4	52,481	52,481	0

Table E-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Travis	Austin-Bergstrom Intl	2275050011	0.55	0.67	-18	9,912	9,912	0
Travis	Austin-Bergstrom Intl	2275050012	17.31	18.66	-7	19,471	19,471	0
Travis	Austin-Bergstrom Intl	2275060011	0.20	1.06	-81	14,122	14,122	0
Travis	Austin-Bergstrom Intl	2275060012	18.78	18.71	0	20,201	20,201	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275060012	2.45	2.38	3	1,129	1,129	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275050011	0.07	0.07	0	2,277	2,277	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	1,751.34	12.39	14,035	156,837	156,837	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275020000	4.22	4.07	4	530	530	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275050012	0.14	0.14	0	881	881	0
Dallas	Dallas Love Field	2275060012	21.10	11.82	78	14,252	14,252	0
Dallas	Dallas Love Field	2275060011	0.14	0.09	65	7,821	7,821	0
Dallas	Dallas Love Field	2275050012	18.32	13.82	33	14,431	14,431	0
Dallas	Dallas Love Field	2275050011	0.15	0.06	130	1,333	1,333	0
Dallas	Dallas Love Field	2275020000	405.68	322.45	26	51,171	51,171	0
Dallas	Dallas Love Field	2275001000	1.32	1.16	14	589	589	0
Harris	Ellington Field	2275060011	0.22	0.58	-62	13,668	13,668	0
Harris	Ellington Field	2275050011	0.20	0.33	-38	4,903	4,903	0
Harris	Ellington Field	2275060012	22.45	18.47	22	31,284	31,284	0
Harris	Ellington Field	2275020000	60.86	70.04	-13	14,930	14,930	0

Table E-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Harris	Ellington Field	2275001000	29.77	58.00	-49	30,778	30,778	0
Harris	Ellington Field	2275050012	13.19	16.39	-20	14,017	14,017	0
Bexar	San Antonio Intl	2275020000	339.28	379.15	-11	39,181	39,181	0
Bexar	San Antonio Intl	2275050011	0.14	0.14	2	1,264	1,264	0
Bexar	San Antonio Intl	2275050012	4.26	4.58	-7	3,941	3,941	0
Bexar	San Antonio Intl	2275060011	0.06	0.12	-48	4,125	4,125	0
Bexar	San Antonio Intl	2275060012	9.56	8.98	6	10,712	10,712	0
Bexar	San Antonio Intl	2275001000	11.78	29.59	-60	1,391	1,391	0
Harris	David Wayne Hooks Memorial	2275020000	0.02	0.02	0	2	2	0
Harris	David Wayne Hooks Memorial	2275060012	0.70	0.70	0	1,803	1,803	0
Harris	David Wayne Hooks Memorial	2275060011	0.04	0.04	0	502	502	0
Harris	David Wayne Hooks Memorial	2275050011	2.12	2.12	0	65,380	65,380	0
Harris	David Wayne Hooks Memorial	2275001000	18.36	0.13	14,035	1,644	1,644	0
Harris	David Wayne Hooks Memorial	2275050012	4.10	4.10	0	25,299	25,299	0
Tarrant	Fort Worth Alliance	2275060011	0.26	0.34	-25	17,174	17,174	0
Tarrant	Fort Worth Alliance	2275020000	243.93	211.83	15	5,725	5,725	0
Tarrant	Fort Worth Alliance	2275060012	4.23	2.26	87	5,724	5,724	0
Tarrant	Fort Worth Alliance	2275050012	88.00	49.73	77	28,625	28,625	0

Table E-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Denton	Northwest Rgnl	2275060011	1.09	1.47	-26	82,170	82,170	0
Denton	Northwest Rgnl	2275060012	0.55	0.10	441	830	830	0
Bexar	Stinson Muni	2275020000	0.31	0.26	18	168	168	0
Bexar	Stinson Muni	2275050011	0.33	1.29	-75	14,397	14,397	0
Bexar	Stinson Muni	2275050012	2.34	2.76	-15	2,098	2,098	0
Bexar	Stinson Muni	2275060011	1.75	1.02	72	58,245	58,245	0
Bexar	Stinson Muni	2275060012	3.55	6.89	-49	7,021	7,021	0
Denton	Denton Muni	2275060012	12.14	4.12	195	19,983	19,983	0
Denton	Denton Muni	2275050012	9.99	3.99	150	4,440	4,440	0
Denton	Denton Muni	2275060011	1.29	0.89	44	49,586	49,586	0
El Paso	El Paso Intl	2275020000	224.69	227.58	-1	24,283	24,283	0
El Paso	El Paso Intl	2275050011	0.33	0.33	0	10,093	10,093	0
El Paso	El Paso Intl	2275060012	1.05	1.18	-11	1,831	1,831	0
El Paso	El Paso Intl	2275060011	0.32	0.32	0	3,994	3,994	0
El Paso	El Paso Intl	2275050012	0.72	0.71	1	3,979	3,979	0
El Paso	El Paso Intl***	2275001000	34.00	0.25	13,776	3,046	3,046	0
Dallas	Addison	2275060012	10.20	4.95	106	16,256	16,256	0
Dallas	Addison	2275050012	35.17	18.86	86	13,716	13,716	0
Dallas	Addison	2275060011	0.48	0.38	25	20,828	20,828	0
Brazoria	Pearland Rgnl	2275060012	0.03	0.03	0	85	85	0
Brazoria	Pearland Rgnl	2275060011	0.02	0.02	0	218	218	0
Brazoria	Pearland Rgnl	2275050012	2.71	2.71	0	16,715	16,715	0

Table E-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Brazoria	Pearland Rgnl	2275050011	1.40	1.40	0	42,982	42,982	0
Nueces	Corpus Christi Intl	2275050012	0.47	0.47	0	2,927	2,927	0
Nueces	Corpus Christi Intl	2275050011	0.24	0.24	0	7,526	7,526	0
Nueces	Corpus Christi Intl	2275060011	0.14	0.14	0	1,785	1,785	0
Nueces	Corpus Christi Intl	2275060012	0.38	0.37	3	723	723	0
Nueces	Corpus Christi Intl	2275001000	336.94	2.38	14,035	30,174	30,174	0
Nueces	Corpus Christi Intl	2275020000	27.80	35.16	-21	6,725	6,725	0
Tom Green	San Angelo Rgnl/Mathis Field	2275050012	1.02	1.02	0	6,253	6,253	0
Tom Green	San Angelo Rgnl/Mathis Field	2275060011	0.04	0.04	0	492	492	0
Tom Green	San Angelo Rgnl/Mathis Field	2275060012	3.18	3.01	6	3,241	3,241	0
Tom Green	San Angelo Rgnl/Mathis Field	2275001000	283.67	2.01	14,035	25,404	25,404	0
Tom Green	San Angelo Rgnl/Mathis Field	2275020000	12.84	12.76	1	1,436	1,436	0
Tom Green	San Angelo Rgnl/Mathis Field	2275050011	0.53	0.53	0	16,157	16,157	0
Brazoria	Brazoria County	2275050012	5.55	5.55	0	34,263	34,263	0
Brazoria	Brazoria County	2275060011	0.06	0.06	0	780	780	0
Brazoria	Brazoria County	2275050011	0.43	0.43	0	13,324	13,324	0
Brazoria	Brazoria County	2275020000	6.43	7.05	-9	639	639	0
Brazoria	Brazoria County	2275001000	18.61	0.13	14,035	1,667	1,667	0
Brazoria	Brazoria County	2275060012	0.78	0.78	0	2,004	2,004	0
Harris	West Houston	2275060012	0.15	0.15	0	391	391	0
Harris	West Houston	2275050012	2.34	2.34	0	14,434	14,434	0
Harris	West Houston	2275050011	1.21	1.21	0	37,300	37,300	0

Table E-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Harris	West Houston	2275060011	0.01	0.01	0	109	109	0
Dallas	Mesquite Metro	2275050012	2.33	0.64	268	1,015	1,015	0
Dallas	Mesquite Metro	2275060011	0.67	0.73	-8	41,596	41,596	0
Dallas	Mesquite Metro	2275060012	5.83	1.95	198	8,117	8,117	0
Tarrant	Fort Worth Meacham Intl	2275050012	32.94	15.41	114	12,131	12,131	0
Tarrant	Fort Worth Meacham Intl	2275060011	0.42	0.31	36	16,869	16,869	0
Tarrant	Fort Worth Meacham Intl	2275060012	5.45	2.20	148	8,909	8,909	0
Medina	Hondo Muni	2275050012	2.15	73.91	-97	13,253	455,851	-97
Medina	Hondo Muni	2275050011	1.11	0	100	34,248	0	100
Lubbock	Lubbock Preston Smith Intl	2275020000	62.59	62.09	1	9,041	9,041	0
Lubbock	Lubbock Preston Smith Intl	2275060012	3.48	3.54	-2	6,138	6,138	0
Lubbock	Lubbock Preston Smith Intl	2275060011	0.07	0.07	0	948	948	0
Lubbock	Lubbock Preston Smith Intl	2275050012	0.75	0.75	0	4,663	4,663	0
Lubbock	Lubbock Preston Smith Intl	2275050011	0.39	0.39	0	12,050	12,050	0
Lubbock	Lubbock Preston Smith Intl	2275001000	50.50	0.36	14,035	4,523	4,523	0
Fort Bend	Sugar Land Rgnl	2275001000	4.31	0.03	14,035	386	386	0
Fort Bend	Sugar Land Rgnl	2275060012	0.33	0.33	0	860	860	0
Fort Bend	Sugar Land Rgnl	2275060011	0.17	0.17	0	2,211	2,211	0

Table E-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Fort Bend	Sugar Land Rgnl	2275050012	1.88	1.88	0	11,632	11,632	0
Fort Bend	Sugar Land Rgnl	2275050011	0.97	0.97	0	29,911	29,911	0

*Airports with total aircraft LTO's greater than 45,000

a. Previous Inventory was based on the same LTO data but used EDMS and older EPA generic emission factors.

**Percent Increase greater than 1,000%, high change due to updates to Military EF update.

*** There were some specific military LTOs, that's why the percent difference was a little different.

The new EPA generic military emission factors replaced the earlier factors provided in the SIP 1992 Guidance, which were based on engine test data from 1987 to 1991. The EPA's new emission factors were derived from the International Civil Aviation Organization (ICAO) engine databank factors that were matched to U.S. military aircraft and weighted based on the current fleet composition. A comparison of the revised and previous generic military emission factors is summarized in Table E-6. (Eastern Research Group to United States Environmental Protection Agency Memorandum - Updating the Generic Military Emission Factors for the 2014 National Emission Inventory, December 15, 2015)

Table E-6. Comparison of Revised Military Criteria Emission Factors[1] to the Previous Generic Military Emission Factors[2] (tons/LTO)*

Pollutant	2014 NEI (1992 SIP EF)	Revised Emission Factors (2015 EDMS)	Percent Difference
THC	6.17E-04	4.72E-03	665
VOC	7.10E-04	5.43E-03	666
TOG	7.16E-04	5.46E-03	663
NO_x	7.90E-05	1.12E-02	14035
CO	1.41E-02	1.30E-02	-8
SO_x	7.50E-06	1.06E-03	13967
$PM_{10\text{-}PRI}$	3.02E-04	6.97E-04	131

*There may be rounding errors in the 1992 SIP EF and Percent Change numbers

[1] Memorandum to Laurel Driver from Roger Chang and Richard Billings (ERG) Updating the Generic Military Emission Factors for the 2014 National Emission Inventory, December 18, 2015.

[2] U.S. EPA, Procedures for Emission Inventory Preparation Volume IV: Mobile Sources, EPA420-R-92-009, December 1992.

> **The use of the latest EPA emission factors is consistent with developing inventories based on the latest data and methods currently available, and therefore no changes were made to these factors.**

An additional concern was that Sheppard Airforce Base also seemed to have an unusually high level of activity. ERG first confirmed the data was correctly compiled.

> **However, since Sheppard is the busiest dual-use Air Force base in the U.S. it is to be expected that the base has a large number of LTOs compared to other airports in Texas (see https://www.sheppard.af.mil/News/Article-Display/Article/1412802/sheppard-has-busiest-joint-use-airfield-in-af/).**

Differences of multiple orders of magnitude were noted for NO_x emissions for generic military aircraft operations (including Sheppard AFB) between the 2011 and 2017 inventories, which matched the difference in the new EPA generic emission factors for military aircraft.

> **No change was required as the newer EPA emission factors replaced older emission factors developed in 1987.**

In cases where quantitative data were developed, checks were made to ensure their accuracy. To this end ERG spot checked data and compared the calculated values to the previous 2014 trend inventories. The inventory data were also summarized for the TCEQ to evaluate independently. Data found to be questionable were examined in greater detail to determine if errors might be present and what adjustments might be needed. Where data were revised, the procedures and assumptions used were documented. The ERG Project Manager and task leads reviewed and approved all data adjustments.

ERG also confirmed that all aircraft in the previous inventory were included in the input/output files used to develop the new 2011 inventory (see Table E-7). Note that the small difference in the first 8 rows of Table E-7 are due to the change in the Hondo Municipal Airport data. Hondo Municipal Airport data originally included some aircraft-specific local data. These were removed and replaced with generic data from TAF.

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Dassault Falcon 2000	5	6	-17
Bombardier Learjet 24	7	8	-13
Bombardier Learjet 35	12	13	-8
Bombardier Learjet 45	13	14	-7
Cessna 560 Citation V	13	14	-7
Cessna 750 Citation X	13	14	-7
Raytheon Beechjet 400	13	14	-7
Bombardier Challenger 600	23	24	-4
Aerostar PA-60	7	7	0
Agusta A-109	2	2	0
Airbus A300B2-100 Series	2	2	0
Airbus A300B4-600 Series	4	4	0
Airbus A300C4-600 Series	1	1	0
Airbus A300F4-600 Series	4	4	0
Airbus A310-200 Series	9	9	0
Airbus A310-300 Series	1	1	0
Airbus A318-100 Series	4	4	0

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Airbus A319-100 Series	15	15	0
Airbus A320-100 Series	6	6	0
Airbus A320-200 Series	7	7	0
Airbus A321-100 Series	1	1	0
Airbus A321-200 Series	1	1	0
Airbus A330-200 Series	2	2	0
Airbus A330-300 Series	2	2	0
Airbus A340-300 Series	3	3	0
Antonov 12 Cub	2	2	0
Antonov 124 Ruslan	3	3	0
ATR 42-200	3	3	0
ATR 42-300	1	1	0
ATR 72-200	13	13	0
Aviat Husky A1B	7	7	0
Ayres Turbo Thrush T-65	1	1	0
BAC 1-11 200	1	1	0
BAE 146-100	3	3	0
BAE Jetstream 31	2	2	0
Bell 206 JetRanger	9	9	0
Bell AH-1S Cobra	3	3	0
Bell UH-1 Iroquois	1	1	0
Boeing 707-300 Series	1	1	0
Boeing 717-200 Series	5	5	0
Boeing 727-100 Series	8	8	0
Boeing 727-200 Series	19	19	0
Boeing 737-100 Series	12	12	0
Boeing 737-200 Series	9	9	0
Boeing 737-300 Series	24	24	0
Boeing 737-400 Series	21	21	0
Boeing 737-500 Series	16	16	0
Boeing 737-600 Series	2	2	0
Boeing 737-700 Series	24	24	0
Boeing 737-800 Series	28	28	0
Boeing 737-900 Series	13	13	0
Boeing 737-900-ER	1	1	0
Boeing 747-100 Series	2	2	0

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Boeing 747-200 Series	7	7	0
Boeing 747-400 Series	5	5	0
Boeing 757-200 Series	22	22	0
Boeing 757-300 Series	6	6	0
Boeing 767-200 ER	3	3	0
Boeing 767-200 Series	7	7	0
Boeing 767-300 ER	3	3	0
Boeing 767-300 Series	4	4	0
Boeing 767-400 ER	2	2	0
Boeing 777-200 Series	9	9	0
Boeing 777-300 Series	5	5	0
Boeing C-17A	2	2	0
Boeing DC-10-10 Series	5	5	0
Boeing DC-10-30 Series	2	2	0
Boeing DC-10-30ER	1	1	0
Boeing DC-3	2	2	0
Boeing DC-8 Series 50	1	1	0
Boeing DC-8 Series 60	2	2	0
Boeing DC-8 Series 70	7	7	0
Boeing DC-9-10 Series	5	5	0
Boeing DC-9-20 Series	9	9	0
Boeing DC-9-30 Series	17	17	0
Boeing DC-9-40 Series	1	1	0
Boeing DC-9-50 Series	4	4	0
Boeing F/A-18 Hornet	2	2	0
Boeing KC-135 Stratotanker	1	1	0
Boeing MD-10-1	2	2	0
Boeing MD-11	8	8	0
Boeing MD-11-ER	1	1	0
Boeing MD-81	2	2	0
Boeing MD-82	22	22	0
Boeing MD-83	6	6	0
Boeing MD-87	15	15	0
Boeing MD-88	2	2	0
Boeing MD-90	2	2	0
Boeing Stearman PT-17 / A75N1	1	1	0

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Bombardier Challenger 300	8	8	0
Bombardier Challenger 601	2	2	0
Bombardier Challenger 604	2	2	0
Bombardier CL-415	1	1	0
Bombardier CRJ-100	4	4	0
Bombardier CRJ-200	16	16	0
Bombardier CRJ-700	18	18	0
Bombardier CRJ-900	7	7	0
Bombardier CRJ-900-ER	1	1	0
Bombardier de Havilland Dash 8 Q400	7	7	0
Bombardier Global Express	5	5	0
Bombardier Learjet 25	12	12	0
Bombardier Learjet 31	11	11	0
Bombardier Learjet 35A/36A (C-21A)	2	2	0
Bombardier Learjet 36	1	1	0
Bombardier Learjet 40	10	10	0
Bombardier Learjet 55	11	11	0
Bombardier Learjet 60	11	11	0
CASA 212-100 Series	2	2	0
CASA C-101 Aviojet	1	1	0
Cessna 150 Series	13	13	0
Cessna 172 Skyhawk	80	80	0
Cessna 182	18	18	0
Cessna 206	14	14	0
Cessna 208 Caravan	20	20	0
Cessna 210 Centurion	14	14	0
Cessna 310	14	14	0
Cessna 337 Skymaster	4	4	0
Cessna 340	11	11	0
Cessna 402	8	8	0
Cessna 414	12	12	0
Cessna 421 Golden Eagle	15	15	0
Cessna 425 Conquest I	12	12	0
Cessna 441 Conquest II	12	12	0
Cessna 500 Citation I	31	31	0
Cessna 501 Citation ISP	14	14	0

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Cessna 525 CitationJet	13	13	0
Cessna 550 Citation II	12	12	0
Cessna 551 Citation IISP	3	3	0
Cessna 552 T-47A	1	1	0
Cessna 560 Citation Excel	9	9	0
Cessna 560 Citation XLS	4	4	0
Cessna 650 Citation III	10	10	0
Cessna 680 Citation Sovereign	11	11	0
Cessna S550 Citation S/II	1	1	0
Cessna T-37 Tweet	1	1	0
Cirrus SR20	9	9	0
Cirrus SR22	14	14	0
Convair CV-580	9	9	0
Dassault Falcon 10	17	17	0
Dassault Falcon 100	1	1	0
Dassault Falcon 200	1	1	0
Dassault Falcon 2000-EX	5	5	0
Dassault Falcon 20-C	9	9	0
Dassault Falcon 20-F	1	1	0
Dassault Falcon 50	10	10	0
Dassault Falcon 900	8	8	0
Dassault Falcon 900-EX	1	1	0
DeHavilland DHC-2 Mk III Beaver	1	1	0
DeHavilland DHC-6-100 Twin Otter	3	3	0
DeHavilland DHC-6-200 Twin Otter	1	1	0
DeHavilland DHC-6-300 Twin Otter	1	1	0
DeHavilland DHC-8-100	3	3	0
DeHavilland DHC-8-200	2	2	0
DeHavilland DHC-8-300	1	1	0
Dornier 328 Jet	3	3	0
Dornier 328-100 Series	4	4	0
EADS Socata TB-20 Trinidad	4	4	0
EADS Socata TB-9 Tampico	1	1	0
EADS Socata TBM-700	11	11	0
Embraer 312 Tucano	1	1	0
Embraer EMB110 Bandeirante	4	4	0

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Embraer EMB120 Brasilia	4	4	0
Embraer ERJ135	19	19	0
Embraer ERJ135-LR	1	1	0
Embraer ERJ140	21	21	0
Embraer ERJ145	27	27	0
Embraer ERJ145-EU	1	1	0
Embraer ERJ145-LR	1	1	0
Embraer ERJ145-XR	3	3	0
Embraer ERJ170	5	5	0
Embraer ERJ175	3	3	0
Embraer ERJ190	4	4	0
Fairchild Metro IVC	1	1	0
Fairchild SA-226-T Merlin III	8	8	0
Fairchild SA-226-TC Metro II	3	3	0
Fairchild SA-227-AC Metro III	7	7	0
Fairchild SA-227-AT Expeditor	5	5	0
Fairchild SA-26-T Merlin II	4	4	0
Falcon 7X	3	3	0
Fokker F27 Friendship	1	1	0
Fokker F27-100 Series	1	1	0
Gulfstream G100	3	3	0
Gulfstream G150	8	8	0
Gulfstream G200	7	7	0
Gulfstream G300	5	5	0
Gulfstream G400	6	6	0
Gulfstream G500	5	5	0
Gulfstream G550	2	2	0
Gulfstream I	6	6	0
Gulfstream II	7	7	0
Gulfstream II-B	1	1	0
Gulfstream IV-SP	3	3	0
Gulfstream V-SP	7	7	0
Hawker HS-125 Series 1	2	2	0
Hawker HS-125 Series 400	3	3	0
Hawker HS-125 Series 600	3	3	0
Hawker HS-125 Series 700	7	7	0

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Hughes 500D	1	1	0
Israel IAI-1124 Westwind I	9	9	0
Israel IAI-1124-A Westwind II	2	2	0
Israel IAI-1125 Astra	6	6	0
Israel IAI-1126 Galaxy	6	6	0
Lancair 360	5	5	0
Lockheed C-130 Hercules	7	7	0
Lockheed C-5 Galaxy	2	2	0
Lockheed L-1329 Jetstar I	1	1	0
Lockheed L-1329 Jetstar II	5	5	0
Lockheed Martin F-16 Fighting Falcon	4	4	0
Lockheed P-3 Orion ANP:P3A	1	1	0
Lockheed S-3 Viking	1	1	0
Maule MT-7-235	7	7	0
Mitsubishi MU-2	12	12	0
Mitsubishi MU-300 Diamond	6	6	0
Mooney M20-K	16	16	0
NAMC YS-11-100 Series	1	1	0
Partenavia P.68 Victor	1	1	0
Piaggio P.180 Avanti	10	10	0
Pilatus PC-12	13	13	0
Pilatus PC-6 Porter	1	1	0
Piper PA-23 Apache/Aztec	13	13	0
Piper PA-24 Comanche	10	10	0
Piper PA-27 Aztec	3	3	0
Piper PA-28 Cherokee Series	33	33	0
Piper PA-30 Twin Comanche	14	14	0
Piper PA-31 Navajo	12	12	0
Piper PA-31T Cheyenne	15	15	0
Piper PA-32 Cherokee Six	13	13	0
Piper PA-34 Seneca	13	13	0
Piper PA-42 Cheyenne Series	10	10	0
Piper PA46-TP Meridian	12	12	0
Rans S7S	1	1	0
Raytheon Beech 18	8	8	0
Raytheon Beech 1900-C	4	4	0

Table E-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Raytheon Beech 1900-D	1	1	0
Raytheon Beech 55 Baron	40	40	0
Raytheon Beech 60 Duke	10	10	0
Raytheon Beech 99	8	8	0
Raytheon Beech Baron 58	16	16	0
Raytheon Beech Bonanza 36	31	31	0
Raytheon Beech D17S Staggerwing	2	2	0
Raytheon Hawker 1000	7	7	0
Raytheon Hawker 4000 Horizon	3	3	0
Raytheon Hawker 800	7	7	0
Raytheon Hawker 900	1	1	0
Raytheon King Air 100	13	13	0
Raytheon King Air 90	17	17	0
Raytheon Premier I	7	7	0
Raytheon Super King Air 200	45	45	0
Raytheon Super King Air 300	15	15	0
Robinson R22	9	9	0
Rockwell 1121 Jet Commander	5	5	0
Rockwell 1121A Jet Commander-A	5	5	0
Rockwell Commander 500	8	8	0
Rockwell Commander 680	6	6	0
Rockwell Commander 690	13	13	0
Rockwell Sabreliner 40	4	4	0
Rockwell Sabreliner 50	1	1	0
Rockwell Sabreliner 65	2	2	0
Rockwell Sabreliner 80	1	1	0
Ryan Navion B	1	1	0
Saab 340-A	2	2	0
Saab 340-B	10	10	0
Shorts 330	2	2	0
Shorts 360-100 Series	3	3	0
Sikorsky S-76 Spirit	7	7	0
Sikorsky UH-60 Black Hawk	1	1	0
T-38 Talon	6	6	0

2011 Airports Compared to 2017 Airports

The airports in the 2011 inventory and the airports in the 2017 inventory were compared to identify differences in the datasets. As expected, there were changes during the 6 years, with some airports closing and some opening. The 29 airports that closed sometime between 2011 and 2017, or that did not have activity, are listed in Table E-8. These 29 airports were small and accounted for only 0.0526% of total LTOs in 2011 combined.

348 "new" airports opened during this time period or had activity in 2017 that was absent in 2011. These new airports were small, accounting for only 0.80% of total LTOs in 2017.

> **It should be noted that some airport codes changed between 2011 and 2017 and were in fact the same airports. These airports were not included in Tables E-8 and E-9.**

These observations track with the significant increase in small aircraft facilities in the Dallas/Fort Worth area between 2011 and 2017. Many of these are very small operations, air taxis and helicopter services which have been increasing over the years.

> **No change was needed as the data seem to be capturing a new and growing trend. (See** https://www.bizjournals.com/dallas/news/2016/11/11/air-medical-group-med-trans-corp-denton-hq.html and https://www.dallasnews.com/business/technology/2018/05/08/uber-getting-plans-ground-air-taxis-dallas-los-angeles)

Table E-8. Airports in the 2011 Inventory that were not included in the 2017 Inventory (closed)

Airport Code	Airport	2011 LTO	Percent of Total 2011 LTOs
03TA	Gay Hill Farm	9	0.0002%
11TE	Flying M Ranch	1	0.0000%
1TE2	Flying F Ranch	287	0.0059%
1TX4	Shoreline Ranch	109	0.0023%
2E3	Cluck Ranch	9	0.0002%
2TA0	Darmar Medical Emergency	142	0.0029%
30TX	Farmer's Co-Op	84	0.0017%
39XS	Palo Pinto General Hospital	142	0.0029%
3E7	Pronger Bros Ranch	9	0.0002%
3TS5	Purdy-Nielsen Memorial Airpark	78	0.0016%
49TE	Stowers Ranch	9	0.0002%
4TE0	Lone Star Steel Company	9	0.0002%
4TX9	Medical Center Hospital	142	0.0029%
54XS	Boyd Field	83	0.0017%
56TE	Cardiff Brothers	9	0.0002%

Table E-8. Airports in the 2011 Inventory that were not included in the 2017 Inventory (closed)

Airport Code	Airport	2011 LTO	Percent of Total 2011 LTOs
62TX	Barge Ranch	9	0.0002%
65TA	Flying C Ranch	56	0.0011%
79TX	Ag-Air Inc	105	0.0022%
7T3	Goliad County Industrial Airpark	61	0.0013%
83R	Glen Beicker Ranch	9	0.0002%
8TX7	Skyhaven	366	0.0076%
96TS	Nuttall	9	0.0002%
LA50	Mobil	142	0.0029%
TA92	Rowan	142	0.0029%
TE89	Verhalen	58	0.0012%
TS46	P H	142	0.0029%
TS95	Aviasud Airpark	179	0.0037%
TX04	Spohn-Alice	142	0.0029%
XS73	Double D Ranch	9	0.0002%
		Total	**0.0526%**

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
00TA	Sw Region FAA	55	0.0012%
00TE	TCJC-Northeast Campus	55	0.0012%
00TS	Alpine Range	167	0.0037%
01TA	Thirty Matlock Office Center	55	0.0012%
01TX	Mims Farm	104	0.0023%
01XA	Seton Medical Center Hays	55	0.0012%
02TE	Baylor Medical Center	55	0.0012%
04XS	Napiers	55	0.0012%
05TS	Dew Drop	116	0.0026%
06XA	J & W Windy Hill	1	0.0000%
06XS	Campbell Field	116	0.0026%
07TX	Pecks	55	0.0012%
07XS	Allen Ponderosa	55	0.0012%
08TX	Cross Wind	110	0.0024%
0TA4	Erco Field	95	0.0021%
0TE2	Bell Helicopter Hurst	55	0.0012%
0TS1	Dooley	116	0.0026%
0TS2	Ultralight Intl	224	0.0049%
0TX0	Nassau Bay	228	0.0050%
0TX1	Pecan Plantation	975	0.0214%
0TX2	Heliport-Facility 5a	55	0.0012%
0TX4	Aerospatiale Helicopter Corp	55	0.0012%
0TX5	Shiloh	123	0.0027%
0TX7	Lazy K Acres	189	0.0041%
0TX8	Jacobia Field	94	0.0021%
0TX9	Card Aerodrome	94	0.0021%
0XA0	Parkland Hospital Nr 2	55	0.0012%
0XA1	Kothmann Ranch	55	0.0012%
0XA9	Methodist Mansfield Medical Center	55	0.0012%
0XS4	Eds	55	0.0012%
0XS9	French Field	93	0.0020%
10XA	Sterling	106	0.0023%
11XA	Briar Lakes Ranch	1	0.0000%
12T	Ferris Red Oak Muni	55	0.0012%
12TS	BLO	302	0.0066%
12XA	Wood Farm Airfield	96	0.0021%
13XA	Flying 5b Ranch	92	0.0020%
13XS	Presbyterian Hospital of Rockwall	55	0.0012%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
14XA	Frog Pond	1	0.0000%
15TS	Owens Country Sausage	55	0.0012%
17TA	Heli-Dyne Systems Inc	55	0.0012%
17XA	Hunter Field	1	0.0000%
18TX	Flying 'T' Ranch	1	0.0000%
19TA	Lagrone Ranch	94	0.0021%
19TS	Kvue-Tv	55	0.0012%
19XA	Baylor Medical Center Irving	55	0.0012%
19XS	Draggintail Acres	139	0.0031%
1TS4	Eds Hangar	55	0.0012%
1TS9	Four Winds	1	0.0000%
1XS3	John Peter Smith Health Network	55	0.0012%
1XS6	Hillcrest Baptist Hospital	55	0.0012%
20TA	Mag Drop	96	0.0021%
20XA	St. Luke's Hospital at The Village	55	0.0012%
20XS	Klutts Field	144	0.0032%
22TS	Gray Steel	55	0.0012%
23TE	Texas Rgnl Medical Center	55	0.0012%
24TS	North Hills Hospital	55	0.0012%
24XS	Furst Ranch	55	0.0012%
25TE	Taylor's Air Park	104	0.0023%
26XA	Solana North	55	0.0012%
27TE	Sierra Providence Hospital	55	0.0012%
27TS	Walden Ranch	55	0.0012%
27XA	Arnett Landing	95	0.0021%
2TA2	The Medical Center of Mesquite	55	0.0012%
2TE3	Weems Farm	116	0.0026%
2TE7	Beach Ranch	98	0.0022%
2TS0	Myska Field	131	0.0029%
2TS4	Circle R Ranch	108	0.0024%
2TS6	Eagle's Nest Estates	545	0.0120%
2TS7	Jamak Fabrication	55	0.0012%
2TX8	Eagle's Landing	131	0.0029%
30XA	Emergency Room at Magnolia	55	0.0012%
31XA	Indian Falls Ranch	1	0.0000%
31XS	Fly-N-Ski	94	0.0021%
32XS	Cedar Circle	55	0.0012%
33XS	Six Mile Volunteer Fire Department	55	0.0012%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
34TA	JSI	142	0.0031%
34TX	Buckmaster	55	0.0012%
34XS	Flying Hare	108	0.0024%
35TA	Texas Health Presbyterian Hospital Plano	55	0.0012%
37TA	Texas Health Presbyterian Hospital Dallas	55	0.0012%
37TS	Skinner	1	0.0000%
38XA	Walk-Air	106	0.0023%
3T6	Clark	252	0.0055%
3TX1	Paradise Point	144	0.0032%
3TX2	Flying S Farm	131	0.0029%
3TX3	Sitton Field	131	0.0029%
3TX6	Lowell Smith Jr	1	0.0000%
3TX7	Flying P	116	0.0026%
3TX8	Drop Field	116	0.0026%
3TX9	Rafter J	104	0.0023%
3XA0	Drennan	1	0.0000%
3XA8	Chicken Strip	118	0.0026%
3XS7	Bell Training Facility	55	0.0012%
41TS	Flying T Ranch	1	0.0000%
41TX	Henington	94	0.0021%
44TA	Aero Crafter Inc	55	0.0012%
45XA	Buelah	110	0.0024%
46XA	Flying A	55	0.0012%
46XS	Windy Hill	116	0.0026%
47XA	Luv Field	121	0.0027%
48TE	4m Ranch Airfield	1	0.0000%
49TS	E D S	55	0.0012%
49XS	Mccasland Ranch	1	0.0000%
4TA1	Warschun Ranch	116	0.0026%
4TX2	Stage Coach Hills	338	0.0074%
4TX4	Birk	167	0.0037%
4TX8	Addington Field	123	0.0027%
4XA7	Baylor Health Center at Irving Coppell	55	0.0012%
4XS4	Baylor Medical Center at Carrollton	55	0.0012%
51TA	Harris Methodist Southwest Helistop	55	0.0012%
51TE	Barstool Ranch	1	0.0000%
53TE	Christus Santa Rosa Westover Hills	55	0.0012%
54TA	George P Shanks	104	0.0023%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
55TE	Lebegue LSA Landing	171	0.0037%
56TA	Dallas/Fort Worth Medical Center	55	0.0012%
57TA	Trinity Meadows Race Track	55	0.0012%
58TX	Tailspin Estates	124	0.0027%
59TX	Benjamin Franklin	111	0.0024%
59XA	Texas Farms and Ranches	55	0.0012%
5TS0	Shoreline Hospital	55	0.0012%
5TX0	Hidden Valley Airpark	565	0.0124%
5TX4	Black Mark Strip	1	0.0000%
5TX5	PSF	55	0.0012%
5TX6	Hilliard Landing Area	1	0.0000%
5XA0	Hunter's Creek	95	0.0021%
5XA6	Comanche Ridge Ranch	1	0.0000%
5XA9	Venable Airpark	1	0.0000%
60TA	Air Ranch Estates	1	0.0000%
60TS	Presbyterian Hospital of Commerce	55	0.0012%
61TE	Kezer Air Ranch	266	0.0058%
65TE	Windwood Farm	103	0.0023%
66TE	The Landings	171	0.0038%
66XS	Baylie	121	0.0027%
68TS	Bishop Field	116	0.0025%
69XA	Richey Airfield	100	0.0022%
6TA3	Culp	95	0.0021%
6TA8	Bell Helicopters Auxiliary	55	0.0012%
6TS2	Dauenhauer Field	115	0.0025%
6TS5	Eds Administration Nr 1	55	0.0012%
6TS9	MCP	55	0.0012%
6TX1	Action 5	55	0.0012%
6TX5	Baptist St Anthony's Hospital	55	0.0012%
6TX7	Flying L Airpark	104	0.0023%
6TX8	Hess	167	0.0037%
6XA0	Circle Ranch	92	0.0020%
6XA4	Zadow Air	107	0.0023%
6XS2	Luscombe Acres	161	0.0035%
6XS3	Mullins Landing	149	0.0033%
70TS	Memorial Hermann Katy Hospital	55	0.0012%
73TE	Moore Pvt	95	0.0021%
73TS	Fire Department Training Center	55	0.0012%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
75TS	Venus	125	0.0027%
76TX	Spanish Oaks	1	0.0000%
76XA	High Lonesome	1	0.0000%
77TA	Blue Skies	95	0.0021%
78TX	Baylor University Medical Center Grapevine	55	0.0012%
79TS	Tallows Field	121	0.0027%
7TS1	Cowden	55	0.0012%
7TS4	Roma	1	0.0000%
7TX3	Big Town	55	0.0012%
7TX4	Hillcrest	302	0.0066%
7XA0	West Texas VA Medical Center	55	0.0012%
7XS1	Flying E Ranch	95	0.0021%
80TE	Opela	55	0.0012%
81XA	River Falls	181	0.0040%
84TE	W4 Ranch	92	0.0020%
84XS	Lang Ranch	93	0.0020%
85TS	Aerospatiale Helicopter Corp	55	0.0012%
85XA	Windmillcreek	1	0.0000%
88TS	Fort Wolters Helicopters	55	0.0012%
8TA5	Short Stop	128	0.0028%
8TA7	Stark Field	95	0.0021%
8TS1	Retta	97	0.0021%
8TS5	Stol Field	97	0.0021%
8TX1	Medical Emergency GBC	55	0.0012%
8TX6	Harper	1	0.0000%
8TX9	North Texas Medical Center	55	0.0012%
8XA7	Yacht Club	120	0.0026%
8XS2	Ayers Field	98	0.0022%
90TA	Faulkner Point	55	0.0012%
91XA	Crosscut Field	107	0.0023%
93TX	John Peter Smith Ems Building	55	0.0012%
94TE	Barbaro North	55	0.0012%
94TS	Mc David Honda	55	0.0012%
95TE	Star	55	0.0012%
97XS	Tilghman	103	0.0023%
98TA	Weatherford Rgnl Medical Center	55	0.0012%
99TA	Peacock Willow Creek	55	0.0012%
99XS	Sam Little Intl	95	0.0021%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
9F5	TCJC-South Campus	55	0.0012%
9TA4	Placid	55	0.0012%
9TA5	Charlton-Careflite	55	0.0012%
9TE0	Twin Acres	95	0.0021%
9TS4	Ladue Ranch	55	0.0012%
9TS6	Goodlett Field	97	0.0021%
9TS8	Dallas Rehabilitation Institute	55	0.0012%
9TS9	Toyota Of Dallas Inc	55	0.0012%
9TX2	Bennetts	109	0.0024%
9TX8	Infomart	55	0.0012%
9XA4	Leger	97	0.0021%
9XS7	Reeder	91	0.0020%
E34	Smiley Johnson Muni/Bass Field	920	0.0202%
T14	Taylor	123	0.0027%
T25	Aero Estates	165	0.0036%
T33	Rives Air Park	1	0.0000%
T34	Talon Air	55	0.0012%
T37	Goldthwaite Muni	1	0.0000%
T69	Alfred C 'Bubba' Thomas	5,122	0.1124%
TA01	Phillips Farm	104	0.0023%
TA08	Flying M	144	0.0032%
TA11	TSA	1,601	0.0351%
TA16	Travis Field	91	0.0020%
TA18	Sunset	102	0.0022%
TA21	Windmill Hill	1	0.0000%
TA25	Cook Canyon Ranch	1	0.0000%
TA26	Coyote Crossing	97	0.0021%
TA37	Belo Broadcasting	55	0.0012%
TA40	Dallas City Hall	55	0.0012%
TA46	Baum	95	0.0021%
TA47	Richards	195	0.0043%
TA48	Hawk Nest	55	0.0012%
TA51	Eagle	103	0.0023%
TA54	Clear Fork Ranch	55	0.0012%
TA60	Hurn	111	0.0024%
TA69	Lupton Farms	55	0.0012%
TA71	Terrell Community Hospital	55	0.0012%
TA77	Cottonpatch Aerodrome	123	0.0027%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
TA83	Short Field	1	0.0000%
TA88	Premier Aviation Inc	55	0.0012%
TA94	Creech	55	0.0012%
TA99	Bell Helicopter Plant-3	55	0.0012%
TE02	Aresti Aerodrome	104	0.0023%
TE05	Mx Ranch	55	0.0012%
TE16	Cow Pasture	97	0.0021%
TE20	Putman	55	0.0012%
TE22	Texas Scottish Rite Hospital for Children	55	0.0012%
TE24	Horseshoe Lake	1	0.0000%
TE30	Harris Hospital	55	0.0012%
TE31	Mc David Pontiac Company	55	0.0012%
TE34	Reb Folbre's Place	138	0.0030%
TE43	Parkland Health & Hospital System	55	0.0012%
TE45	Buffalo Chips Airpark	289	0.0063%
TE50	Hirok	104	0.0023%
TE52	Chigger Field	93	0.0020%
TE56	11 Tv Dallas	55	0.0012%
TE59	Holler	55	0.0012%
TE65	NRH Fire Department	55	0.0012%
TE66	LMC	55	0.0012%
TE72	Haven Field	97	0.0021%
TE79	HIG	55	0.0012%
TE80	Medical Center Arlington	55	0.0012%
TE81	Smither Field	116	0.0026%
TE82	5-State	55	0.0012%
TE93	Staggs	55	0.0012%
TS00	Fuller	160	0.0035%
TS06	Medical City Dallas Hospital	55	0.0012%
TS11	Glenmar	108	0.0024%
TS28	Northeast Community Hospital	55	0.0012%
TS40	Celina Field	93	0.0020%
TS47	Rock Creek Ranch	1	0.0000%
TS56	Ktvt Channel 11	55	0.0012%
TS58	Denton Rgnl Medical Ctr - Flow Campus	55	0.0012%
TS60	Superturf	55	0.0012%
TS63	Square Air	142	0.0031%
TS64	Kimi	55	0.0012%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
TS70	Jack Miller	167	0.0037%
TS71	Flying B Ranch	97	0.0021%
TS72	ETMC - Gun Barrel City	55	0.0012%
TS73	Stubbs Strip	160	0.0035%
TS74	Glass	123	0.0027%
TS89	Parker	93	0.0020%
TS98	Wings Over Texas	1	0.0000%
TX06	Carrington	55	0.0012%
TX08	The Ballpark in Arlington	55	0.0012%
TX15	Beggs Ranch/Aledo/	1	0.0000%
TX16	Log Cabin	95	0.0021%
TX17	ETMC - Athens	55	0.0012%
TX18	Redmond Taylor AHP	55	0.0012%
TX22	Leroux	116	0.0026%
TX29	Flying O	118	0.0026%
TX30	H E B Hospital	55	0.0012%
TX32	Bar V K	1	0.0000%
TX33	Haire	116	0.0026%
TX34	Windy Tales	103	0.0023%
TX40	Echo Lake	151	0.0033%
TX46	Blackwood Airpark	132	0.0029%
TX50	Denton Community Hospital	55	0.0012%
TX53	Police H Port-Redbird	55	0.0012%
TX55	Southland Center	55	0.0012%
TX58	Southwest Custom Aircraft	55	0.0012%
TX59	Eds Administration Nr 2	55	0.0012%
TX60	T I Company	55	0.0012%
TX65	Beechwood	55	0.0012%
TX67	Embry Ranch	97	0.0021%
TX71	JMK Intl Inc	55	0.0012%
TX74	Thomas Flying Field	97	0.0021%
TX76	BMCG	55	0.0012%
TX77	Mallick Tower	55	0.0012%
TX78	Block Ranch	104	0.0023%
TX80	Eds Superdrome	55	0.0012%
TX83	Water Department	55	0.0012%
TX84	GMF Ranch	55	0.0012%
TX85	City of Fort Worth	55	0.0012%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
TX89	Ganze Ranch Airstrip	181	0.0040%
TX90	Flight Safety Texas	55	0.0012%
TX91	Madeira Airpark	1	0.0000%
TX95	Coppenger Farm	97	0.0021%
TX96	Maxwell Field	123	0.0027%
TX98	Hawkins Private	97	0.0021%
XA0	Prose Field	123	0.0027%
XA10	Ponderosa Field	116	0.0026%
XA11	Lake Pointe Medical Center	55	0.0012%
XA18	Baylor All Saints Medical Center	55	0.0012%
XA21	Las Colinas Medical Center	55	0.0012%
XA33	Thorny Woods	101	0.0022%
XA36	Cook Children's Medical Center	55	0.0012%
XA37	Plaza Medical Center	55	0.0012%
XA42	Connies Aviation	109	0.0024%
XA45	Weedfalls	101	0.0022%
XA53	Presbyterian Hospital of Allen	55	0.0012%
XA56	Hunt Rgnl Medical Center	55	0.0012%
XA59	Medical Center of Lewisville	55	0.0012%
XA61	Baylor University Medical Center Dallas	55	0.0012%
XA62	Methodist Dallas Medical Center	55	0.0012%
XA63	AAF	55	0.0012%
XA68	Akroville	131	0.0029%
XA69	Shelton Pvt	55	0.0012%
XA72	Stocker	116	0.0026%
XA75	Double A	111	0.0024%
XA79	Baylor Rgnl Medical Center at Plano	55	0.0012%
XA83	South Padre Island	55	0.0012%
XA86	Driftwood Ranch	124	0.0027%
XA87	Coon Creek Club	55	0.0012%
XA91	Wildwood	106	0.0023%
XS02	Tarrant County Water Control	55	0.0012%
XS06	Flying B Ranch	1	0.0000%
XS14	Weese Intl	1	0.0000%
XS19	Cedar Park Rgnl Medical Center	55	0.0012%
XS34	Skylark	97	0.0021%
XS54	Arlington Marriott Hotel	55	0.0012%
XS60	Mustang Community Airfield	116	0.0026%

Table E-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
XS62	The 88	1	0.0000%
XS78	Santiago Cattle Company	91	0.0020%
XS80	Scout	1	0.0000%
XS91	Pickle Plantation	94	0.0021%
XS96	Hillwood	55	0.0012%
XS97	Methodist Charlton Medical Center	55	0.0012%
		Total	**0.8044%**

2017 and 2020 to Previous 2017 and 2020 Comparison

ERG performed data checks comparing the 2017 and 2020 inventories, similar to the checks comparing the 2011 inventory using AEDT and revised generic emission factors, and the 2011 inventory using EDMS and the previous generic emission factors. Table E-10 summarizes the counties with an absolute difference of 1000% percent or greater, comparing the new 2017 inventory created using AEDT and EPA's revised generic emission factors (from the 2017 trend inventory based on 2014 activity data) with that based on the prior EDMS model and the EPA's older emission factors. Similar to 2011, there were some emissions with large differences. ERG then evaluated the data at the airport level within those counties to identify where the underlying issues were. These airports are summarized in Table E-11. For 2017 some of these differences were clearly caused by the differences in LTO data.

> **Since the 2017 trend inventory was based on 2014 data projected to 2017 instead of actual 2017 data, the LTO and projection data used in these different approaches appeared to be correct and were correctly applied, therefore no changes were required based on this QA check.**

The data from Table E-11 showed that the LTO data matched although the emissions were significantly higher in the new 2017 inventory, as expected due to the differences in models and emission factors.

> **Therefore, no changes were required based on this QA check.**

In reviewing the data, ERG first confirmed the LTO values were correct, noting that the LTOs only increased from 4,305 to 13,300, a difference of only about 9,000 LTOs. In other cases, the emission differences were entirely due to LTO changes between 2014 and 2017 (for example see John R Armstrong Airport). If there was a large LTO change, ERG went back to the original data to ensure there were no transcription errors. ERG then checked with airports having significant changes in LTOs, verifying that the original source data was consistent with those changes.

> **For these reasons no changes were required based on this QA check.**

ERG then reviewed the data at the airport and SCC level, summarized in Table E-12. ERG confirmed the changes in emissions were due to generic military activity and the revised generic military emission factors. ERG also confirmed that in all the cases the military data with high emission differences were due to generic activity.

> **Therefore, no changes were required based on this QA check.**

Some of the variance in activity identified when comparing the 2014 and the 2017 inventories can also be attributed to the repeal of the Wright Amendment in October 2014. This amendment limited airport destinations in the Dallas/Fort Worth area (e.g., Love Field and Meacham Airports). Once the amendment was repealed, activity at Love Field and Mecham increased while activity decreased at Dallas/Fort Worth. Also, there was a decline in activity at smaller airports outside the Dallas/Fort Worth area (e.g., El Paso, Austin and Houston) where flights were being directed to when the amendment was enforced. These airports were no longer needed as a hub prior to leaving the state once the amendment was repealed.

Additionally, it was noted that for some airports the total LTOs were similar between years but shifted between SCCs. These can be seen in Table E-13. This is not unusual as specific aircraft can be used in general aviation, air taxis or commercial operations; for example, a Cessna Citation M2 may be privately owned as a general aviation aircraft or it may be owned by a business providing air taxi services, and if these services are regularly scheduled it may be considered a small commercial aircraft. It is often up to the airport to make these subjective determinations about which category the aircraft falls into as they are more likely to know how the aircraft is being used. The subjective aspect of assigning SCCs would explain why the LTOs can remain relatively consistent while the SCC assignments can vary. For aircraft specific data where the EPA updated their SCC assignments, ERG included these recent EPA changes in these inventories, which also accounted for some of the identified differences.

For these reasons, no changes were required based on this QA check.

The aircraft counts in the AEDT input and output files were also compared to confirm that all aircraft were successfully imported into AEDT, as summarized in Table E-14.

No changes were required based on this QA check.

Table E-10. Counties with The Highest Absolute Percent Changes in Emissions

County	2017 NO_x Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_x Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	111.89	0.31	36,332	13,303	4,308	209
Karnes	19.23	0.08	22,751	3,083	1,289	139
Victoria	264.02	2.38	11,009	32,018	30,422	5
Culberson	1.13	0.02	5,106	413	360	15
Wichita	553.26	10.90	4,974	80,887	75,066	8
Aransas	129.28	3.02	4,181	24,100	41,207	-42
Reeves	36.75	0.96	3,746	11,913	10,864	10
Angelina	23.86	0.66	3,540	29,500	9,541	209
Walker	24.16	0.80	2,934	14,956	10,846	38
Calhoun	8.77	0.36	2,359	6,375	5,004	27
Atascosa	6.35	0.26	2,358	4,882	3,375	45
La Salle	12.87	0.53	2,328	5,818	6,346	-8
Guadalupe	35.37	1.80	1,866	32,750	24,880	32
Matagorda	9.11	0.59	1,440	10,546	8,411	25
Howard	7.03	0.46	1,414	11,815	6,649	78
Coryell	2.18	0.16	1,294	7,609	2,351	224

Table E-10. Counties with The Highest Absolute Percent Changes in Emissions

County	2017 NO_x Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_x Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Nueces	380.64	30.55	1,146	58,159	39,755	46
McLennan	142.09	12.05	1,079	98,449	67,109	47

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission.

Table E-11. Airports with the Highest Absolute Percent Changes in Emissions Within the Previously Identified Counties

County	Airport	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Absolute Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Nueces	John R. Armstrong Memorial Field	0.02	0.000033	55,225	267	1	26,098
Jim Wells	Alice Intl	111.89	0.31	36,343	13,300	4,305	209
Karnes	Karnes County	19.22	0.07	26,580	2,836	1,050	170
Victoria	Victoria Rgnl	263.49	2.19	11,934	29,208	28,136	4
Matagorda	Palacios Muni	8.34	0.11	7,549	3,530	1,480	139
Culberson	Culberson County	1.13	0.02	6,108	300	250	20
Wichita	Sheppard AFB/Wichita Falls Muni	545.62	9.36	5,731	51,526	52,931	-3
Aransas	Aransas Co	129.27	3.02	4,185	24,000	41,110	-42
McLennan	Tstc Waco	84.01	2.05	3,995	49,256	28,878	71
Calhoun	Calhoun County	8.62	0.22	3,883	4,350	3,041	43
Reeves	Pecos Muni	36.74	0.95	3,759	11,800	10,755	10
Angelina	Angelina County	23.84	0.64	3,642	29,200	9,250	216
Walker	Huntsville Muni	24.15	0.79	2,967	14,807	10,701	38
Atascosa	Pleasanton Muni	6.34	0.25	2,474	4,640	3,140	48
La Salle	Cotulla-La Salle County	12.86	0.52	2,367	5,539	6,075	-9
Guadalupe	New Braunfels Muni	35.03	1.47	2,277	27,149	19,459	40
Howard	Big Spring Mc Mahon-Wrinkle	7.02	0.46	1,432	11,760	6,596	78
Coryell	Gatesville Muni	2.17	0.14	1,406	7,350	2,100	250
Nueces	Corpus Christi Intl	379.97	29.89	1,171	48,506	30,259	60

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and previous EPA generic emission factors.

Table E-12. SCCs With the Highest Absolute Percent Change in Emissions Within the Previously Identified Airport/County Combinations

County	Airport	SCC**	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	Alice Intl	2275001000	111.67	0.08	141,250	10,000	1,000	900
Angelina	Angelina County	2275001000	21.27	0.02	107,571	1,904	250	662
Guadalupe	New Braunfels Muni	2275001000	33.24	0.09	34,974	2,977	1,200	148
Nueces	Corpus Christi Intl	2275001000	358.33	1.12	31,936	32,089	14,158	127
McLennan	Tstc Waco	2275001000	81.10	0.42	19,212	7,263	5,316	37
Nueces	John R. Armstrong Memorial Field	2275050011	0.01	0.00	18,781	192	1	18,781
Victoria	Victoria Rgnl	2275001000	262.95	1.67	15,625	23,548	21,166	11
Reeves	Pecos Muni	2275001000	35.93	0.23	15,448	3,218	2,925	10
La Salle	Cotulla-La Salle County	2275001000	12.28	0.08	15,448	1,100	1,000	10
Atascosa	Pleasanton Muni	2275001000	6.03	0.04	14,035	540	540	0
Calhoun	Calhoun County	2275001000	8.37	0.06	14,035	750	750	0
Howard	Big Spring Mc Mahon-Wrinkle	2275001000	6.25	0.04	14,035	560	560	0
Matagorda	Palacios Muni	2275001000	8.15	0.06	14,035	730	730	0
Culberson	Culberson County	2275001000	1.12	0.01	14,035	100	100	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	545.44	3.86	14,035	48,846	48,846	0
Walker	Huntsville Muni	2275001000	23.24	0.16	14,032	2,082	2,082	0
Aransas	Aransas Co	2275001000	128.42	1.28	9,903	11,500	16,250	-29

* High percent change due to updates to Military EF update

**Military LTOs were all generic

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Dallas/Fort Worth Intl	2275050012	6.26	0.92	583	8,482	795	967
Tarrant	Dallas/Fort Worth Intl	2275020000	4,491.64	3,577.72	26	287,772	354,184	-19
Tarrant	Dallas/Fort Worth Intl	2275060012	155.69	2.04	7,521	30,897	8,206	277
Harris	George Bush Intercontinental/Houston	2275050012	0.40	2.39	-83	1,778	2,502	-29
Harris	George Bush Intercontinental/Houston	2275020000	2,010.35	1,485.23	35	165,570	206,746	-20
Harris	George Bush Intercontinental/Houston	2275060011	0.90	0.02	5,189	11,434	1,063	976
Harris	George Bush Intercontinental/Houston	2275060012	200.19	188.07	6	88,193	90,915	-3
Harris	George Bush Intercontinental/Houston	2275050011	0.14	0.01	1,464	4,238	502	744
Harris	George Bush Intercontinental/Houston	2275001000	2.59	0.71	266	236	847	-72
Dallas	Dallas Love Field	2275060011	0.24	1.07	-77	3,079	6,115	-50
Dallas	Dallas Love Field	2275020000	661.37	439.63	50	69,693	55,306	26
Dallas	Dallas Love Field	2275050011	0.69	0.12	488	21,293	1,295	1,545
Dallas	Dallas Love Field	2275060012	3.99	14.25	-72	10,232	11,616	-12
Dallas	Dallas Love Field	2275050012	1.94	30.62	-94	9,100	19,394	-53
Dallas	Dallas Love Field	2275001000	6.06	0.97	526	543	2,172	-75
Harris	William P Hobby	2275001000	5.45	0.11	4,967	489	1,575	-69
Harris	William P Hobby	2275020000	505.28	529.75	-5	59,171	84,375	-30
Harris	William P Hobby	2275050011	0.68	0.05	1,296	20,954	694	2,921

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Harris	William P Hobby	2275060011	0.22	0.01	2,091	2,770	901	207
Harris	William P Hobby	2275060012	4.97	20.24	-75	9,929	17,964	-45
Harris	William P Hobby	2275050012	1.71	12.14	-86	8,540	15,342	-44
Travis	Austin-Bergstrom Intl	2275060011	0.00	0.55	-100	2	7,457	-100
Travis	Austin-Bergstrom Intl	2275001000	0.08	0.08	-7	90	68	32
Travis	Austin-Bergstrom Intl	2275020000	648.50	745.94	-13	63,306	85,937	-26
Travis	Austin-Bergstrom Intl	2275050011	0.21	0.07	185	7,515	1,627	362
Travis	Austin-Bergstrom Intl	2275060012	1.36	9.76	-86	597	13,203	-95
Travis	Austin-Bergstrom Intl	2275050012	30.97	12.00	158	21,851	13,911	57
Denton	Northwest Rgnl	2275050011	2.90	2.80	3	89,146	86,262	3
Denton	Northwest Rgnl	2275060011	0.01	0.01	-41	73	123	-41
Denton	Northwest Rgnl	2275050012	0.09	0.09	3	572	553	3
Denton	Northwest Rgnl	2275060012	0.10	0.17	-40	260	436	-40
Tarrant	Fort Worth Meacham Intl	2275050011	1.76	1.07	65	54,082	32,832	65
Tarrant	Fort Worth Meacham Intl	2275050012	3.41	2.06	65	20,929	12,708	65
Tarrant	Fort Worth Meacham Intl	2275060012	1.73	1.53	13	4,469	3,949	13
Tarrant	Fort Worth Meacham Intl***	2275001000	7.96	0.03	30,451	713	330	116
Tarrant	Fort Worth Meacham Intl	2275060011	0.10	0.09	13	1,245	1,101	13
Tarrant	Fort Worth Meacham Intl	2275020000	0.93	0.27	239	96	30	223
Bexar	San Antonio Intl	2275050012	1.12	10.22	-89	6,516	10,748	-39

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO$_X$ Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO$_X$ Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Bexar	San Antonio Intl	2275020000	570.76	531.01	7	44,689	52,295	-15
Bexar	San Antonio Intl	2275060012	3.72	16.65	-78	8,075	13,152	-39
Bexar	San Antonio Intl	2275060011	0.17	0.57	-69	2,203	4,771	-54
Bexar	San Antonio Intl	2275050011	0.55	0.07	667	16,822	1,214	1,285
Bexar	San Antonio Intl	2275001000	26.96	1.07	2,423	2,416	665	263
Collin	Collin County Rgnl At Mc Kinney	2275060012	0.48	0.23	106	1,227	595	106
Collin	Collin County Rgnl At Mc Kinney	2275050011	1.56	0.34	353	47,973	10,586	353
Collin	Collin County Rgnl At Mc Kinney***	2275001000	0.25	0.00	19,567	23	16	39
Collin	Collin County Rgnl At Mc Kinney	2275050012	3.00	6.15	-51	18,564	37,974	-51
Collin	Collin County Rgnl At Mc Kinney	2275060011	0.03	0.01	106	342	166	106
Potter	Rick Husb+ Amarillo Intl	2275050012	1.10	0.47	131	6,617	2,926	126
Potter	Rick Husb+ Amarillo Intl	2275020000	43.37	33.49	30	7,264	7,252	0
Potter	Rick Husb+ Amarillo Intl	2275050011	0.56	0.25	126	17,087	7,556	126
Potter	Rick Husb+ Amarillo Intl	2275060011	0.11	0.10	19	1,433	1,203	19
Potter	Rick Husb+ Amarillo Intl	2275060012	15.04	1.67	798	8,816	4,319	104
Potter	Rick Husb+ Amarillo Intl***	2275001000	275.54	0.88	31,220	24,675	11,136	122
Denton	Denton Muni***	2275001000	1.17	0.01	12,271	105	120	-12
Denton	Denton Muni	2275060011	0.02	0.02	-2	215	219	-2
Denton	Denton Muni	2275050012	2.83	10.16	-72	17,490	62,746	-72
Denton	Denton Muni	2275050011	1.47	0.57	158	45,199	17,491	158

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Denton	Denton Muni	2275020000	0.11	0.17	-34	11	18	-37
Denton	Denton Muni	2275060012	0.30	0.31	-3	767	787	-3
Tarrant	Fort Worth Alliance	2275050012	2.02	2.04	-1	12,210	12,596	-3
Tarrant	Fort Worth Alliance***	2275001000	68.88	0.68	10,073	6,169	8,571	-28
Tarrant	Fort Worth Alliance	2275020000	233.61	70.31	232	4,871	2,945	65
Tarrant	Fort Worth Alliance	2275050011	1.03	1.06	-3	31,552	32,545	-3
Tarrant	Fort Worth Alliance	2275060012	0.74	2.38	-69	1,055	2,638	-60
Harris	David Wayne Hooks Memorial	2275020000	0.02	0.02	-2	2	2	-2
Harris	David Wayne Hooks Memorial	2275050012	2.46	3.73	-34	14,647	23,073	-37
Harris	David Wayne Hooks Memorial	2275050011	1.22	1.94	-37	37,607	59,624	-37
Harris	David Wayne Hooks Memorial	2275001000	8.19	0.11	7,581	734	1,350	-46
Harris	David Wayne Hooks Memorial	2275060012	0.52	0.71	-27	1,340	1,829	-27
Harris	David Wayne Hooks Memorial	2275060011	0.03	0.04	-22	399	510	-22
El Paso	El Paso Intl	2275050011	0.40	0.50	-20	12,173	15,284	-20
El Paso	El Paso Intl	2275060011	0.13	0.18	-30	1,490	2,283	-35
El Paso	El Paso Intl	2275020000	187.26	202.23	-7	17,272	21,326	-19
El Paso	El Paso Intl	2275050012	0.82	1.00	-18	4,712	5,955	-21
El Paso	El Paso Intl***	2275001000	117.10	0.30	39,025	10,487	3,730	181
El Paso	El Paso Intl	2275060012	8.70	3.25	168	7,339	8,459	-13
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	545.44	3.86	14,035	48,846	48,846	0

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Wichita	Sheppard AFB/Wichita Falls Muni	2275050012	0.12	0.12	0	748	748	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275020000	0.34	5.32	-94	30	1,405	-98
Wichita	Sheppard AFB/Wichita Falls Muni	2275050011	0.06	0.06	0	1,932	1,932	0
Harris	West Houston	2275060012	0.15	0.16	-4	391	408	-4
Harris	West Houston	2275050012	2.34	2.47	-6	14,434	15,278	-6
Harris	West Houston	2275060011	0.01	0.01	-4	109	114	-4
Harris	West Houston	2275050011	1.21	1.28	-6	37,301	39,483	-6
Williamson	Georgetown Muni	2275060012	0.14	0.09	66	365	220	66
Williamson	Georgetown Muni	2275060011	0.01	0.00	65	102	62	65
Williamson	Georgetown Muni	2275050011	1.21	0.27	354	37,131	8,174	354
Williamson	Georgetown Muni	2275050012	2.33	4.75	-51	14,368	29,322	-51
Williamson	Georgetown Muni	2275001000	2.57	0.01	34,981	231	93	148
Bexar	Stinson Muni	2275001000	47.97	0.40	11,834	4,296	5,088	-16
Bexar	Stinson Muni	2275020000	0.02	0.01	97	2	1	97
Bexar	Stinson Muni	2275060011	0.03	0.03	-15	371	436	-15
Bexar	Stinson Muni	2275060012	0.52	0.61	-15	1,330	1,564	-15
Bexar	Stinson Muni	2275050011	1.04	0.85	23	32,012	26,118	23
Bexar	Stinson Muni	2275050012	2.01	1.64	23	12,387	10,107	23
Dallas	Addison	2275060012	1.09	1.35	-19	2,805	3,480	-19
Dallas	Addison	2275001000	1.80	0.01	12,312	161	183	-12

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Dallas	Addison	2275060011	0.06	0.08	-19	782	970	-19
Dallas	Addison	2275050012	2.09	1.97	6	12,824	12,199	5
Dallas	Addison	2275020000	0.49	1.12	-56	51	112	-54
Dallas	Addison	2275050011	1.08	1.02	5	33,139	31,525	5
McLennan	TSTC Waco	2275060012	0.01	0.01	16	21	18	16
McLennan	TSTC Waco	2275020000	0.02	0.01	99	2	1	99
McLennan	TSTC Waco	2275060011	0.00	0.00	17	6	5	17
McLennan	TSTC Waco	2275050011	0.98	0.55	78	30,256	16,971	78
McLennan	TSTC Waco	2275001000	81.10	0.42	19,212	7,263	5,316	37
McLennan	TSTC Waco	2275050012	1.90	1.06	78	11,708	6,567	78
Nueces	Corpus Christi Intl	2275001000	358.33	1.12	31,936	32,089	14,158	127
Nueces	Corpus Christi Intl	2275050012	0.40	0.84	-52	2,491	5,160	-52
Nueces	Corpus Christi Intl	2275020000	16.38	26.36	-38	2,930	4,732	-38
Nueces	Corpus Christi Intl	2275050011	0.21	0.05	347	6,436	1,439	347
Nueces	Corpus Christi Intl	2275060011	0.06	0.08	-22	809	1,040	-22
Nueces	Corpus Christi Intl	2275060012	4.58	1.45	217	3,750	3,732	1
Medina	Hondo Muni	2275050012	2.17	2.25	-4	13,376	13,883	-4
Medina	Hondo Muni	2275050011	1.12	1.17	-4	34,567	35,877	-4
Webb	Laredo Intl	2275020000	60.13	43.76	37	2,886	5,992	-52
Webb	Laredo Intl****	2275001000	201.74	0.22	91,435	18,070	2,519	617

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Webb	Laredo Intl	2275050011	0.48	0.02	2,346	14,622	598	2,346
Webb	Laredo Intl	2275050012	1.06	0.36	198	5,658	2,153	163
Webb	Laredo Intl	2275060011	0.08	0.01	1,004	1,004	92	995
Webb	Laredo Intl	2275060012	8.52	0.13	6,561	5,544	333	1,567
Harris	Ellington Field	2275001000	137.16	9.15	1,398	12,283	13,567	-9
Harris	Ellington Field	2275060012	1.30	7.11	-82	3,330	16,546	-80
Harris	Ellington Field	2275020000	9.40	19.84	-53	997	7,582	-87
Harris	Ellington Field	2275060011	0.07	0.08	-9	928	7,268	-87
Harris	Ellington Field	2275050011	0.68	0.05	1,210	20,809	2,357	783
Harris	Ellington Field	2275050012	1.30	4.05	-68	8,052	6,283	28
Tarrant	Gr+ Prairie Muni***	2275001000	21.22	0.24	8,658	1,900	3,066	-38
Tarrant	Gr+ Prairie Muni	2275060012	0.03	0.01	106	73	35	106
Tarrant	Gr+ Prairie Muni	2275050011	1.02	0.74	38	31,401	22,820	38

Table E-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Gr+ Prairie Muni	2275050012	1.97	1.43	38	12,151	8,831	38
Tarrant	Gr+ Prairie Muni	2275060011	0.00	0.00	101	20	10	101
		Total	**11,871.77**	**8,137.52**	**46**	**2,063,504**	**2,040,522**	**1**

*Airports with total aircraft LTO's greater than 45,000

** High percent change due to updates to Military EF update

***Military LTOs were all

****There were some specific differences, but the majority were generic military LTOs.

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table E-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Aerostar PA-60	2	2	0
Agusta A-109	2	2	0
Air Tractor 802	1	1	0
Air Tractor AT-502	1	1	0
Air Tractor AT-502B	1	1	0
Air Tractor AT-602	1	1	0
Airbus A300B2-100 Series	1	1	0
Airbus A300B2-200 Series	1	1	0
Airbus A300B4-600 Series	2	2	0
Airbus A300F4-600 Series	8	8	0
Airbus A310-200 Series	6	6	0
Airbus A310-300 Series	1	1	0
Airbus A319-100 Series	14	14	0
Airbus A320-100 Series	1	1	0
Airbus A320-200 Series	13	13	0
Airbus A321-100 Series	10	10	0
Airbus A321-200 Series	1	1	0
Airbus A330-200 Series	2	2	0
Airbus A330-200 Series Freighter	1	1	0
Airbus A330-300 Series	3	3	0
Airbus A340-200 Series	1	1	0
Airbus A350-800 Series	1	1	0
Airbus A350-900 series	1	1	0
Airbus A380-800 Series/Trent 970	2	2	0
Antonov 12 Cub	1	1	0
Antonov 124 Ruslan	3	3	0
Antonov AN28 Cash	1	1	0
ATR 42-200	4	4	0
ATR 42-320	1	1	0
ATR 72-200	4	4	0
Aviat Husky A1B	2	2	0
Ayres S2R-T34 Turbo-Thrush	1	1	0
BAE Jetstream 31	4	4	0
BAE Jetstream 32	1	1	0
BAE Jetstream 32-EP	1	1	0
BAE Jetstream 41	4	4	0
Bell 206 JetRanger	2	2	0
Bell 407 / Rolls-Royce 250-C47B	2	2	0

Table E-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Bell UH-1 Iroquois	1	1	0
Boeing 717-200 Series	5	5	0
Boeing 727-100 Series	1	1	0
Boeing 727-200 Series	13	13	0
Boeing 737-100 Series	12	12	0
Boeing 737-200 Series	1	1	0
Boeing 737-300 Series	16	16	0
Boeing 737-300 Series Freighter	1	1	0
Boeing 737-400 Series	22	22	0
Boeing 737-400 Series Freighter	1	1	0
Boeing 737-500 Series	2	2	0
Boeing 737-600 Series	2	2	0
Boeing 737-700 Series	20	20	0
Boeing 737-800 Series	23	23	0
Boeing 737-800 with winglets	1	1	0
Boeing 737-900 Series	15	15	0
Boeing 737-900-ER	6	6	0
Boeing 747-200 Series	13	13	0
Boeing 747-400 Series	4	4	0
Boeing 747-400 Series Freighter	3	3	0
Boeing 747-800 Freighter	3	3	0
Boeing 757-200 Series	1	1	0
Boeing 757-200 Series Freighter	1	1	0
Boeing 757-300 Series	3	3	0
Boeing 767-200 ER	10	10	0
Boeing 767-200 Series	1	1	0
Boeing 767-300 ER	12	12	0
Boeing 767-300 ER Freighter	1	1	0
Boeing 767-400 ER	4	4	0
Boeing 777-200 Series	6	6	0
Boeing 777-200-LR	2	2	0
Boeing 777-300 ER	2	2	0
Boeing 777-300 Series	1	1	0
Boeing 787-900 Dreamliner	5	5	0
Boeing DC-10-10 Series	6	6	0
Boeing DC-10-30 Series	5	5	0
Boeing DC-10-40 Series	1	1	0
Boeing DC-6	1	1	0

Table E-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Boeing DC-8 Series 60	2	2	0
Boeing DC-9-10 Series	1	1	0
Boeing DC-9-20 Series	17	17	0
Boeing DC-9-30 Series	12	12	0
Boeing F/A-18 Hornet	1	1	0
Boeing MD-11	5	5	0
Boeing MD-11-ER	1	1	0
Boeing MD-82	23	23	0
Boeing MD-83	1	1	0
Boeing MD-88	3	3	0
Boeing MD-90	6	6	0
Bombardier Challenger 300	16	16	0
Bombardier Challenger 600	3	3	0
Bombardier Challenger 601	3	3	0
Bombardier Challenger 604	5	5	0
Bombardier CL-415	1	1	0
Bombardier CRJ-200	19	19	0
Bombardier CRJ-700	24	24	0
Bombardier CRJ-900	16	16	0
Bombardier Global Express	17	17	0
Bombardier Learjet 24	1	1	0
Bombardier Learjet 25	1	1	0
Bombardier Learjet 31	3	3	0
Bombardier Learjet 35	2	2	0
Bombardier Learjet 40	2	2	0
Bombardier Learjet 45	3	3	0
Bombardier Learjet 55	2	2	0
Bombardier Learjet 60	3	3	0
CASA 295	1	1	0
CASA CN-235-100	1	1	0
Cessna 150 Series	3	3	0
Cessna 172 Skyhawk	9	9	0
Cessna 182	3	3	0
Cessna 206	2	2	0
Cessna 208 Caravan	13	13	0
Cessna 210 Centurion	4	4	0
Cessna 310	2	2	0
Cessna 337 Skymaster	2	2	0

Table E-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Cessna 340	2	2	0
Cessna 402	1	1	0
Cessna 414	3	3	0
Cessna 421 Golden Eagle	2	2	0
Cessna 425 Conquest I	2	2	0
Cessna 441 Conquest II	1	1	0
Cessna 500 Citation I	2	2	0
Cessna 501 Citation ISP	8	8	0
Cessna 525 CitationJet	3	3	0
Cessna 525A CitationJet	1	1	0
Cessna 525B CitationJet	1	1	0
Cessna 525C CitationJet	1	1	0
Cessna 550 Citation II	2	2	0
Cessna 560 Citation Excel	4	4	0
Cessna 560 Citation V	1	1	0
Cessna 560 Citation XLS	1	1	0
Cessna 650 Citation III	6	6	0
Cessna 680 Citation Sovereign	3	3	0
Cessna 750 Citation X	4	4	0
Cirrus SR20	2	2	0
Cirrus SR22	3	3	0
Convair CV-440	10	10	0
Convair CV-580	1	1	0
Dassault Falcon 10	15	15	0
Dassault Falcon 200	1	1	0
Dassault Falcon 2000	2	2	0
Dassault Falcon 2000-EX	5	5	0
Dassault Falcon 50	3	3	0
Dassault Falcon 900	1	1	0
Dassault Falcon 900-EX	1	1	0
DeHavilland DHC-2 Mk III Beaver	1	1	0
DeHavilland DHC-3 Otter	1	1	0
DeHavilland DHC-6-100 Twin Otter	1	1	0
Dornier 228-100 Series	1	1	0
Dornier 328 Jet	1	1	0
EADS Socata TB-10 Tobago	1	1	0
EADS Socata TB-20 Trinidad	1	1	0
EADS Socata TBM-700	2	2	0

Table E-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Eclipse 500 / PW610F	2	2	0
Embraer 500	3	3	0
Embraer 505	2	2	0
Embraer EMB120 Brasilia	6	6	0
Embraer ERJ135	13	13	0
Embraer ERJ135 Legacy Business	1	1	0
Embraer ERJ135-ER	1	1	0
Embraer ERJ135-LR	1	1	0
Embraer ERJ140	19	19	0
Embraer ERJ145	24	24	0
Embraer ERJ145-EU	1	1	0
Embraer ERJ145-LR	1	1	0
Embraer ERJ145-XR	1	1	0
Embraer ERJ170	11	11	0
Embraer ERJ175	24	24	0
Embraer ERJ175-LR	1	1	0
Embraer ERJ190	4	4	0
Embraer ERJ195	1	1	0
Fairchild SA-226-T Merlin III	1	1	0
Fairchild SA-226-TC Metro II	1	1	0
Fairchild SA-227-AC Metro III	1	1	0
Fairchild SA-26-T Merlin II	1	1	0
Falcon 7X	5	5	0
Grumman A-6 Intruder	1	1	0
Grumman G-21G Goose	1	1	0
Grumman G-73 Mallard	1	1	0
Gulfstream G100	1	1	0
Gulfstream G150	8	8	0
Gulfstream G200	7	7	0
Gulfstream G280	1	1	0
Gulfstream G300	1	1	0
Gulfstream G350	1	1	0
Gulfstream G400	1	1	0
Gulfstream G450	3	3	0
Gulfstream G550	7	7	0
Gulfstream I	1	1	0
Gulfstream II	1	1	0
Gulfstream II-B	1	1	0

Table E-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Gulfstream IV-SP	1	1	0
Gulfstream V-SP	1	1	0
Hawker HS-125 Series 1	3	3	0
Hawker HS-125 Series 400	1	1	0
Hawker HS-125 Series 600	1	1	0
Hughes 500D	2	2	0
Ilyushin 76 Candid	2	2	0
Israel IAI-1124 Westwind I	1	1	0
Israel IAI-1124-A Westwind II	2	2	0
Israel IAI-1125 Astra	1	1	0
Lancair 360	1	1	0
Let 410	1	1	0
Lockheed C-130 Hercules	2	2	0
Lockheed C-141 Starlifter	1	1	0
Lockheed P-3 Orion ANP:P3A	1	1	0
Maule MT-7-235	2	2	0
Mitsubishi MU-2	3	3	0
Mitsubishi MU-300 Diamond	1	1	0
Mooney M20-K	3	3	0
MRJ90	1	1	0
Partenavia P.68 Victor	1	1	0
Piaggio P.180 Avanti	2	2	0
Pilatus PC-12	7	7	0
Pilatus PC-6 Porter	1	1	0
Pilatus Turbo Trainer PC-9	1	1	0
Piper PA-23 Apache/Aztec	3	3	0
Piper PA-24 Comanche	3	3	0
Piper PA-28 Cherokee Series	7	7	0
Piper PA-30 Twin Comanche	1	1	0
Piper PA-31 Navajo	1	1	0
Piper PA-31T Cheyenne	2	2	0
Piper PA-32 Cherokee Six	2	2	0
Piper PA-34 Seneca	3	3	0
Piper PA-42 Cheyenne Series	1	1	0
Piper PA46-TP Meridian	4	4	0
Raytheon Beech 18	5	5	0
Raytheon Beech 1900-C	2	2	0
Raytheon Beech 1900-D	1	1	0

Table E-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Raytheon Beech 55 Baron	3	3	0
Raytheon Beech 60 Duke	1	1	0
Raytheon Beech 99	1	1	0
Raytheon Beech Baron 58	1	1	0
Raytheon Beech Bonanza 36	3	3	0
Raytheon Beechjet 400	3	3	0
Raytheon Hawker 800	8	8	0
Raytheon King Air 100	1	1	0
Raytheon King Air 90	4	4	0
Raytheon Premier I	2	2	0
Raytheon Super King Air 200	9	9	0
Raytheon Super King Air 300	6	6	0
Robinson R22	3	3	0
Robinson R44 Raven / Lycoming O-540-F1B5	1	1	0
Rockwell 1121 Jet Commander	1	1	0
Rockwell 1121B Jet Commander-B	1	1	0
Rockwell Commander 500	1	1	0
Rockwell Commander 690	1	1	0
Rockwell Sabreliner 40	1	1	0
Rockwell Sabreliner 65	1	1	0
Saab 2000	1	1	0
Shorts 330	1	1	0
Sikorsky CH-53 Sea Stallion	2	2	0
Sikorsky S-76 Spirit	1	1	0
Sikorsky UH-60 Black Hawk	1	1	0
SOCATA TBM 850	1	1	0
T-38 Talon	1	1	0

After the controlled inventory was developed by applying the airport level APU and GSE control strategies to the uncontrolled inventory, ERG compared the two inventories to confirm the control strategies were incorporated correctly. Table E-15 shows the difference in NO_X emissions between the controlled and uncontrolled 2017 inventories.

No changes were required based on this QA check as the differences between the uncontrolled and controlled estimates reflected an expected decline in emissions.

Table E-15. Comparison of Controlled and Uncontrolled 2017 Emissions

Airport	Uncontrolled 2017 NO_X Emissions (tons)	Controlled 2017 NO_X Emissions (tons)	Percent Change (%)
Abilene Rgnl	114.95	114.79	-0.14
Austin-Bergstrom Intl	731.96	730.92	-0.14
Corpus Christi Intl	381.53	380.70	-0.22
Curtis Field	1.03	0.99	-4.03
El Paso Intl	326.29	321.10	-1.59
George Bush Intercontinental/Houston	2,336.08	2,279.82	-2.41
Lubbock Preston Smith Intl	125.77	124.01	-1.40
Rick Husband Amarillo Intl	340.33	338.14	-0.64
San Angelo Rgnl/Mathis Field	7.70	7.33	-4.77
San Antonio Intl	634.50	620.77	-2.17
Valley Intl	225.23	222.25	-1.33
William P Hobby	561.04	543.25	-3.17
		Average	**-1.83**

ERG performed the same comparison checks for 2020 as was done for 2017. The new 2020 statewide inventory (projected from the new 2017 baseline inventories) was compared to the previous 2020 inventory (developed from the Trend Analysis using the 2014 as the baseline). As expected, Tables E-16 to E-19 show differences/trends that are very similar to those seen in Tables E-10 to E-13. The small differences are due to the fact that the previous and recently projected 2020 inventories used factors based on the TAF data which have been updated since the 2014 inventory. ERG also confirmed that the aircraft used in the 2020 inventories matched the original aircraft used in the 2017 baseline as noted in Table E-20. Table E-21 shows the difference in NO_X emissions between the controlled and uncontrolled 2020 inventories, similar to Table E-15 for 2017.

No changes were required based on this QA check.

Table E-16. Counties with the Highest Absolute Percent Changes in Emissions

County	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	111.89	0.31	36,331	13,303	4,308	209
Karnes	19.23	0.08	22,690	3,089	1,294	139
Victoria	264.03	2.39	10,966	31,957	30,540	5
Culberson	1.13	0.02	5,091	416	362	15
Wichita	552.44	10.92	4,960	80,959	75,272	8
Aransas	129.28	3.02	4,181	24,102	41,209	-42
Reeves	36.75	0.96	3,745	11,916	10,866	10
Angelina	23.86	0.66	3,539	29,507	9,547	209
Walker	24.16	0.80	2,933	14,960	10,848	38
Atascosa	6.35	0.26	2,356	4,888	3,380	45
La Salle	12.87	0.53	2,327	5,825	6,351	-8
Calhoun	8.77	0.36	2,322	6,425	5,084	26
Guadalupe	35.61	1.83	1,845	36,353	25,322	44
Matagorda	9.11	0.60	1,432	10,611	8,459	25
Howard	7.03	0.46	1,413	11,816	6,650	78
Coryell	2.18	0.16	1,292	7,615	2,355	223
Nueces	382.57	31.09	1,130	57,961	40,471	43
McLennan	142.56	12.30	1,059	101,910	68,799	48

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors.

Table E-17. Airports with the Highest Absolute Percent Changes in Emissions Within the Previously Identified Counties.

County	Airport	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Nueces	John R. Armstrong Memorial Field	0.02	0.000034	55,632	274	1	26,346
Jim Wells	Alice Intl	111.89	0.31	36,343	13,300	4,305	209
Karnes	Karnes County	19.22	0.07	26,580	2,836	1,050	170
Victoria	Victoria Rgnl	263.83	2.20	11,917	29,537	28,210	5
Matagorda	Palacios Muni	8.34	0.11	7,549	3,530	1,480	139
Culberson	Culberson County	1.13	0.02	6,108	300	250	20
Wichita	Sheppard AFB/Wichita Falls Muni	549.62	9.36	5,773	52,407	52,931	-1
Aransas	Aransas Co	129.27	3.02	4,185	24,000	41,110	-42
McLennan	TSTC Waco	84.08	2.07	3,970	50,287	29,084	73
Calhoun	Calhoun County	8.62	0.22	3,830	4,350	3,084	41
Reeves	Pecos Muni	36.74	0.95	3,759	11,800	10,755	10
Angelina	Angelina County	23.84	0.64	3,642	29,200	9,250	216
Walker	Huntsville Muni	24.15	0.79	2,967	14,807	10,701	38
Atascosa	Pleasanton Muni	6.34	0.25	2,474	4,640	3,140	48
La Salle	Cotulla-La Salle County	12.86	0.52	2,367	5,539	6,075	-9
Guadalupe	New Braunfels Muni	35.27	1.50	2,252	30,615	19,799	55
Howard	Big Spring Mc Mahon-Wrinkle	7.02	0.46	1,432	11,760	6,596	78
Coryell	Gatesville Muni	2.17	0.14	1,406	7,350	2,100	250
Nueces	Corpus Christi Intl	381.89	30.42	1,155	48,145	30,797	56

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table E-18. SCCs With the Highest Absolute Percent Change in Emissions Within the Previously Identified Airport/County Combinations.

County	Airport	SCC**	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)*	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	Alice Intl	2275001000	111.67	0.08	141,250	10,000	1,000	900
Angelina	Angelina County	2275001000	21.27	0.02	107,571	1,904	250	662
Guadalupe	New Braunfels Muni	2275001000	33.24	0.10	34,372	2,977	1,220	144
Nueces	Corpus Christi Intl	2275001000	358.33	1.14	31,378	32,089	14,409	123
McLennan	TSTC Waco	2275001000	81.10	0.42	19,075	7,263	5,354	36
Nueces	John R. Armstrong Memorial Field	2275050011	0.01	0.00	18,989	198	1	18,989
Victoria	Victoria Rgnl	2275001000	262.95	1.68	15,584	23,548	21,222	11
Reeves	Pecos Muni	2275001000	35.93	0.23	15,448	3,218	2,925	10
La Salle	Cotulla-La Salle County	2275001000	12.28	0.08	15,448	1,100	1,000	10
Atascosa	Pleasanton Muni	2275001000	6.03	0.04	14,035	540	540	0
Calhoun	Calhoun County	2275001000	8.37	0.06	14,035	750	750	0
Howard	Big Spring Mc Mahon-Wrinkle	2275001000	6.25	0.04	14,035	560	560	0
Matagorda	Palacios Muni	2275001000	8.15	0.06	14,035	730	730	0
Culberson	Culberson County	2275001000	1.12	0.01	14,035	100	100	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	545.44	3.86	14,035	48,846	48,846	0
Walker	Huntsville Muni	2275001000	23.24	0.16	14,032	2,082	2,082	0
Aransas	Aransas Co	2275001000	128.42	1.28	9,903	11,500	16,250	-29

*High percent change due to updates to Military EF update

**Military LTOs were all generic

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission

Table E-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Dallas/Fort Worth Intl	2275050012	6.56	0.98	570	8,891.83	850.36	946
Tarrant	Dallas/Fort Worth Intl	2275060012	75.29	2.18	3,347	14,941.21	8,774.03	70
Tarrant	Dallas/Fort Worth Intl	2275020000	5,231.63	3,825.47	37	335,181.92	378,710.16	-11
Harris	George Bush Intercontinental/Houston	2275020000	2,260.41	1,590.24	42	186,164.88	221,363.95	-16
Harris	George Bush Intercontinental/Houston	2275050012	0.41	2.56	-84	1,834.80	2,678.59	-32
Harris	George Bush Intercontinental/Houston	2275060011	0.57	0.02	2,998	7,170.37	1,137.80	530
Harris	George Bush Intercontinental/Houston	2275001000	2.59	0.76	242	236.17	907.02	-74
Harris	George Bush Intercontinental/Houston	2275050011	0.14	0.01	1,407	4,372.14	537.33	714
Harris	George Bush Intercontinental/Houston	2275060012	125.54	201.37	-38	55,307.21	97,343.26	-43
Dallas	Dallas Love Field	2275060011	0.25	1.14	-78	3,172.20	6,499.51	-51
Dallas	Dallas Love Field	2275020000	694.46	467.29	49	73,180.34	58,786.55	24
Dallas	Dallas Love Field	2275060012	4.11	15.15	-73	10,542.23	12,346.76	-15
Dallas	Dallas Love Field	2275050012	1.95	32.55	-94	9,120.67	20,613.91	-56
Dallas	Dallas Love Field	2275001000	6.06	1.03	489	543.00	2,308.35	-76
Dallas	Dallas Love Field	2275050011	0.69	0.13	455	21,339.80	1,376.04	1,451
Harris	William P Hobby	2275060012	4.94	21.46	-77	9,868.73	19,046.89	-48
Harris	William P Hobby	2275060011	0.22	0.01	1,954	2,753.67	955.33	188
Harris	William P Hobby	2275001000	5.45	0.11	4,679	488.50	1,670.42	-71
Harris	William P Hobby	2275020000	551.77	561.68	-2	64,614.55	89,460.73	-28
Harris	William P Hobby	2275050012	1.77	12.88	-86	8,799.00	16,266.61	-46
Harris	William P Hobby	2275050011	0.70	0.05	1,256	21,589.26	735.39	2,836
Travis	Austin-Bergstrom Intl	2275050011	0.21	0.08	170	7,550.22	1,724.90	338

Table E-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Travis	Austin-Bergstrom Intl	2275060011	0.00	0.59	-100	2.01	7,907.31	-100
Travis	Austin-Bergstrom Intl	2275050012	31.11	12.73	144	21,953.40	14,750.63	49
Travis	Austin-Bergstrom Intl	2275060012	1.37	10.35	-87	599.36	14,000.77	-96
Travis	Austin-Bergstrom Intl	2275020000	759.99	790.99	-4	74,189.57	91,126.04	-19
Travis	Austin-Bergstrom Intl	2275001000	0.08	0.09	-12	90.00	72.06	25
Denton	Northwest Rgnl	2275060012	0.08	0.18	-54	208.89	454.60	-54
Denton	Northwest Rgnl	2275050011	2.97	2.86	4	91,319.17	87,886.42	4
Denton	Northwest Rgnl	2275050012	0.09	0.09	4	585.61	563.37	4
Denton	Northwest Rgnl	2275060011	0.00	0.01	-54	58.34	127.86	-54
Tarrant	Fort Worth Meacham Intl	2275050012	3.63	2.12	71	22,259.68	13,049.60	71
Tarrant	Fort Worth Meacham Intl	2275060012	1.78	1.57	13	4,602.18	4,054.93	13
Tarrant	Fort Worth Meacham Intl***	2275001000	7.96	0.03	29,650	712.50	338.53	110
Tarrant	Fort Worth Meacham Intl	2275050011	1.87	1.10	71	57,521.36	33,715.51	71
Tarrant	Fort Worth Meacham Intl	2275060011	0.10	0.09	13	1,281.93	1,130.53	13
Tarrant	Fort Worth Meacham Intl	2275020000	0.93	0.28	230	96.33	30.58	215
Bexar	San Antonio Intl	2275050012	1.07	10.97	-90	6,250.65	11,538.62	-46
Bexar	San Antonio Intl	2275050011	0.52	0.08	582	16,052.34	1,303.77	1,131
Bexar	San Antonio Intl	2275020000	646.78	570.05	13	50,638.77	56,139.66	-10
Bexar	San Antonio Intl***	2275001000	26.96	1.15	2,250	2,416.00	714.30	238
Bexar	San Antonio Intl	2275060012	3.63	17.87	-80	8,133.90	14,118.42	-42
Bexar	San Antonio Intl	2275060011	0.18	0.61	-71	2,229.44	5,121.47	-56
Collin	Collin County Rgnl At Mc Kinney	2275050011	1.67	0.35	380	51,321.69	10,700.21	380

Table E-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Collin	Collin County Rgnl At Mc Kinney	2275060012	0.48	0.23	104	1,226.96	601.72	104
Collin	Collin County Rgnl At Mc Kinney	2275060011	0.03	0.01	104	342.04	167.54	104
Collin	Collin County Rgnl At Mc Kinney	2275050012	3.21	6.21	-48	19,859.57	38,383.47	-48
Collin	Collin County Rgnl At Mc Kinney***	2275001000	0.25	0.00	19,357	22.50	16.35	38
Potter	Rick Husb+ Amarillo Intl	2275050011	0.56	0.25	126	17,370.08	7,677.11	126
Potter	Rick Husb+ Amarillo Intl	2275050012	1.11	0.48	131	6,726.58	2,972.68	126
Potter	Rick Husb+ Amarillo Intl	2275020000	47.75	34.03	40	7,997.10	7,368.16	9
Potter	Rick Husb+ Amarillo Intl***	2275001000	275.54	0.89	30,724	24,675.36	11,315.21	118
Potter	Rick Husb+ Amarillo Intl	2275060012	12.24	1.70	619	7,174.79	4,388.25	64
Potter	Rick Husb+ Amarillo Intl	2275060011	0.09	0.10	-5	1,166.53	1,222.34	-5
Denton	Denton Muni	2275060012	0.30	0.32	-6	767.19	814.77	-6
Denton	Denton Muni	2275060011	0.02	0.02	-5	214.86	227.28	-5
Denton	Denton Muni	2275050011	1.49	0.59	153	45,904.02	18,111.38	153
Denton	Denton Muni	2275020000	0.11	0.17	-37	11.03	18.23	-39
Denton	Denton Muni***	2275001000	1.17	0.01	11,847	105.11	124.36	-15
Denton	Denton Muni	2275050012	2.88	10.52	-73	17,763.14	64,970.05	-73
Harris	David Wayne Hooks Memorial	2275050011	1.29	1.97	-35	39,543.91	60,695.05	-35
Harris	David Wayne Hooks Memorial	2275060012	0.52	0.72	-28	1,340.35	1,862.10	-28
Harris	David Wayne Hooks Memorial	2275060011	0.03	0.04	-23	398.59	519.15	-23
Harris	David Wayne Hooks Memorial***	2275001000	8.19	0.11	7,446	733.50	1,374.04	-47
Harris	David Wayne Hooks Memorial	2275050012	2.59	3.80	-32	15,400.85	23,487.17	-34
Harris	David Wayne Hooks Memorial	2275020000	0.02	0.02	-3	2.00	2.07	-3

Table E-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Fort Worth Alliance	2275050012	2.06	2.07	-1	12,399.42	12,800.31	-3
Tarrant	Fort Worth Alliance	2275020000	244.31	71.45	242	5,093.82	2,993.07	70
Tarrant	Fort Worth Alliance	2275060012	0.77	2.42	-68	1,089.07	2,681.27	-59
Tarrant	Fort Worth Alliance	2275050011	1.04	1.07	-3	32,041.14	33,073.49	-3
Tarrant	Fort Worth Alliance***	2275001000	68.88	0.69	9,911	6,168.50	8,709.74	-29
Williamson	Georgetown Muni***	2275001000	2.57	0.01	34,649	230.50	93.76	146
Williamson	Georgetown Muni	2275060011	0.01	0.00	64	101.81	62.17	64
Williamson	Georgetown Muni	2275050012	2.48	4.79	-48	15,314.97	29,602.18	-48
Williamson	Georgetown Muni	2275060012	0.14	0.09	64	365.19	222.17	64
Williamson	Georgetown Muni	2275050011	1.29	0.27	380	39,577.41	8,252.04	380
Harris	West Houston	2275060011	0.01	0.01	-8	109.00	118.68	-8
Harris	West Houston	2275050012	2.44	2.58	-5	15,067.53	15,942.70	-5
Harris	West Houston	2275050011	1.27	1.34	-5	38,937.97	41,200.38	-5
Harris	West Houston	2275060012	0.15	0.17	-8	391.00	425.73	-8
El Paso	El Paso Intl	2275060012	7.95	3.39	134	6,704.98	8,830.89	-24
El Paso	El Paso Intl	2275020000	201.89	211.12	-4	18,621.34	22,263.04	-16
El Paso	El Paso Intl	2275060011	0.11	0.19	-39	1,361.63	2,383.46	-43
El Paso	El Paso Intl***	2275001000	117.10	0.31	37,377	10,487.00	3,893.96	169
El Paso	El Paso Intl	2275050012	0.82	1.05	-22	4,712.86	6,216.39	-24
El Paso	El Paso Intl	2275050011	0.40	0.52	-24	12,174.09	15,956.20	-24
Wichita	Sheppard AFB/Wichita Falls Muni	2275020000	0.38	5.32	-93	34.00	1,405.00	-98
Wichita	Sheppard AFB/Wichita Falls Muni***	2275001000	545.44	3.86	14,035	48,845.50	48,846.00	0

Table E-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

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Wichita	Sheppard AFB/Wichita Falls Muni	2275050011	0.06	0.06	0	1,932.28	1,932.00	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275050012	0.12	0.12	0	747.72	748.00	0
Bexar	Stinson Muni	2275020000	0.02	0.01	94	2.00	1.03	94
Bexar	Stinson Muni	2275060012	0.52	0.62	-16	1,329.79	1,589.50	-16
Bexar	Stinson Muni	2275050011	1.05	0.86	22	32,441.98	26,536.45	22
Bexar	Stinson Muni	2275060011	0.03	0.03	-16	370.71	442.79	-16
Bexar	Stinson Muni	2275050012	2.03	1.66	22	12,553.83	10,268.81	22
Bexar	Stinson Muni***	2275001000	47.97	0.41	11,645	4,296.00	5,170.01	-17
Mclennan	TSTC Waco***	2275001000	81.10	0.42	19,075	7,263.00	5,353.97	36
Mclennan	TSTC Waco	2275050012	1.94	1.07	81	11,995.49	6,613.60	81
Mclennan	TSTC Waco	2275020000	0.02	0.01	97	2.00	1.01	97
Mclennan	TSTC Waco	2275060011	0.00	0.00	16	5.89	5.07	16
Mclennan	TSTC Waco	2275050011	1.01	0.56	81	30,999.10	17,092.33	81
Mclennan	TSTC Waco	2275060012	0.01	0.01	16	21.11	18.26	16
Medina	Hondo Muni	2275050012	2.23	2.31	-4	13,752.33	14,274.40	-4
Medina	Hondo Muni	2275050011	1.16	1.20	-4	35,539.17	36,887.60	-4
Dallas	Addison	2275020000	0.49	1.14	-57	51.38	114.14	-55
Dallas	Addison	2275060012	1.09	1.37	-21	2,805.43	3,544.60	-21
Dallas	Addison	2275050011	1.06	1.04	1	32,511.99	32,114.15	1
Dallas	Addison	2275060011	0.06	0.08	-21	782.08	987.84	-21
Dallas	Addison***	2275001000	1.80	0.01	12,084	161.00	186.78	-14
Dallas	Addison	2275050012	2.05	2.01	2	12,580.92	12,426.86	1

Table E-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO$_X$ Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO$_X$ Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Nueces	Corpus Christi Intl	2275060011	0.06	0.08	-34	700.08	1,058.16	-34
Nueces	Corpus Christi Intl***	2275001000	358.33	1.14	31,378	32,089.00	14,409.46	123
Nueces	Corpus Christi Intl	2275060012	3.96	1.47	169	3,245.05	3,797.79	-15
Nueces	Corpus Christi Intl	2275020000	18.95	26.83	-29	3,388.41	4,815.58	-30
Nueces	Corpus Christi Intl	2275050011	0.20	0.05	330	6,288.36	1,464.04	330
Nueces	Corpus Christi Intl	2275050012	0.39	0.85	-54	2,434.34	5,251.48	-54
Tarrant	Gr+ Prairie Muni	2275050012	2.06	1.44	43	12,731.55	8,913.87	43
Tarrant	Gr+ Prairie Muni***	2275001000	21.22	0.24	8,577	1,900.00	3,095.25	-39
Tarrant	Gr+ Prairie Muni	2275060012	0.03	0.01	104	72.73	35.66	104
Tarrant	Gr+ Prairie Muni	2275050011	1.07	0.75	43	32,901.24	23,035.04	43
Tarrant	Gr+ Prairie Muni	2275060011	0.00	0.00	99	20.27	10.19	99
Brazoria	Pearl+ Rgnl	2275050012	2.12	2.28	-7	13,067.10	14,078.15	-7
Brazoria	Pearl+ Rgnl	2275060012	0.07	0.08	-11	175.95	196.87	-11
Brazoria	Pearl+ Rgnl	2275050011	1.10	1.18	-7	33,768.40	36,382.17	-7
Brazoria	Pearl+ Rgnl	2275060011	0.00	0.00	-11	49.05	54.81	-11
Webb	Laredo Intl	2275050012	1.08	0.36	201	5,756.82	2,170.40	165
Webb	Laredo Intl	2275050011	0.48	0.02	2,369	14,875.67	602.55	2,369
Webb	Laredo Intl	2275060011	0.05	0.01	650	686.96	92.47	643
Webb	Laredo Intl	2275020000	68.14	44.12	54	3,270.73	6,040.74	-46
Webb	Laredo Intl***	2275001000	201.74	0.22	90,693	18,070.00	2,539.24	612
Webb	Laredo Intl	2275060012	6.68	0.13	5,076	4,015.39	335.31	1,097
Harris	Ellington Field***	2275001000	137.16	9.15	1,398	12,283.00	13,567.46	-9

Table E-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

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Harris	Ellington Field	2275050011	0.68	0.05	1,210	20,809.14	2,356.89	783
Harris	Ellington Field	2275060012	1.30	7.11	-82	3,329.80	16,545.80	-80
Harris	Ellington Field	2275060011	0.07	0.08	-9	927.70	7,268.07	-87
Harris	Ellington Field	2275020000	9.40	19.84	-53	996.50	7,582.27	-87
Harris	Ellington Field	2275050012	1.30	4.05	-68	8,052.36	6,282.52	28
		Total	**13,013**	**8,673**	**50**	**2,176,811**	**2,183,522**	**-0.31**

*Airports with total aircraft LTO's greater than 45,000

** High percent change due to updates to Military EF update

***Military LTOs were all generic

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table E-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Aerostar PA-60	2	2	0
Agusta A-109	2	2	0
Air Tractor 802	1	1	0
Air Tractor AT-502	1	1	0
Air Tractor AT-502B	1	1	0
Air Tractor AT-602	1	1	0
Airbus A300B2-100 Series	1	1	0
Airbus A300B2-200 Series	1	1	0
Airbus A300B4-600 Series	2	2	0
Airbus A300F4-600 Series	8	8	0
Airbus A310-200 Series	6	6	0
Airbus A310-300 Series	1	1	0
Airbus A319-100 Series	14	14	0
Airbus A320-100 Series	1	1	0
Airbus A320-200 Series	13	13	0
Airbus A321-100 Series	10	10	0
Airbus A321-200 Series	1	1	0
Airbus A330-200 Series	2	2	0
Airbus A330-200 Series Freighter	1	1	0
Airbus A330-300 Series	3	3	0
Airbus A340-200 Series	1	1	0
Airbus A350-800 Series	1	1	0
Airbus A350-900 series	1	1	0
Airbus A380-800 Series/Trent 970	2	2	0
Antonov 12 Cub	1	1	0
Antonov 124 Ruslan	3	3	0
Antonov AN28 Cash	1	1	0
ATR 42-200	4	4	0
ATR 42-320	1	1	0
ATR 72-200	4	4	0
Aviat Husky A1B	2	2	0
Ayres S2R-T34 Turbo-Thrush	1	1	0
BAE Jetstream 31	4	4	0
BAE Jetstream 32	1	1	0
BAE Jetstream 32-EP	1	1	0
BAE Jetstream 41	4	4	0
Bell 206 JetRanger	2	2	0
Bell 407 / Rolls-Royce 250-C47B	2	2	0

Table E-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Bell UH-1 Iroquois	1	1	0
Boeing 717-200 Series	5	5	0
Boeing 727-100 Series	1	1	0
Boeing 727-200 Series	13	13	0
Boeing 737-100 Series	12	12	0
Boeing 737-200 Series	1	1	0
Boeing 737-300 Series	16	16	0
Boeing 737-300 Series Freighter	1	1	0
Boeing 737-400 Series	22	22	0
Boeing 737-400 Series Freighter	1	1	0
Boeing 737-500 Series	2	2	0
Boeing 737-600 Series	2	2	0
Boeing 737-700 Series	20	20	0
Boeing 737-800 Series	23	23	0
Boeing 737-800 with winglets	1	1	0
Boeing 737-900 Series	15	15	0
Boeing 737-900-ER	6	6	0
Boeing 747-200 Series	13	13	0
Boeing 747-400 Series	4	4	0
Boeing 747-400 Series Freighter	3	3	0
Boeing 747-800 Freighter	3	3	0
Boeing 757-200 Series	1	1	0
Boeing 757-200 Series Freighter	1	1	0
Boeing 757-300 Series	3	3	0
Boeing 767-200 ER	10	10	0
Boeing 767-200 Series	1	1	0
Boeing 767-300 ER	12	12	0
Boeing 767-300 ER Freighter	1	1	0
Boeing 767-400 ER	4	4	0
Boeing 777-200 Series	6	6	0
Boeing 777-200-LR	2	2	0
Boeing 777-300 ER	2	2	0
Boeing 777-300 Series	1	1	0
Boeing 787-900 Dreamliner	5	5	0
Boeing DC-10-10 Series	6	6	0
Boeing DC-10-30 Series	5	5	0
Boeing DC-10-40 Series	1	1	0
Boeing DC-6	1	1	0

Table E-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Boeing DC-8 Series 60	2	2	0
Boeing DC-9-10 Series	1	1	0
Boeing DC-9-20 Series	17	17	0
Boeing DC-9-30 Series	12	12	0
Boeing F/A-18 Hornet	1	1	0
Boeing MD-11	5	5	0
Boeing MD-11-ER	1	1	0
Boeing MD-82	23	23	0
Boeing MD-83	1	1	0
Boeing MD-88	3	3	0
Boeing MD-90	6	6	0
Bombardier Challenger 300	16	16	0
Bombardier Challenger 600	3	3	0
Bombardier Challenger 601	3	3	0
Bombardier Challenger 604	5	5	0
Bombardier CL-415	1	1	0
Bombardier CRJ-200	19	19	0
Bombardier CRJ-700	24	24	0
Bombardier CRJ-900	16	16	0
Bombardier Global Express	17	17	0
Bombardier Learjet 24	1	1	0
Bombardier Learjet 25	1	1	0
Bombardier Learjet 31	3	3	0
Bombardier Learjet 35	2	2	0
Bombardier Learjet 40	2	2	0
Bombardier Learjet 45	3	3	0
Bombardier Learjet 55	2	2	0
Bombardier Learjet 60	3	3	0
CASA 295	1	1	0
CASA CN-235-100	1	1	0
Cessna 150 Series	3	3	0
Cessna 172 Skyhawk	9	9	0
Cessna 182	3	3	0
Cessna 206	2	2	0
Cessna 208 Caravan	13	13	0
Cessna 210 Centurion	4	4	0
Cessna 310	2	2	0
Cessna 337 Skymaster	2	2	0

Table E-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Cessna 340	2	2	0
Cessna 402	1	1	0
Cessna 414	3	3	0
Cessna 421 Golden Eagle	2	2	0
Cessna 425 Conquest I	2	2	0
Cessna 441 Conquest II	1	1	0
Cessna 500 Citation I	2	2	0
Cessna 501 Citation ISP	8	8	0
Cessna 525 CitationJet	3	3	0
Cessna 525A CitationJet	1	1	0
Cessna 525B CitationJet	1	1	0
Cessna 525C CitationJet	1	1	0
Cessna 550 Citation II	2	2	0
Cessna 560 Citation Excel	4	4	0
Cessna 560 Citation V	1	1	0
Cessna 560 Citation XLS	1	1	0
Cessna 650 Citation III	6	6	0
Cessna 680 Citation Sovereign	3	3	0
Cessna 750 Citation X	4	4	0
Cirrus SR20	2	2	0
Cirrus SR22	3	3	0
Convair CV-440	10	10	0
Convair CV-580	1	1	0
Dassault Falcon 10	15	15	0
Dassault Falcon 200	1	1	0
Dassault Falcon 2000	2	2	0
Dassault Falcon 2000-EX	5	5	0
Dassault Falcon 50	3	3	0
Dassault Falcon 900	1	1	0
Dassault Falcon 900-EX	1	1	0
DeHavilland DHC-2 Mk III Beaver	1	1	0
DeHavilland DHC-3 Otter	1	1	0
DeHavilland DHC-6-100 Twin Otter	1	1	0
Dornier 228-100 Series	1	1	0
Dornier 328 Jet	1	1	0
EADS Socata TB-10 Tobago	1	1	0
EADS Socata TB-20 Trinidad	1	1	0
EADS Socata TBM-700	2	2	0

Table E-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Eclipse 500 / PW610F	2	2	0
Embraer 500	3	3	0
Embraer 505	2	2	0
Embraer EMB120 Brasilia	6	6	0
Embraer ERJ135	13	13	0
Embraer ERJ135 Legacy Business	1	1	0
Embraer ERJ135-ER	1	1	0
Embraer ERJ135-LR	1	1	0
Embraer ERJ140	19	19	0
Embraer ERJ145	24	24	0
Embraer ERJ145-EU	1	1	0
Embraer ERJ145-LR	1	1	0
Embraer ERJ145-XR	1	1	0
Embraer ERJ170	11	11	0
Embraer ERJ175	24	24	0
Embraer ERJ175-LR	1	1	0
Embraer ERJ190	4	4	0
Embraer ERJ195	1	1	0
Fairchild SA-226-T Merlin III	1	1	0
Fairchild SA-226-TC Metro II	1	1	0
Fairchild SA-227-AC Metro III	1	1	0
Fairchild SA-26-T Merlin II	1	1	0
Falcon 7X	5	5	0
Grumman A-6 Intruder	1	1	0
Grumman G-21G Goose	1	1	0
Grumman G-73 Mallard	1	1	0
Gulfstream G100	1	1	0
Gulfstream G150	8	8	0
Gulfstream G200	7	7	0
Gulfstream G280	1	1	0
Gulfstream G300	1	1	0
Gulfstream G350	1	1	0
Gulfstream G400	1	1	0
Gulfstream G450	3	3	0
Gulfstream G550	7	7	0
Gulfstream I	1	1	0
Gulfstream II	1	1	0
Gulfstream II-B	1	1	0

Table E-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Gulfstream IV-SP	1	1	0
Gulfstream V-SP	1	1	0
Hawker HS-125 Series 1	3	3	0
Hawker HS-125 Series 400	1	1	0
Hawker HS-125 Series 600	1	1	0
Hughes 500D	2	2	0
Ilyushin 76 Candid	2	2	0
Israel IAI-1124 Westwind I	1	1	0
Israel IAI-1124-A Westwind II	2	2	0
Israel IAI-1125 Astra	1	1	0
Lancair 360	1	1	0
Let 410	1	1	0
Lockheed C-130 Hercules	2	2	0
Lockheed C-141 Starlifter	1	1	0
Lockheed P-3 Orion ANP:P3A	1	1	0
Maule MT-7-235	2	2	0
Mitsubishi MU-2	3	3	0
Mitsubishi MU-300 Diamond	1	1	0
Mooney M20-K	3	3	0
MRJ90	1	1	0
Partenavia P.68 Victor	1	1	0
Piaggio P.180 Avanti	2	2	0
Pilatus PC-12	7	7	0
Pilatus PC-6 Porter	1	1	0
Pilatus Turbo Trainer PC-9	1	1	0
Piper PA-23 Apache/Aztec	3	3	0
Piper PA-24 Comanche	3	3	0
Piper PA-28 Cherokee Series	7	7	0
Piper PA-30 Twin Comanche	1	1	0
Piper PA-31 Navajo	1	1	0
Piper PA-31T Cheyenne	2	2	0
Piper PA-32 Cherokee Six	2	2	0
Piper PA-34 Seneca	3	3	0
Piper PA-42 Cheyenne Series	1	1	0
Piper PA46-TP Meridian	4	4	0
Raytheon Beech 18	5	5	0
Raytheon Beech 1900-C	2	2	0
Raytheon Beech 1900-D	1	1	0

Table E-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Raytheon Beech 55 Baron	3	3	0
Raytheon Beech 60 Duke	1	1	0
Raytheon Beech 99	1	1	0
Raytheon Beech Baron 58	1	1	0
Raytheon Beech Bonanza 36	3	3	0
Raytheon Beechjet 400	3	3	0
Raytheon Hawker 800	8	8	0
Raytheon King Air 100	1	1	0
Raytheon King Air 90	4	4	0
Raytheon Premier I	2	2	0
Raytheon Super King Air 200	9	9	0
Raytheon Super King Air 300	6	6	0
Robinson R22	3	3	0
Robinson R44 Raven / Lycoming O-540-F1B5	1	1	0
Rockwell 1121 Jet Commander	1	1	0
Rockwell 1121B Jet Commander-B	1	1	0
Rockwell Commander 500	1	1	0
Rockwell Commander 690	1	1	0
Rockwell Sabreliner 40	1	1	0
Rockwell Sabreliner 65	1	1	0
Saab 2000	1	1	0
Shorts 330	1	1	0
Sikorsky CH-53 Sea Stallion	2	2	0
Sikorsky S-76 Spirit	1	1	0
Sikorsky UH-60 Black Hawk	1	1	0
SOCATA TBM 850	1	1	0
T-38 Talon	1	1	0

Table E-21. Comparison of Controlled and Uncontrolled 2020 Emissions

Airport	Uncontrolled 2020 NO_X Emissions (tons)	Controlled 2020 NO_X Emissions (tons)	Percent Change (%)
Abilene Rgnl	115.18	115.01	-0.14
Austin-Bergstrom Intl	851.64	850.42	-0.14
Corpus Christi Intl	383.63	382.70	-0.24
Curtis Field	1.03	0.99	-4.03
El Paso Intl	340.98	335.43	-1.63
George Bush Intercontinental/Houston	2519.71	2459.59	-2.39
Lubbock Preston Smith Intl	132.45	130.53	-1.45
Rick Husband Amarillo Intl	342.08	339.83	-0.66
San Angelo Rgnl/Mathis Field	7.49	7.12	-4.91
San Antonio Intl	714.50	698.94	-2.18
Valley Intl	232.09	228.89	-1.38
William P Hobby	611.49	592.07	-3.18
		Average	**-1.86**

E. Reconciliation with User Requirements

ERG applied basic quality assurance/quality control (QA/QC) considerations to conduct this project. As per the requirements of a Category III QAPP, 10% of these estimates were validated by ensuring that the emission estimates for 2011, 2017 and 2020 were consistent with the previous 2011 inventory, the 2017 trend inventories, and the 2020 trend inventories, respectively. Below is a summary of the QA findings:

- Variance between earlier EDMS estimates and output from the FAA's new AEDT model were consistent with the FAA's expectations.
- Elevated activity levels at Sheppard airport appear to be realistic as it is the largest mixed-use Air Force airbase in the U.S.
- Increased air taxi activities in the Dallas/Fort Worth area have been noted by independent data sources.
- Correct application of new EPA generic military emission factors that replace factors that are three decades old.
- Repeal of the Wright Amendment accounted for changes for airports in the Dallas/Fort Worth Area as well as smaller connecting airports in El Paso, Houston, and Austin.

Based on the QA checks one corrective action was required and made:

- Revised the 2011 Hondo Municipal Airport LTO data to use the FAA actual 2011 values from TAF in lieu of the grown 2008 local data using TAF growth rates that were in error.

APPENDIX 12

DEVELOPMENT OF THE STATEWIDE AIRCRAFT INVENTORY FOR 2020

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Eastern Research Group, Inc.

Development of the Statewide Aircraft Inventory for 2020

Final

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

May 13, 2019

www.erg.com

ERG No. 0345.00.019

DEVELOPMENT OF THE STATEWIDE AIRCRAFT INVENTORY FOR 2020

TCEQ Contract No. 582-15-50416
Work Order No. 582-18-82508-19

Prepared for:

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1.0 Executive Summary

The purpose of this study is to develop a set of average summer weekday (tons per day) emission inventories (EI) for Texas airport activities based on a 2017 base year for the 2020 attainment year. The inventories include all counties in Texas and provide both controlled and uncontrolled ozone precursor emissions datasets.

Eastern Research Group (ERG) developed emissions inventories for criteria and hazardous air pollutants (HAPs). The inventory will be used to support the State Implementation Plan (SIP) and other airport-related inquiries.

The emissions associated with airport activities are attributed to the following sources with associated source classification codes (SCC):

- Commercial aviation (SCC: 2275020000)
- Air taxis
  - Piston driven (SCC: 2275060011)
  - Turbine driven (SCC: 2275060012)
- General aviation
  - Piston driven (SCC: 2275050011)
  - Turbine driven (SCC: 2275050012)
- Military (SCC: 2275001000)
- Auxiliary Power Units (SCC: 2275070000)
- Ground Support Equipment
  - Compressed natural gas (CNG)-fueled (SCC: 2268008005)
  - Diesel-fueled (SCC: 2270008005)
  - Gasoline-fueled (SCC: 2265008005)
  - Liquefied petroleum gas (LPG)-fueled (SCC: 2267008005).

To estimate emissions from these sources, ERG projected the base year emissions inventory obtained for Work Order 582-18-82508-19 for calendar year 2017 which included controlled and uncontrolled emissions. The 2020 emissions were projected based on growth factors from the FAA's 2017 TAF data[1].

In 2017, general aviation aircraft outfitted with piston engines account for 50% of the total aircraft activities. Commercial aircraft, General aviation aircraft outfitted with jet engines, military aircraft, air taxi aircraft outfitted with jet engines, and air taxi aircraft outfitted with piston engines account for 20%, 19%, 7%, 3%, and 1% of the total aircraft activities, respectively. Harris County and Tarrant County had the highest aircraft activity, accounting for 13.4% and 12.8% respectively of all Texas activity.

2.0 Emission Projection Procedures

The 2017 base year controlled and uncontrolled inventories were projected to 2020 based on growth factors from the FAA's 2017 TAF data[1]. The TAF data included aircraft operations data by airport and general aircraft type (AT, GA, MIL, AC). A takeoff and a landing are two separate operations, and the two operations combined equal an LTO cycle. Therefore, the operations data were converted into LTO data by dividing by 2. Growth factors were calculated by dividing the projected 2020 year LTO data by the 2017 base year LTO data. This provided growth factors by airport and generic aircraft type. Where the airport/generic aircraft type data did not link up to the base year inventory, generic aircraft type growth factors were developed. These factors are listed in Appendix A. Quality assurance checks implemented for this project are summarized in Appendix B.

These factors were then applied to the 2017 controlled and uncontrolled base year inventories to project the controlled and uncontrolled inventories for 2020. For more detailed information on the development of the 2017 base year inventories, please see the *2017 Texas Statewide Aircraft Emissions Inventory*.

3.0 Summary of Texas Airport Emissions

The results of implementing the emissions projection procedures for the year 2020 are presented in Table 3-1 through Table 3-5.

Table 3-1. Controlled and Uncontrolled Daily Criteria Emissions (Tons Per Day)

Pollutant	Controlled Emissions	Uncontrolled Emissions
CO	109.05	109.42
NO_X	43.81	44.15
$PM_{10\text{-}PRI}$	2.12	2.17
$PM_{25\text{-}PRI}$	1.85	1.90
SO_2	4.53	4.58
VOC	11.35	11.38

Table 3-2. Controlled Daily Criteria Emissions by Type (Tons Per Day)

Type	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC
Air Taxi, Piston	1.47	0.01	0.03	0.02	0.00	0.01
Air Taxi, Turbine	2.12	0.91	0.11	0.11	0.13	0.41
APU	0.64	0.52	0.08	0.08	0.08	0.05
Commercial	34.30	31.24	0.22	0.22	3.24	4.35
General Aviation, Piston	39.71	0.21	0.76	0.53	0.03	0.50
General Aviation, Turbine	12.26	0.47	0.28	0.28	0.11	1.09
GSE	7.39	0.86	0.04	0.04	0.04	0.26
Military	11.16	9.59	0.60	0.58	0.91	4.67
Total	109.05	43.81	2.12	1.85	4.53	11.35

Table 3-3. Uncontrolled Daily Criteria Emissions by Type (Tons Per Day)

Type	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC
Air Taxi, Piston	1.47	0.01	0.03	0.02	0.00	0.01
Air Taxi, Turbine	2.12	0.91	0.11	0.11	0.13	0.41
APU	1.00	0.86	0.12	0.12	0.13	0.08
Commercial	34.30	31.24	0.22	0.22	3.24	4.35
General Aviation, Piston	39.71	0.21	0.76	0.53	0.03	0.50
General Aviation, Turbine	12.26	0.47	0.28	0.28	0.11	1.09
GSE	7.40	0.87	0.04	0.04	0.04	0.26
Military	11.16	9.59	0.60	0.58	0.91	4.67
Total	109.42	44.15	2.17	1.90	4.58	11.38

Table 3-4. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Anderson	1.04E-01	2.19E-03	1.70E-03	2.01E-03	3.25E-04	3.11E-03	1.82E+01
Andrews	8.07E-02	1.69E-03	1.30E-03	9.77E-04	1.98E-04	2.14E-03	1.42E+01
Angelina	4.87E-01	1.40E-02	1.18E-02	6.54E-02	6.94E-03	4.17E-02	8.08E+01
Aransas	6.05E-01	2.60E-02	2.46E-02	3.54E-01	3.37E-02	1.76E-01	6.60E+01
Archer	3.33E-02	7.01E-04	5.48E-04	4.36E-04	8.95E-05	9.53E-04	5.92E+00
Armstrong	4.72E-03	9.31E-05	6.42E-05	2.56E-05	3.93E-06	5.92E-05	7.86E-01
Atascosa	8.65E-02	2.49E-03	2.14E-03	1.74E-02	1.74E-03	9.88E-03	1.34E+01
Austin	3.96E-02	8.10E-04	6.01E-04	3.81E-04	7.33E-05	8.46E-04	6.85E+00
Bailey	5.47E-02	1.16E-03	9.06E-04	7.33E-04	1.51E-04	1.60E-03	9.76E+00
Bandera	1.47E-02	2.91E-04	2.04E-04	9.27E-05	1.54E-05	2.12E-04	2.46E+00
Bastrop	3.87E-01	3.77E-04	3.30E-04	1.21E-03	3.99E-04	4.85E-03	3.38E+01
Baylor	2.49E-02	5.19E-04	4.00E-04	3.01E-04	6.08E-05	6.60E-04	4.39E+00
Bee	6.45E-02	1.35E-03	1.04E-03	7.78E-04	1.57E-04	1.71E-03	1.14E+01
Bell	9.16E-01	2.74E-02	2.45E-02	2.90E-01	3.05E-02	1.36E-01	1.27E+02
Bexar	4.39E+00	7.11E-02	6.25E-02	2.10E+00	2.18E-01	4.45E-01	4.61E+02
Blanco	1.37E-02	2.70E-04	1.86E-04	7.42E-05	1.14E-05	1.72E-04	2.28E+00
Bosque	6.29E-02	1.30E-03	9.88E-04	7.00E-04	1.39E-04	1.54E-03	1.10E+01
Bowie	3.65E-03	7.19E-05	4.96E-05	1.98E-05	3.04E-06	4.57E-05	6.08E-01
Brazoria	1.67E+00	3.72E-02	2.92E-02	4.38E-02	6.51E-03	5.56E-02	2.94E+02
Brazos	7.52E-01	2.49E-02	2.26E-02	2.68E-01	2.76E-02	1.35E-01	9.99E+01
Brewster	8.81E-02	1.86E-03	1.44E-03	1.79E-03	2.79E-04	2.63E-03	1.54E+01
Briscoe	1.80E-05	3.54E-07	2.45E-07	9.73E-08	1.50E-08	2.25E-07	2.99E-03
Brooks	4.60E-02	9.59E-04	7.35E-04	5.43E-04	1.09E-04	1.19E-03	8.10E+00
Brown	1.97E-01	4.44E-03	3.50E-03	7.26E-03	9.82E-04	7.59E-03	3.47E+01
Burleson	2.53E-02	5.27E-04	4.05E-04	3.04E-04	6.13E-05	6.66E-04	4.45E+00
Burnet	3.03E-01	6.65E-03	5.21E-03	1.26E-02	1.55E-03	1.20E-02	5.22E+01
Caldwell	7.56E-01	1.65E-02	1.29E-02	2.15E-02	3.03E-03	2.60E-02	1.32E+02
Calhoun	1.15E-01	3.27E-03	2.82E-03	2.40E-02	2.39E-03	1.35E-02	1.76E+01
Callahan	5.15E-03	1.02E-04	7.11E-05	3.07E-05	4.97E-06	7.05E-05	8.62E-01
Cameron	1.75E+00	6.31E-02	5.96E-02	1.11E+00	1.07E-01	4.33E-01	1.89E+02
Camp	2.59E-03	5.33E-05	4.02E-05	2.75E-05	5.40E-06	6.06E-05	4.51E-01
Carson	4.34E-02	9.09E-04	7.02E-04	5.36E-04	1.09E-04	1.18E-03	7.68E+00
Cass	1.58E-01	3.31E-03	2.54E-03	1.90E-03	3.83E-04	4.16E-03	2.79E+01
Castro	2.36E-02	4.89E-04	3.71E-04	2.63E-04	5.23E-05	5.79E-04	4.13E+00
Chambers	1.66E-01	3.46E-03	2.66E-03	2.00E-03	4.03E-04	4.38E-03	2.92E+01
Cherokee	1.77E-01	3.72E-03	2.88E-03	2.90E-03	5.03E-04	5.05E-03	3.11E+01
Childress	2.66E-02	5.57E-04	4.30E-04	3.28E-04	6.66E-05	7.19E-04	4.71E+00

Table 3-4. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM10-PRI	PM25-PRI	SO$_2$	VOC	LTO
Clay	3.65E-02	7.76E-04	6.15E-04	5.16E-04	1.07E-04	1.12E-03	6.56E+00
Cochran	9.32E-03	1.95E-04	1.50E-04	1.13E-04	2.28E-05	2.47E-04	1.64E+00
Coke	2.58E-03	5.39E-05	4.14E-05	3.10E-05	6.27E-06	6.81E-05	4.55E-01
Coleman	5.82E-02	1.22E-03	9.36E-04	7.05E-04	1.43E-04	1.55E-03	1.03E+01
Collin	1.44E+00	3.10E-02	2.41E-02	1.94E-02	3.85E-03	4.00E-02	2.55E+02
Collingsworth	3.21E-02	7.06E-04	5.55E-04	1.29E-03	1.63E-04	1.27E-03	5.56E+00
Colorado	1.09E-01	2.28E-03	1.76E-03	1.32E-03	2.66E-04	2.89E-03	1.93E+01
Comal	3.13E-01	6.52E-03	5.00E-03	3.71E-03	7.47E-04	8.14E-03	5.51E+01
Comanche	7.66E-02	1.60E-03	1.23E-03	9.19E-04	1.86E-04	2.02E-03	1.35E+01
Cooke	2.42E-01	5.10E-03	3.92E-03	4.33E-03	7.07E-04	6.90E-03	4.24E+01
Coryell	1.21E-01	2.71E-03	2.14E-03	5.98E-03	7.14E-04	5.28E-03	2.09E+01
Cottle	9.47E-03	1.98E-04	1.52E-04	1.14E-04	2.30E-05	2.50E-04	1.67E+00
Crane	1.08E-02	2.24E-04	1.73E-04	1.29E-04	2.61E-05	2.84E-04	1.90E+00
Crockett	6.51E-02	1.40E-03	1.09E-03	1.91E-03	2.62E-04	2.23E-03	1.13E+01
Crosby	4.73E-02	1.01E-03	7.99E-04	6.77E-04	1.41E-04	1.47E-03	8.51E+00
Culberson	8.57E-03	2.93E-04	2.62E-04	3.11E-03	2.98E-04	1.59E-03	1.14E+00
Dallam	2.29E-02	4.79E-04	3.70E-04	2.83E-04	5.75E-05	6.20E-04	4.05E+00
Dallas	6.27E+00	1.05E-01	8.95E-02	2.13E+00	2.30E-01	4.71E-01	7.74E+02
Dawson	1.13E-01	2.36E-03	1.82E-03	1.38E-03	2.78E-04	3.02E-03	2.00E+01
Deaf Smith	1.08E-01	2.28E-03	1.76E-03	1.89E-03	3.16E-04	3.10E-03	1.89E+01
Delta	1.80E-05	3.54E-07	2.45E-07	9.73E-08	1.50E-08	2.25E-07	2.99E-03
Denton	2.79E+00	5.73E-02	4.19E-02	2.80E-02	4.91E-03	5.56E-02	4.77E+02
DeWitt	3.71E-03	7.70E-05	5.86E-05	4.19E-05	8.34E-06	9.21E-05	6.51E-01
Dickens	3.09E-03	6.08E-05	4.20E-05	1.67E-05	2.57E-06	3.87E-05	5.14E-01
Dimmit	2.35E-02	4.88E-04	3.73E-04	2.72E-04	5.46E-05	5.99E-04	4.12E+00
Donley	1.49E-02	3.12E-04	2.40E-04	1.80E-04	3.64E-05	3.95E-04	2.63E+00
Duval	1.96E-02	3.99E-04	2.95E-04	1.85E-04	3.55E-05	4.12E-04	3.37E+00
Eastland	8.59E-02	1.79E-03	1.38E-03	1.03E-03	2.09E-04	2.27E-03	1.52E+01
Ector	4.11E-01	8.59E-03	6.61E-03	4.98E-03	1.01E-03	1.09E-02	7.26E+01
Edwards	1.02E-02	2.07E-04	1.51E-04	8.93E-05	1.67E-05	1.99E-04	1.75E+00
El Paso	1.91E+00	4.27E-02	3.88E-02	9.23E-01	9.49E-02	2.76E-01	2.10E+02
Ellis	3.82E-01	8.09E-03	6.26E-03	7.89E-03	1.23E-03	1.16E-02	6.69E+01
Erath	1.86E-01	3.91E-03	3.00E-03	2.81E-03	5.00E-04	5.11E-03	3.27E+01
Falls	4.01E-03	8.20E-05	6.08E-05	3.87E-05	7.45E-06	8.59E-05	6.92E-01
Fannin	1.21E-01	2.50E-03	1.90E-03	1.36E-03	2.71E-04	2.99E-03	2.12E+01
Fayette	9.83E-02	2.04E-03	1.55E-03	1.11E-03	2.22E-04	2.45E-03	1.72E+01
Fisher	3.10E-02	6.47E-04	4.98E-04	3.73E-04	7.52E-05	8.17E-04	5.47E+00
Floyd	5.26E-02	1.09E-03	8.36E-04	6.12E-04	1.23E-04	1.34E-03	9.24E+00

Table 3-4. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM10-PRI	PM25-PRI	SO$_2$	VOC	LTO
Foard	3.81E-03	8.01E-05	6.23E-05	4.90E-05	1.00E-05	1.07E-04	6.77E-01
Fort Bend	1.04E+00	2.47E-02	1.97E-02	4.16E-02	5.51E-03	4.25E-02	1.83E+02
Franklin	5.75E-02	1.20E-03	9.30E-04	7.12E-04	1.45E-04	1.56E-03	1.02E+01
Freestone	1.24E-02	2.58E-04	1.98E-04	1.49E-04	3.00E-05	3.26E-04	2.18E+00
Frio	4.24E-02	8.82E-04	6.76E-04	4.99E-04	1.00E-04	1.09E-03	7.45E+00
Gaines	1.44E-01	3.04E-03	2.34E-03	1.76E-03	3.56E-04	3.81E-03	2.53E+01
Galveston	3.18E-01	9.62E-03	8.16E-03	2.55E-02	3.13E-03	2.06E-02	5.67E+01
Garza	8.14E-03	1.66E-04	1.23E-04	7.80E-05	1.50E-05	1.73E-04	1.41E+00
Gillespie	1.40E-01	3.08E-03	2.39E-03	4.31E-03	5.80E-04	4.82E-03	2.44E+01
Glasscock	2.37E-03	4.68E-05	3.23E-05	1.28E-05	1.98E-06	2.97E-05	3.95E-01
Gonzales	1.88E-02	3.92E-04	3.00E-04	2.21E-04	4.45E-05	4.86E-04	3.31E+00
Gray	1.75E-01	3.66E-03	2.81E-03	2.12E-03	4.28E-04	4.65E-03	3.09E+01
Grayson	8.35E-01	1.76E-02	1.35E-02	1.31E-02	2.29E-03	2.32E-02	1.47E+02
Gregg	5.84E-01	1.79E-02	1.55E-02	1.02E-01	1.06E-02	5.90E-02	9.62E+01
Grimes	4.06E-02	8.47E-04	6.51E-04	4.89E-04	9.87E-05	1.07E-03	7.15E+00
Guadalupe	6.24E-01	1.68E-02	1.41E-02	9.76E-02	9.91E-03	5.82E-02	9.96E+01
Hale	6.62E-02	1.42E-03	1.09E-03	2.05E-03	2.67E-04	2.22E-03	1.14E+01
Hall	9.32E-03	1.95E-04	1.50E-04	1.13E-04	2.28E-05	2.47E-04	1.64E+00
Hamilton	5.86E-02	1.25E-03	9.57E-04	7.11E-04	1.42E-04	1.52E-03	1.03E+01
Hansford	2.42E-01	5.06E-03	3.89E-03	2.93E-03	5.93E-04	6.43E-03	4.27E+01
Hardeman	3.42E-02	7.14E-04	5.49E-04	4.14E-04	8.36E-05	9.07E-04	6.03E+00
Hardin	3.34E-02	6.99E-04	5.40E-04	4.12E-04	8.37E-05	9.04E-04	5.91E+00
Harris	1.28E+01	2.07E-01	1.85E-01	8.80E+00	7.82E-01	1.37E+00	1.59E+03
Harrison	1.36E-01	2.85E-03	2.21E-03	1.71E-03	3.48E-04	3.74E-03	2.41E+01
Hartley	8.96E-02	1.96E-03	1.54E-03	3.35E-03	4.29E-04	3.42E-03	1.55E+01
Haskell	1.86E-02	3.89E-04	3.00E-04	2.26E-04	4.56E-05	4.95E-04	3.29E+00
Hays	1.45E-02	2.89E-04	2.03E-04	9.21E-05	1.53E-05	2.10E-04	2.44E+00
Hemphill	5.29E-02	1.10E-03	8.42E-04	6.19E-04	1.24E-04	1.36E-03	9.30E+00
Henderson	1.06E-01	2.28E-03	1.77E-03	2.76E-03	3.92E-04	3.44E-03	1.85E+01
Hidalgo	1.18E+00	2.74E-02	2.35E-02	3.35E-01	3.60E-02	1.10E-01	1.63E+02
Hill	1.05E-01	2.18E-03	1.66E-03	1.20E-03	2.39E-04	2.63E-03	1.84E+01
Hockley	1.10E-01	2.31E-03	1.78E-03	1.35E-03	2.73E-04	2.95E-03	1.95E+01
Hood	2.84E-01	5.91E-03	4.51E-03	3.29E-03	6.59E-04	7.23E-03	4.99E+01
Hopkins	2.67E-01	5.62E-03	4.33E-03	3.85E-03	7.13E-04	7.38E-03	4.71E+01
Houston	7.56E-02	1.57E-03	1.21E-03	8.93E-04	1.80E-04	1.96E-03	1.33E+01
Howard	1.95E-01	4.72E-03	3.85E-03	1.93E-02	2.05E-03	1.30E-02	3.24E+01
Hudspeth	2.45E-02	5.13E-04	3.96E-04	3.02E-04	6.12E-05	6.61E-04	4.33E+00
Hunt	3.53E-01	8.58E-03	7.00E-03	3.62E-02	3.81E-03	2.40E-02	5.83E+01

Table 3-4. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM10-PRI	PM25-PRI	SO$_2$	VOC	LTO
Hutchinson	7.78E-02	1.63E-03	1.26E-03	1.09E-03	2.04E-04	2.14E-03	1.37E+01
Irion	1.55E-03	3.06E-05	2.11E-05	8.40E-06	1.29E-06	1.94E-05	2.58E-01
Jack	2.45E-02	5.06E-04	3.81E-04	2.62E-04	5.17E-05	5.79E-04	4.27E+00
Jackson	1.57E-01	3.39E-03	2.71E-03	4.01E-03	6.24E-04	5.62E-03	2.79E+01
Jasper	1.57E-01	3.28E-03	2.53E-03	1.90E-03	3.84E-04	4.17E-03	2.77E+01
Jeff Davis	1.80E-05	3.54E-07	2.45E-07	9.73E-08	1.50E-08	2.25E-07	2.99E-03
Jefferson	3.62E-01	8.90E-03	7.42E-03	4.48E-02	5.22E-03	2.62E-02	5.90E+01
Jim Hogg	5.22E-03	1.07E-04	8.00E-05	5.27E-05	1.02E-05	1.17E-04	9.06E-01
Jim Wells	4.07E-01	2.02E-02	1.94E-02	3.07E-01	2.90E-02	1.50E-01	3.64E+01
Johnson	3.13E-01	6.59E-03	5.03E-03	3.98E-03	7.53E-04	8.00E-03	5.49E+01
Jones	8.14E-02	1.70E-03	1.30E-03	9.67E-04	1.95E-04	2.12E-03	1.43E+01
Karnes	8.28E-02	3.71E-03	3.52E-03	5.27E-02	5.00E-03	2.59E-02	8.46E+00
Kaufman	3.02E-01	6.32E-03	4.87E-03	3.70E-03	7.48E-04	8.08E-03	5.33E+01
Kendall	6.06E-03	1.19E-04	8.23E-05	3.28E-05	5.04E-06	7.59E-05	1.01E+00
Kenedy	1.53E-03	3.02E-05	2.08E-05	8.30E-06	1.28E-06	1.92E-05	2.55E-01
Kent	5.17E-02	1.08E-03	8.29E-04	6.21E-04	1.25E-04	1.36E-03	9.12E+00
Kerr	5.24E-01	1.09E-02	8.39E-03	6.31E-03	1.27E-03	1.38E-02	9.23E+01
Kimble	6.08E-02	1.33E-03	1.04E-03	2.24E-03	2.89E-04	2.31E-03	1.06E+01
King	3.09E-03	6.08E-05	4.19E-05	1.67E-05	2.57E-06	3.86E-05	5.14E-01
Kinney	9.92E-03	1.95E-04	1.35E-04	5.37E-05	8.26E-06	1.24E-04	1.65E+00
Kleberg	6.54E-02	1.56E-03	1.26E-03	5.06E-03	5.62E-04	3.74E-03	1.11E+01
Knox	4.46E-02	9.29E-04	7.11E-04	5.23E-04	1.05E-04	1.15E-03	7.85E+00
La Salle	1.11E-01	3.50E-03	3.02E-03	3.45E-02	3.30E-03	1.78E-02	1.50E+01
Lamar	1.48E-01	3.20E-03	2.53E-03	2.78E-03	4.86E-04	4.71E-03	2.64E+01
Lamb	7.19E-02	1.52E-03	1.18E-03	1.28E-03	2.19E-04	2.15E-03	1.27E+01
Lampasas	9.11E-02	1.90E-03	1.45E-03	1.06E-03	2.12E-04	2.33E-03	1.60E+01
Lavaca	2.52E-02	5.26E-04	4.04E-04	3.00E-04	6.04E-05	6.58E-04	4.45E+00
Lee	1.11E-01	2.43E-03	1.90E-03	4.32E-03	5.42E-04	4.25E-03	1.92E+01
Leon	1.19E-02	2.37E-04	1.67E-04	7.79E-05	1.32E-05	1.77E-04	2.00E+00
Liberty	1.76E-01	3.93E-03	3.10E-03	8.82E-03	1.04E-03	7.65E-03	3.02E+01
Limestone	3.58E-02	7.46E-04	5.72E-04	4.22E-04	8.50E-05	9.28E-04	6.31E+00
Lipscomb	7.15E-03	1.43E-04	1.02E-04	5.23E-05	9.25E-06	1.18E-04	1.21E+00
Live Oak	2.20E-02	4.55E-04	3.45E-04	2.44E-04	4.85E-05	5.37E-04	3.85E+00
Llano	2.12E-01	5.20E-03	4.24E-03	2.07E-02	2.21E-03	1.40E-02	3.53E+01
Lubbock	1.23E+00	3.00E-02	2.62E-02	3.64E-01	3.82E-02	1.35E-01	1.68E+02
Lynn	2.41E-02	5.01E-04	3.83E-04	2.79E-04	5.60E-05	6.14E-04	4.23E+00
Madison	6.75E-03	1.39E-04	1.04E-04	7.07E-05	1.39E-05	1.56E-04	1.18E+00
Marion	1.63E-02	3.40E-04	2.62E-04	1.97E-04	3.99E-05	4.32E-04	2.87E+00

Table 3-4. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO$_X$	PM10-PRI	PM25-PRI	SO$_2$	VOC	LTO
Martin	1.43E-02	2.97E-04	2.26E-04	1.63E-04	3.25E-05	3.58E-04	2.51E+00
Mason	1.66E-02	3.45E-04	2.63E-04	1.92E-04	3.85E-05	4.22E-04	2.91E+00
Matagorda	1.80E-01	4.64E-03	3.87E-03	2.50E-02	2.56E-03	1.53E-02	2.91E+01
Maverick	9.53E-03	2.00E-04	1.56E-04	1.23E-04	2.51E-05	2.69E-04	1.69E+00
McCulloch	1.80E-01	2.93E-04	2.83E-04	5.31E-03	1.03E-03	1.18E-02	1.05E+01
McLennan	1.83E+00	5.23E-02	4.52E-02	3.92E-01	3.99E-02	2.16E-01	2.79E+02
McMullen	1.55E-03	3.06E-05	2.11E-05	8.40E-06	1.29E-06	1.94E-05	2.58E-01
Medina	9.00E-01	1.88E-02	1.45E-02	1.11E-02	2.22E-03	2.39E-02	1.59E+02
Menard	8.03E-03	1.64E-04	1.22E-04	7.76E-05	1.49E-05	1.72E-04	1.39E+00
Midland	1.20E+00	3.13E-02	2.78E-02	3.63E-01	3.98E-02	1.52E-01	1.59E+02
Milam	5.35E-02	1.11E-03	8.47E-04	6.13E-04	1.23E-04	1.35E-03	9.39E+00
Mills	6.20E-03	1.22E-04	8.43E-05	3.35E-05	5.16E-06	7.77E-05	1.03E+00
Mitchell	3.70E-02	7.75E-04	6.00E-04	4.62E-04	9.39E-05	1.01E-03	6.55E+00
Montague	1.11E-01	2.36E-03	1.82E-03	2.10E-03	3.42E-04	3.28E-03	1.95E+01
Montgomery	5.91E-01	1.52E-02	1.26E-02	6.65E-02	7.05E-03	4.37E-02	9.82E+01
Moore	1.54E-01	3.23E-03	2.49E-03	2.31E-03	4.18E-04	4.29E-03	2.71E+01
Morris	1.23E-03	2.71E-05	2.28E-05	2.30E-05	4.96E-06	4.96E-05	2.29E-01
Motley	1.70E-03	3.54E-05	2.73E-05	2.06E-05	4.16E-06	4.51E-05	2.99E-01
Nacogdoches	2.40E-01	5.19E-03	4.06E-03	7.43E-03	1.01E-03	8.46E-03	4.19E+01
Navarro	2.08E-01	4.33E-03	3.31E-03	2.44E-03	4.89E-04	5.35E-03	3.66E+01
Newton	4.94E-03	1.03E-04	7.98E-05	6.09E-05	1.23E-05	1.33E-04	8.74E-01
Nolan	8.09E-02	1.69E-03	1.30E-03	9.84E-04	1.99E-04	2.16E-03	1.43E+01
Nueces	1.52E+00	6.70E-02	6.40E-02	9.87E-01	9.66E-02	4.71E-01	1.54E+02
Ochiltree	1.49E-01	3.11E-03	2.40E-03	1.80E-03	3.65E-04	3.96E-03	2.63E+01
Oldham	3.42E-02	7.14E-04	5.49E-04	4.14E-04	8.36E-05	9.07E-04	6.03E+00
Orange	9.55E-02	2.23E-03	1.76E-03	1.44E-03	2.90E-04	2.82E-03	1.71E+01
Palo Pinto	4.13E-02	8.61E-04	6.59E-04	4.86E-04	9.77E-05	1.07E-03	7.27E+00
Panola	8.91E-02	2.01E-03	1.60E-03	4.86E-03	5.70E-04	4.12E-03	1.53E+01
Parker	5.35E-01	1.13E-02	8.69E-03	1.01E-02	1.61E-03	1.56E-02	9.36E+01
Parmer	6.33E-02	1.32E-03	1.01E-03	7.49E-04	1.51E-04	1.64E-03	1.12E+01
Pecos	8.51E-02	1.89E-03	1.49E-03	3.32E-03	4.23E-04	3.32E-03	1.48E+01
Polk	7.30E-02	1.52E-03	1.17E-03	8.73E-04	1.76E-04	1.92E-03	1.29E+01
Potter	1.51E+00	6.05E-02	5.72E-02	9.31E-01	8.95E-02	4.03E-01	1.79E+02
Presidio	1.34E-01	2.80E-03	2.15E-03	1.62E-03	3.28E-04	3.54E-03	2.36E+01
Rains	2.71E-03	5.57E-05	4.18E-05	2.81E-05	5.50E-06	6.21E-05	4.71E-01
Randall	3.59E-01	7.49E-03	5.74E-03	4.25E-03	8.56E-04	9.34E-03	6.33E+01
Reagan	1.90E-02	3.96E-04	3.04E-04	2.28E-04	4.60E-05	4.99E-04	3.34E+00
Real	1.21E-02	2.51E-04	1.90E-04	1.35E-04	2.69E-05	2.97E-04	2.12E+00

Table 3-4. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Red River	1.25E-02	2.60E-04	1.99E-04	1.48E-04	2.99E-05	3.26E-04	2.19E+00
Reeves	2.47E-01	9.41E-03	8.62E-03	1.01E-01	9.75E-03	5.21E-02	3.26E+01
Refugio	3.32E-02	6.93E-04	5.32E-04	3.96E-04	7.98E-05	8.69E-04	5.85E+00
Roberts	5.86E-03	1.20E-04	9.02E-05	6.01E-05	1.17E-05	1.33E-04	1.02E+00
Robertson	3.08E-02	6.36E-04	4.80E-04	3.33E-04	6.57E-05	7.34E-04	5.37E+00
Rockwall	4.32E-01	9.04E-03	6.97E-03	5.55E-03	1.09E-03	1.17E-02	7.63E+01
Runnels	2.78E-02	5.85E-04	4.49E-04	3.32E-04	6.65E-05	7.18E-04	4.89E+00
Rusk	1.00E-01	2.33E-03	1.87E-03	7.25E-03	8.06E-04	5.45E-03	1.70E+01
Sabine	1.07E-02	2.24E-04	1.75E-04	1.39E-04	2.86E-05	3.05E-04	1.90E+00
San Augustine	6.81E-03	1.42E-04	1.09E-04	8.23E-05	1.66E-05	1.81E-04	1.20E+00
San Jacinto	1.81E-03	3.56E-05	2.46E-05	9.78E-06	1.51E-06	2.26E-05	3.01E-01
San Patricio	1.97E-01	4.11E-03	3.16E-03	2.38E-03	4.82E-04	5.23E-03	3.47E+01
San Saba	1.68E-02	3.50E-04	2.67E-04	1.93E-04	3.87E-05	4.25E-04	2.95E+00
Schleicher	9.42E-03	1.95E-04	1.47E-04	1.02E-04	2.02E-05	2.25E-04	1.64E+00
Scurry	8.69E-02	1.82E-03	1.40E-03	1.05E-03	2.13E-04	2.31E-03	1.53E+01
Shackelford	3.39E-02	7.09E-04	5.46E-04	4.11E-04	8.31E-05	9.02E-04	5.99E+00
Shelby	1.90E-01	3.98E-03	3.07E-03	2.75E-03	5.07E-04	5.25E-03	3.35E+01
Sherman	2.24E-03	4.67E-05	3.59E-05	2.69E-05	5.43E-06	5.90E-05	3.95E-01
Smith	3.21E-01	8.30E-03	6.92E-03	2.44E-02	3.62E-03	1.68E-02	5.43E+01
Somervell	6.44E-03	1.29E-04	9.25E-05	4.83E-05	8.60E-06	1.09E-04	1.09E+00
Starr	4.36E-03	8.89E-05	6.56E-05	4.06E-05	7.74E-06	9.03E-05	7.51E-01
Stephens	1.21E-01	2.52E-03	1.94E-03	1.44E-03	2.91E-04	3.17E-03	2.13E+01
Sterling	1.98E-03	3.91E-05	2.71E-05	1.13E-05	1.79E-06	2.60E-05	3.30E-01
Stonewall	8.79E-03	1.87E-04	1.48E-04	1.25E-04	2.60E-05	2.73E-04	1.58E+00
Sutton	1.44E-02	3.00E-04	2.30E-04	1.71E-04	3.45E-05	3.75E-04	2.54E+00
Swisher	5.80E-02	1.21E-03	9.24E-04	6.77E-04	1.36E-04	1.49E-03	1.02E+01
Tarrant	2.79E+01	2.87E-01	2.65E-01	1.70E+01	1.86E+00	2.73E+00	1.84E+03
Taylor	7.12E-01	2.68E-02	2.48E-02	3.16E-01	3.17E-02	1.57E-01	9.01E+01
Terrell	4.13E-03	8.45E-05	6.25E-05	3.94E-05	7.56E-06	8.75E-05	7.14E-01
Terry	2.35E-02	4.92E-04	3.80E-04	2.92E-04	5.94E-05	6.40E-04	4.15E+00
Throckmorton	5.60E-04	1.17E-05	8.98E-06	6.72E-06	1.36E-06	1.48E-05	9.87E-02
Titus	1.31E-01	2.74E-03	2.11E-03	1.58E-03	3.20E-04	3.47E-03	2.32E+01
Tom Green	5.91E-02	6.26E-04	5.04E-04	1.98E-02	2.49E-03	3.51E-03	9.08E+00
Travis	5.49E+00	4.44E-02	4.22E-02	2.49E+00	2.82E-01	6.79E-01	3.67E+02
Trinity	1.42E-02	2.94E-04	2.23E-04	1.58E-04	3.15E-05	3.49E-04	2.48E+00
Tyler	1.53E-02	3.19E-04	2.45E-04	1.82E-04	3.66E-05	3.99E-04	2.70E+00
Upshur	1.52E-01	3.18E-03	2.45E-03	1.86E-03	3.78E-04	4.09E-03	2.69E+01
Upton	6.89E-03	1.44E-04	1.11E-04	8.28E-05	1.67E-05	1.82E-04	1.21E+00

Table 3-4. Controlled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Uvalde	1.04E-01	2.41E-03	1.93E-03	5.87E-03	6.91E-04	4.93E-03	1.78E+01
Val Verde	1.26E-01	3.10E-03	2.51E-03	7.16E-03	1.05E-03	6.09E-03	2.20E+01
Van Zandt	3.33E-02	6.85E-04	5.13E-04	3.44E-04	6.71E-05	7.59E-04	5.79E+00
Victoria	9.68E-01	4.79E-02	4.63E-02	7.24E-01	6.87E-02	3.55E-01	8.76E+01
Walker	2.74E-01	8.21E-03	7.15E-03	6.62E-02	6.52E-03	3.64E-02	4.10E+01
Waller	1.73E-01	3.60E-03	2.75E-03	1.99E-03	3.99E-04	4.38E-03	3.04E+01
Ward	1.02E-01	2.14E-03	1.65E-03	1.24E-03	2.51E-04	2.72E-03	1.81E+01
Washington	9.96E-02	2.09E-03	1.60E-03	1.49E-03	2.64E-04	2.71E-03	1.75E+01
Webb	1.33E+00	4.71E-02	4.45E-02	7.71E-01	7.66E-02	3.36E-01	1.29E+02
Wharton	1.17E-01	2.50E-03	1.94E-03	2.89E-03	4.18E-04	3.74E-03	2.05E+01
Wheeler	1.04E-02	2.17E-04	1.67E-04	1.25E-04	2.53E-05	2.75E-04	1.84E+00
Wichita	2.26E+00	1.04E-01	9.91E-02	1.51E+00	1.44E-01	7.45E-01	2.22E+02
Wilbarger	1.33E-01	2.84E-03	2.20E-03	3.11E-03	4.63E-04	4.20E-03	2.33E+01
Willacy	1.25E-02	2.58E-04	1.94E-04	1.30E-04	2.55E-05	2.88E-04	2.18E+00
Williamson	1.19E+00	2.54E-02	1.96E-02	2.15E-02	3.58E-03	3.47E-02	2.09E+02
Wilson	9.38E-03	1.85E-04	1.28E-04	5.08E-05	7.81E-06	1.18E-04	1.56E+00
Winkler	1.19E-02	3.08E-04	2.59E-04	1.66E-03	1.71E-04	1.03E-03	1.94E+00
Wise	3.81E-01	7.93E-03	6.05E-03	4.40E-03	8.82E-04	9.67E-03	6.70E+01
Wood	1.91E-01	3.99E-03	3.07E-03	2.30E-03	4.65E-04	5.05E-03	3.37E+01
Yoakum	8.05E-02	1.68E-03	1.29E-03	9.76E-04	1.97E-04	2.14E-03	1.42E+01
Young	1.28E-01	2.68E-03	2.06E-03	1.70E-03	3.27E-04	3.47E-03	2.26E+01
Zapata	2.74E-02	5.69E-04	4.35E-04	3.19E-04	6.39E-05	7.00E-04	4.81E+00
Zavala	9.56E-03	1.91E-04	1.36E-04	6.88E-05	1.21E-05	1.55E-04	1.62E+00

Table 3-5. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Anderson	1.04E-01	2.19E-03	1.70E-03	2.01E-03	3.25E-04	3.11E-03	1.82E+01
Andrews	8.07E-02	1.69E-03	1.30E-03	9.77E-04	1.98E-04	2.14E-03	1.42E+01
Angelina	4.87E-01	1.40E-02	1.18E-02	6.54E-02	6.94E-03	4.17E-02	8.08E+01
Aransas	6.05E-01	2.60E-02	2.46E-02	3.54E-01	3.37E-02	1.76E-01	6.60E+01
Archer	3.33E-02	7.01E-04	5.48E-04	4.36E-04	8.95E-05	9.53E-04	5.92E+00
Armstrong	4.72E-03	9.31E-05	6.42E-05	2.56E-05	3.93E-06	5.92E-05	7.86E-01
Atascosa	8.65E-02	2.49E-03	2.14E-03	1.74E-02	1.74E-03	9.88E-03	1.34E+01
Austin	3.96E-02	8.10E-04	6.01E-04	3.81E-04	7.33E-05	8.46E-04	6.85E+00
Bailey	5.47E-02	1.16E-03	9.06E-04	7.33E-04	1.51E-04	1.60E-03	9.76E+00
Bandera	1.47E-02	2.91E-04	2.04E-04	9.27E-05	1.54E-05	2.12E-04	2.46E+00
Bastrop	3.87E-01	3.77E-04	3.30E-04	1.21E-03	3.99E-04	4.85E-03	3.38E+01
Baylor	2.49E-02	5.19E-04	4.00E-04	3.01E-04	6.08E-05	6.60E-04	4.39E+00
Bee	6.45E-02	1.35E-03	1.04E-03	7.78E-04	1.57E-04	1.71E-03	1.14E+01
Bell	9.16E-01	2.74E-02	2.45E-02	2.90E-01	3.05E-02	1.36E-01	1.27E+02
Bexar	4.44E+00	7.72E-02	6.86E-02	2.15E+00	2.25E-01	4.49E-01	4.61E+02
Blanco	1.37E-02	2.70E-04	1.86E-04	7.42E-05	1.14E-05	1.72E-04	2.28E+00
Bosque	6.29E-02	1.30E-03	9.88E-04	7.00E-04	1.39E-04	1.54E-03	1.10E+01
Bowie	3.65E-03	7.19E-05	4.96E-05	1.98E-05	3.04E-06	4.57E-05	6.08E-01
Brazoria	1.67E+00	3.72E-02	2.92E-02	4.38E-02	6.51E-03	5.56E-02	2.94E+02
Brazos	7.52E-01	2.49E-02	2.26E-02	2.68E-01	2.76E-02	1.35E-01	9.99E+01
Brewster	8.81E-02	1.86E-03	1.44E-03	1.79E-03	2.79E-04	2.63E-03	1.54E+01
Briscoe	1.80E-05	3.54E-07	2.45E-07	9.73E-08	1.50E-08	2.25E-07	2.99E-03
Brooks	4.60E-02	9.59E-04	7.35E-04	5.43E-04	1.09E-04	1.19E-03	8.10E+00
Brown	1.97E-01	4.44E-03	3.50E-03	7.26E-03	9.82E-04	7.59E-03	3.47E+01
Burleson	2.53E-02	5.27E-04	4.05E-04	3.04E-04	6.13E-05	6.66E-04	4.45E+00
Burnet	3.03E-01	6.65E-03	5.21E-03	1.26E-02	1.55E-03	1.20E-02	5.22E+01
Caldwell	7.56E-01	1.65E-02	1.29E-02	2.15E-02	3.03E-03	2.60E-02	1.32E+02
Calhoun	1.15E-01	3.27E-03	2.82E-03	2.40E-02	2.39E-03	1.35E-02	1.76E+01
Callahan	5.15E-03	1.02E-04	7.11E-05	3.07E-05	4.97E-06	7.05E-05	8.62E-01
Cameron	1.77E+00	6.43E-02	6.07E-02	1.12E+00	1.08E-01	4.34E-01	1.89E+02
Camp	2.59E-03	5.33E-05	4.02E-05	2.75E-05	5.40E-06	6.06E-05	4.51E-01
Carson	4.34E-02	9.09E-04	7.02E-04	5.36E-04	1.09E-04	1.18E-03	7.68E+00
Cass	1.58E-01	3.31E-03	2.54E-03	1.90E-03	3.83E-04	4.16E-03	2.79E+01
Castro	2.36E-02	4.89E-04	3.71E-04	2.63E-04	5.23E-05	5.79E-04	4.13E+00
Chambers	1.66E-01	3.46E-03	2.66E-03	2.00E-03	4.03E-04	4.38E-03	2.92E+01
Cherokee	1.77E-01	3.72E-03	2.88E-03	2.90E-03	5.03E-04	5.05E-03	3.11E+01
Childress	2.66E-02	5.57E-04	4.30E-04	3.28E-04	6.66E-05	7.19E-04	4.71E+00
Clay	3.65E-02	7.76E-04	6.15E-04	5.16E-04	1.07E-04	1.12E-03	6.56E+00

Table 3-5. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Cochran	9.32E-03	1.95E-04	1.50E-04	1.13E-04	2.28E-05	2.47E-04	1.64E+00
Coke	2.58E-03	5.39E-05	4.14E-05	3.10E-05	6.27E-06	6.81E-05	4.55E-01
Coleman	5.82E-02	1.22E-03	9.36E-04	7.05E-04	1.43E-04	1.55E-03	1.03E+01
Collin	1.44E+00	3.10E-02	2.41E-02	1.94E-02	3.85E-03	4.00E-02	2.55E+02
Collingsworth	3.21E-02	7.06E-04	5.55E-04	1.29E-03	1.63E-04	1.27E-03	5.56E+00
Colorado	1.09E-01	2.28E-03	1.76E-03	1.32E-03	2.66E-04	2.89E-03	1.93E+01
Comal	3.13E-01	6.52E-03	5.00E-03	3.71E-03	7.47E-04	8.14E-03	5.51E+01
Comanche	7.66E-02	1.60E-03	1.23E-03	9.19E-04	1.86E-04	2.02E-03	1.35E+01
Cooke	2.42E-01	5.10E-03	3.92E-03	4.33E-03	7.07E-04	6.90E-03	4.24E+01
Coryell	1.21E-01	2.71E-03	2.14E-03	5.98E-03	7.14E-04	5.28E-03	2.09E+01
Cottle	9.47E-03	1.98E-04	1.52E-04	1.14E-04	2.30E-05	2.50E-04	1.67E+00
Crane	1.08E-02	2.24E-04	1.73E-04	1.29E-04	2.61E-05	2.84E-04	1.90E+00
Crockett	6.51E-02	1.40E-03	1.09E-03	1.91E-03	2.62E-04	2.23E-03	1.13E+01
Crosby	4.73E-02	1.01E-03	7.99E-04	6.77E-04	1.41E-04	1.47E-03	8.51E+00
Culberson	8.57E-03	2.93E-04	2.62E-04	3.11E-03	2.98E-04	1.59E-03	1.14E+00
Dallam	2.29E-02	4.79E-04	3.70E-04	2.83E-04	5.75E-05	6.20E-04	4.05E+00
Dallas	6.27E+00	1.05E-01	8.95E-02	2.13E+00	2.30E-01	4.71E-01	7.74E+02
Dawson	1.13E-01	2.36E-03	1.82E-03	1.38E-03	2.78E-04	3.02E-03	2.00E+01
Deaf Smith	1.08E-01	2.28E-03	1.76E-03	1.89E-03	3.16E-04	3.10E-03	1.89E+01
Delta	1.80E-05	3.54E-07	2.45E-07	9.73E-08	1.50E-08	2.25E-07	2.99E-03
Denton	2.79E+00	5.73E-02	4.19E-02	2.80E-02	4.91E-03	5.56E-02	4.77E+02
DeWitt	3.71E-03	7.70E-05	5.86E-05	4.19E-05	8.34E-06	9.21E-05	6.51E-01
Dickens	3.09E-03	6.08E-05	4.20E-05	1.67E-05	2.57E-06	3.87E-05	5.14E-01
Dimmit	2.35E-02	4.88E-04	3.73E-04	2.72E-04	5.46E-05	5.99E-04	4.12E+00
Donley	1.49E-02	3.12E-04	2.40E-04	1.80E-04	3.64E-05	3.95E-04	2.63E+00
Duval	1.96E-02	3.99E-04	2.95E-04	1.85E-04	3.55E-05	4.12E-04	3.37E+00
Eastland	8.59E-02	1.79E-03	1.38E-03	1.03E-03	2.09E-04	2.27E-03	1.52E+01
Ector	4.11E-01	8.59E-03	6.61E-03	4.98E-03	1.01E-03	1.09E-02	7.26E+01
Edwards	1.02E-02	2.07E-04	1.51E-04	8.93E-05	1.67E-05	1.99E-04	1.75E+00
El Paso	1.94E+00	4.56E-02	4.18E-02	9.40E-01	9.77E-02	2.78E-01	2.10E+02
Ellis	3.82E-01	8.09E-03	6.26E-03	7.89E-03	1.23E-03	1.16E-02	6.69E+01
Erath	1.86E-01	3.91E-03	3.00E-03	2.81E-03	5.00E-04	5.11E-03	3.27E+01
Falls	4.01E-03	8.20E-05	6.08E-05	3.87E-05	7.45E-06	8.59E-05	6.92E-01
Fannin	1.21E-01	2.50E-03	1.90E-03	1.36E-03	2.71E-04	2.99E-03	2.12E+01
Fayette	9.83E-02	2.04E-03	1.55E-03	1.11E-03	2.22E-04	2.45E-03	1.72E+01
Fisher	3.10E-02	6.47E-04	4.98E-04	3.73E-04	7.52E-05	8.17E-04	5.47E+00
Floyd	5.26E-02	1.09E-03	8.36E-04	6.12E-04	1.23E-04	1.34E-03	9.24E+00
Foard	3.81E-03	8.01E-05	6.23E-05	4.90E-05	1.00E-05	1.07E-04	6.77E-01

Table 3-5. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Fort Bend	1.04E+00	2.47E-02	1.97E-02	4.16E-02	5.51E-03	4.25E-02	1.83E+02
Franklin	5.75E-02	1.20E-03	9.30E-04	7.12E-04	1.45E-04	1.56E-03	1.02E+01
Freestone	1.24E-02	2.58E-04	1.98E-04	1.49E-04	3.00E-05	3.26E-04	2.18E+00
Frio	4.24E-02	8.82E-04	6.76E-04	4.99E-04	1.00E-04	1.09E-03	7.45E+00
Gaines	1.44E-01	3.04E-03	2.34E-03	1.76E-03	3.56E-04	3.81E-03	2.53E+01
Galveston	3.18E-01	9.62E-03	8.16E-03	2.55E-02	3.13E-03	2.06E-02	5.67E+01
Garza	8.14E-03	1.66E-04	1.23E-04	7.80E-05	1.50E-05	1.73E-04	1.41E+00
Gillespie	1.40E-01	3.08E-03	2.39E-03	4.31E-03	5.80E-04	4.82E-03	2.44E+01
Glasscock	2.37E-03	4.68E-05	3.23E-05	1.28E-05	1.98E-06	2.97E-05	3.95E-01
Gonzales	1.88E-02	3.92E-04	3.00E-04	2.21E-04	4.45E-05	4.86E-04	3.31E+00
Gray	1.75E-01	3.66E-03	2.81E-03	2.12E-03	4.28E-04	4.65E-03	3.09E+01
Grayson	8.35E-01	1.76E-02	1.35E-02	1.31E-02	2.29E-03	2.32E-02	1.47E+02
Gregg	5.84E-01	1.79E-02	1.55E-02	1.02E-01	1.06E-02	5.90E-02	9.62E+01
Grimes	4.06E-02	8.47E-04	6.51E-04	4.89E-04	9.87E-05	1.07E-03	7.15E+00
Guadalupe	6.24E-01	1.68E-02	1.41E-02	9.76E-02	9.91E-03	5.82E-02	9.96E+01
Hale	6.62E-02	1.42E-03	1.09E-03	2.05E-03	2.67E-04	2.22E-03	1.14E+01
Hall	9.32E-03	1.95E-04	1.50E-04	1.13E-04	2.28E-05	2.47E-04	1.64E+00
Hamilton	5.86E-02	1.25E-03	9.57E-04	7.11E-04	1.42E-04	1.52E-03	1.03E+01
Hansford	2.42E-01	5.06E-03	3.89E-03	2.93E-03	5.93E-04	6.43E-03	4.27E+01
Hardeman	3.42E-02	7.14E-04	5.49E-04	4.14E-04	8.36E-05	9.07E-04	6.03E+00
Hardin	3.34E-02	6.99E-04	5.40E-04	4.12E-04	8.37E-05	9.04E-04	5.91E+00
Harris	1.30E+01	2.40E-01	2.18E-01	9.05E+00	8.18E-01	1.39E+00	1.59E+03
Harrison	1.36E-01	2.85E-03	2.21E-03	1.71E-03	3.48E-04	3.74E-03	2.41E+01
Hartley	8.96E-02	1.96E-03	1.54E-03	3.35E-03	4.29E-04	3.42E-03	1.55E+01
Haskell	1.86E-02	3.89E-04	3.00E-04	2.26E-04	4.56E-05	4.95E-04	3.29E+00
Hays	1.45E-02	2.89E-04	2.03E-04	9.21E-05	1.53E-05	2.10E-04	2.44E+00
Hemphill	5.29E-02	1.10E-03	8.42E-04	6.19E-04	1.24E-04	1.36E-03	9.30E+00
Henderson	1.06E-01	2.28E-03	1.77E-03	2.76E-03	3.92E-04	3.44E-03	1.85E+01
Hidalgo	1.18E+00	2.74E-02	2.35E-02	3.35E-01	3.60E-02	1.10E-01	1.63E+02
Hill	1.05E-01	2.18E-03	1.66E-03	1.20E-03	2.39E-04	2.63E-03	1.84E+01
Hockley	1.10E-01	2.31E-03	1.78E-03	1.35E-03	2.73E-04	2.95E-03	1.95E+01
Hood	2.84E-01	5.91E-03	4.51E-03	3.29E-03	6.59E-04	7.23E-03	4.99E+01
Hopkins	2.67E-01	5.62E-03	4.33E-03	3.85E-03	7.13E-04	7.38E-03	4.71E+01
Houston	7.56E-02	1.57E-03	1.21E-03	8.93E-04	1.80E-04	1.96E-03	1.33E+01
Howard	1.95E-01	4.72E-03	3.85E-03	1.93E-02	2.05E-03	1.30E-02	3.24E+01
Hudspeth	2.45E-02	5.13E-04	3.96E-04	3.02E-04	6.12E-05	6.61E-04	4.33E+00
Hunt	3.53E-01	8.58E-03	7.00E-03	3.62E-02	3.81E-03	2.40E-02	5.83E+01
Hutchinson	7.78E-02	1.63E-03	1.26E-03	1.09E-03	2.04E-04	2.14E-03	1.37E+01

Table 3-5. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Irion	1.55E-03	3.06E-05	2.11E-05	8.40E-06	1.29E-06	1.94E-05	2.58E-01
Jack	2.45E-02	5.06E-04	3.81E-04	2.62E-04	5.17E-05	5.79E-04	4.27E+00
Jackson	1.57E-01	3.39E-03	2.71E-03	4.01E-03	6.24E-04	5.62E-03	2.79E+01
Jasper	1.57E-01	3.28E-03	2.53E-03	1.90E-03	3.84E-04	4.17E-03	2.77E+01
Jeff Davis	1.80E-05	3.54E-07	2.45E-07	9.73E-08	1.50E-08	2.25E-07	2.99E-03
Jefferson	3.62E-01	8.90E-03	7.42E-03	4.48E-02	5.22E-03	2.62E-02	5.90E+01
Jim Hogg	5.22E-03	1.07E-04	8.00E-05	5.27E-05	1.02E-05	1.17E-04	9.06E-01
Jim Wells	4.07E-01	2.02E-02	1.94E-02	3.07E-01	2.90E-02	1.50E-01	3.64E+01
Johnson	3.13E-01	6.59E-03	5.03E-03	3.98E-03	7.53E-04	8.00E-03	5.49E+01
Jones	8.14E-02	1.70E-03	1.30E-03	9.67E-04	1.95E-04	2.12E-03	1.43E+01
Karnes	8.28E-02	3.71E-03	3.52E-03	5.27E-02	5.00E-03	2.59E-02	8.46E+00
Kaufman	3.02E-01	6.32E-03	4.87E-03	3.70E-03	7.48E-04	8.08E-03	5.33E+01
Kendall	6.06E-03	1.19E-04	8.23E-05	3.28E-05	5.04E-06	7.59E-05	1.01E+00
Kenedy	1.53E-03	3.02E-05	2.08E-05	8.30E-06	1.28E-06	1.92E-05	2.55E-01
Kent	5.17E-02	1.08E-03	8.29E-04	6.21E-04	1.25E-04	1.36E-03	9.12E+00
Kerr	5.24E-01	1.09E-02	8.39E-03	6.31E-03	1.27E-03	1.38E-02	9.23E+01
Kimble	6.08E-02	1.33E-03	1.04E-03	2.24E-03	2.89E-04	2.31E-03	1.06E+01
King	3.09E-03	6.08E-05	4.19E-05	1.67E-05	2.57E-06	3.86E-05	5.14E-01
Kinney	9.92E-03	1.95E-04	1.35E-04	5.37E-05	8.26E-06	1.24E-04	1.65E+00
Kleberg	6.54E-02	1.56E-03	1.26E-03	5.06E-03	5.62E-04	3.74E-03	1.11E+01
Knox	4.46E-02	9.29E-04	7.11E-04	5.23E-04	1.05E-04	1.15E-03	7.85E+00
La Salle	1.11E-01	3.50E-03	3.02E-03	3.45E-02	3.30E-03	1.78E-02	1.50E+01
Lamar	1.48E-01	3.20E-03	2.53E-03	2.78E-03	4.86E-04	4.71E-03	2.64E+01
Lamb	7.19E-02	1.52E-03	1.18E-03	1.28E-03	2.19E-04	2.15E-03	1.27E+01
Lampasas	9.11E-02	1.90E-03	1.45E-03	1.06E-03	2.12E-04	2.33E-03	1.60E+01
Lavaca	2.52E-02	5.26E-04	4.04E-04	3.00E-04	6.04E-05	6.58E-04	4.45E+00
Lee	1.11E-01	2.43E-03	1.90E-03	4.32E-03	5.42E-04	4.25E-03	1.92E+01
Leon	1.19E-02	2.37E-04	1.67E-04	7.79E-05	1.32E-05	1.77E-04	2.00E+00
Liberty	1.76E-01	3.93E-03	3.10E-03	8.82E-03	1.04E-03	7.65E-03	3.02E+01
Limestone	3.58E-02	7.46E-04	5.72E-04	4.22E-04	8.50E-05	9.28E-04	6.31E+00
Lipscomb	7.15E-03	1.43E-04	1.02E-04	5.23E-05	9.25E-06	1.18E-04	1.21E+00
Live Oak	2.20E-02	4.55E-04	3.45E-04	2.44E-04	4.85E-05	5.37E-04	3.85E+00
Llano	2.12E-01	5.20E-03	4.24E-03	2.07E-02	2.21E-03	1.40E-02	3.53E+01
Lubbock	1.24E+00	3.10E-02	2.72E-02	3.70E-01	3.92E-02	1.36E-01	1.68E+02
Lynn	2.41E-02	5.01E-04	3.83E-04	2.79E-04	5.60E-05	6.14E-04	4.23E+00
Madison	6.75E-03	1.39E-04	1.04E-04	7.07E-05	1.39E-05	1.56E-04	1.18E+00
Marion	1.63E-02	3.40E-04	2.62E-04	1.97E-04	3.99E-05	4.32E-04	2.87E+00
Martin	1.43E-02	2.97E-04	2.26E-04	1.63E-04	3.25E-05	3.58E-04	2.51E+00

Table 3-5. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Mason	1.66E-02	3.45E-04	2.63E-04	1.92E-04	3.85E-05	4.22E-04	2.91E+00
Matagorda	1.80E-01	4.64E-03	3.87E-03	2.50E-02	2.56E-03	1.53E-02	2.91E+01
Maverick	9.53E-03	2.00E-04	1.56E-04	1.23E-04	2.51E-05	2.69E-04	1.69E+00
McCulloch	1.80E-01	3.06E-04	2.95E-04	5.53E-03	1.03E-03	1.19E-02	1.05E+01
McLennan	1.83E+00	5.23E-02	4.52E-02	3.92E-01	3.99E-02	2.16E-01	2.79E+02
McMullen	1.55E-03	3.06E-05	2.11E-05	8.40E-06	1.29E-06	1.94E-05	2.58E-01
Medina	9.00E-01	1.88E-02	1.45E-02	1.11E-02	2.22E-03	2.39E-02	1.59E+02
Menard	8.03E-03	1.64E-04	1.22E-04	7.76E-05	1.49E-05	1.72E-04	1.39E+00
Midland	1.20E+00	3.13E-02	2.78E-02	3.63E-01	3.98E-02	1.52E-01	1.59E+02
Milam	5.35E-02	1.11E-03	8.47E-04	6.13E-04	1.23E-04	1.35E-03	9.39E+00
Mills	6.20E-03	1.22E-04	8.43E-05	3.35E-05	5.16E-06	7.77E-05	1.03E+00
Mitchell	3.70E-02	7.75E-04	6.00E-04	4.62E-04	9.39E-05	1.01E-03	6.55E+00
Montague	1.11E-01	2.36E-03	1.82E-03	2.10E-03	3.42E-04	3.28E-03	1.95E+01
Montgomery	5.91E-01	1.52E-02	1.26E-02	6.65E-02	7.05E-03	4.37E-02	9.82E+01
Moore	1.54E-01	3.23E-03	2.49E-03	2.31E-03	4.18E-04	4.29E-03	2.71E+01
Morris	1.23E-03	2.71E-05	2.28E-05	2.30E-05	4.96E-06	4.96E-05	2.29E-01
Motley	1.70E-03	3.54E-05	2.73E-05	2.06E-05	4.16E-06	4.51E-05	2.99E-01
Nacogdoches	2.40E-01	5.19E-03	4.06E-03	7.43E-03	1.01E-03	8.46E-03	4.19E+01
Navarro	2.08E-01	4.33E-03	3.31E-03	2.44E-03	4.89E-04	5.35E-03	3.66E+01
Newton	4.94E-03	1.03E-04	7.98E-05	6.09E-05	1.23E-05	1.33E-04	8.74E-01
Nolan	8.09E-02	1.69E-03	1.30E-03	9.84E-04	1.99E-04	2.16E-03	1.43E+01
Nueces	1.53E+00	6.76E-02	6.46E-02	9.89E-01	9.70E-02	4.71E-01	1.54E+02
Ochiltree	1.49E-01	3.11E-03	2.40E-03	1.80E-03	3.65E-04	3.96E-03	2.63E+01
Oldham	3.42E-02	7.14E-04	5.49E-04	4.14E-04	8.36E-05	9.07E-04	6.03E+00
Orange	9.55E-02	2.23E-03	1.76E-03	1.44E-03	2.90E-04	2.82E-03	1.71E+01
Palo Pinto	4.13E-02	8.61E-04	6.59E-04	4.86E-04	9.77E-05	1.07E-03	7.27E+00
Panola	8.91E-02	2.01E-03	1.60E-03	4.86E-03	5.70E-04	4.12E-03	1.53E+01
Parker	5.35E-01	1.13E-02	8.69E-03	1.01E-02	1.61E-03	1.56E-02	9.36E+01
Parmer	6.33E-02	1.32E-03	1.01E-03	7.49E-04	1.51E-04	1.64E-03	1.12E+01
Pecos	8.51E-02	1.89E-03	1.49E-03	3.32E-03	4.23E-04	3.32E-03	1.48E+01
Polk	7.30E-02	1.52E-03	1.17E-03	8.73E-04	1.76E-04	1.92E-03	1.29E+01
Potter	1.52E+00	6.18E-02	5.85E-02	9.37E-01	9.07E-02	4.04E-01	1.79E+02
Presidio	1.34E-01	2.80E-03	2.15E-03	1.62E-03	3.28E-04	3.54E-03	2.36E+01
Rains	2.71E-03	5.57E-05	4.18E-05	2.81E-05	5.50E-06	6.21E-05	4.71E-01
Randall	3.59E-01	7.49E-03	5.74E-03	4.25E-03	8.56E-04	9.34E-03	6.33E+01
Reagan	1.90E-02	3.96E-04	3.04E-04	2.28E-04	4.60E-05	4.99E-04	3.34E+00
Real	1.21E-02	2.51E-04	1.90E-04	1.35E-04	2.69E-05	2.97E-04	2.12E+00
Red River	1.25E-02	2.60E-04	1.99E-04	1.48E-04	2.99E-05	3.26E-04	2.19E+00

Table 3-5. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Reeves	2.47E-01	9.41E-03	8.62E-03	1.01E-01	9.75E-03	5.21E-02	3.26E+01
Refugio	3.32E-02	6.93E-04	5.32E-04	3.96E-04	7.98E-05	8.69E-04	5.85E+00
Roberts	5.86E-03	1.20E-04	9.02E-05	6.01E-05	1.17E-05	1.33E-04	1.02E+00
Robertson	3.08E-02	6.36E-04	4.80E-04	3.33E-04	6.57E-05	7.34E-04	5.37E+00
Rockwall	4.32E-01	9.04E-03	6.97E-03	5.55E-03	1.09E-03	1.17E-02	7.63E+01
Runnels	2.78E-02	5.85E-04	4.49E-04	3.32E-04	6.65E-05	7.18E-04	4.89E+00
Rusk	1.00E-01	2.33E-03	1.87E-03	7.25E-03	8.06E-04	5.45E-03	1.70E+01
Sabine	1.07E-02	2.24E-04	1.75E-04	1.39E-04	2.86E-05	3.05E-04	1.90E+00
San Augustine	6.81E-03	1.42E-04	1.09E-04	8.23E-05	1.66E-05	1.81E-04	1.20E+00
San Jacinto	1.81E-03	3.56E-05	2.46E-05	9.78E-06	1.51E-06	2.26E-05	3.01E-01
San Patricio	1.97E-01	4.11E-03	3.16E-03	2.38E-03	4.82E-04	5.23E-03	3.47E+01
San Saba	1.68E-02	3.50E-04	2.67E-04	1.93E-04	3.87E-05	4.25E-04	2.95E+00
Schleicher	9.42E-03	1.95E-04	1.47E-04	1.02E-04	2.02E-05	2.25E-04	1.64E+00
Scurry	8.69E-02	1.82E-03	1.40E-03	1.05E-03	2.13E-04	2.31E-03	1.53E+01
Shackelford	3.39E-02	7.09E-04	5.46E-04	4.11E-04	8.31E-05	9.02E-04	5.99E+00
Shelby	1.90E-01	3.98E-03	3.07E-03	2.75E-03	5.07E-04	5.25E-03	3.35E+01
Sherman	2.24E-03	4.67E-05	3.59E-05	2.69E-05	5.43E-06	5.90E-05	3.95E-01
Smith	3.21E-01	8.30E-03	6.92E-03	2.44E-02	3.62E-03	1.68E-02	5.43E+01
Somervell	6.44E-03	1.29E-04	9.25E-05	4.83E-05	8.60E-06	1.09E-04	1.09E+00
Starr	4.36E-03	8.89E-05	6.56E-05	4.06E-05	7.74E-06	9.03E-05	7.51E-01
Stephens	1.21E-01	2.52E-03	1.94E-03	1.44E-03	2.91E-04	3.17E-03	2.13E+01
Sterling	1.98E-03	3.91E-05	2.71E-05	1.13E-05	1.79E-06	2.60E-05	3.30E-01
Stonewall	8.79E-03	1.87E-04	1.48E-04	1.25E-04	2.60E-05	2.73E-04	1.58E+00
Sutton	1.44E-02	3.00E-04	2.30E-04	1.71E-04	3.45E-05	3.75E-04	2.54E+00
Swisher	5.80E-02	1.21E-03	9.24E-04	6.77E-04	1.36E-04	1.49E-03	1.02E+01
Tarrant	2.79E+01	2.87E-01	2.65E-01	1.70E+01	1.86E+00	2.73E+00	1.84E+03
Taylor	7.13E-01	2.69E-02	2.49E-02	3.17E-01	3.18E-02	1.57E-01	9.01E+01
Terrell	4.13E-03	8.45E-05	6.25E-05	3.94E-05	7.56E-06	8.75E-05	7.14E-01
Terry	2.35E-02	4.92E-04	3.80E-04	2.92E-04	5.94E-05	6.40E-04	4.15E+00
Throckmorton	5.60E-04	1.17E-05	8.98E-06	6.72E-06	1.36E-06	1.48E-05	9.87E-02
Titus	1.31E-01	2.74E-03	2.11E-03	1.58E-03	3.20E-04	3.47E-03	2.32E+01
Tom Green	6.22E-02	8.97E-04	7.76E-04	2.08E-02	2.70E-03	3.72E-03	9.08E+00
Travis	5.49E+00	4.48E-02	4.25E-02	2.50E+00	2.83E-01	6.79E-01	3.67E+02
Trinity	1.42E-02	2.94E-04	2.23E-04	1.58E-04	3.15E-05	3.49E-04	2.48E+00
Tyler	1.53E-02	3.19E-04	2.45E-04	1.82E-04	3.66E-05	3.99E-04	2.70E+00
Upshur	1.52E-01	3.18E-03	2.45E-03	1.86E-03	3.78E-04	4.09E-03	2.69E+01
Upton	6.89E-03	1.44E-04	1.11E-04	8.28E-05	1.67E-05	1.82E-04	1.21E+00
Uvalde	1.04E-01	2.41E-03	1.93E-03	5.87E-03	6.91E-04	4.93E-03	1.78E+01

Table 3-5. Uncontrolled Daily Criteria Emission by County (Tons Per Day)

County	CO	NO_X	PM10-PRI	PM25-PRI	SO_2	VOC	LTO
Val Verde	1.26E-01	3.10E-03	2.51E-03	7.16E-03	1.05E-03	6.09E-03	2.20E+01
Van Zandt	3.33E-02	6.85E-04	5.13E-04	3.44E-04	6.71E-05	7.59E-04	5.79E+00
Victoria	9.68E-01	4.79E-02	4.63E-02	7.24E-01	6.87E-02	3.55E-01	8.76E+01
Walker	2.74E-01	8.21E-03	7.15E-03	6.62E-02	6.52E-03	3.64E-02	4.10E+01
Waller	1.73E-01	3.60E-03	2.75E-03	1.99E-03	3.99E-04	4.38E-03	3.04E+01
Ward	1.02E-01	2.14E-03	1.65E-03	1.24E-03	2.51E-04	2.72E-03	1.81E+01
Washington	9.96E-02	2.09E-03	1.60E-03	1.49E-03	2.64E-04	2.71E-03	1.75E+01
Webb	1.33E+00	4.71E-02	4.45E-02	7.71E-01	7.66E-02	3.36E-01	1.29E+02
Wharton	1.17E-01	2.50E-03	1.94E-03	2.89E-03	4.18E-04	3.74E-03	2.05E+01
Wheeler	1.04E-02	2.17E-04	1.67E-04	1.25E-04	2.53E-05	2.75E-04	1.84E+00
Wichita	2.26E+00	1.04E-01	9.91E-02	1.51E+00	1.44E-01	7.45E-01	2.22E+02
Wilbarger	1.33E-01	2.84E-03	2.20E-03	3.11E-03	4.63E-04	4.20E-03	2.33E+01
Willacy	1.25E-02	2.58E-04	1.94E-04	1.30E-04	2.55E-05	2.88E-04	2.18E+00
Williamson	1.19E+00	2.54E-02	1.96E-02	2.15E-02	3.58E-03	3.47E-02	2.09E+02
Wilson	9.38E-03	1.85E-04	1.28E-04	5.08E-05	7.81E-06	1.18E-04	1.56E+00
Winkler	1.19E-02	3.08E-04	2.59E-04	1.66E-03	1.71E-04	1.03E-03	1.94E+00
Wise	3.81E-01	7.93E-03	6.05E-03	4.40E-03	8.82E-04	9.67E-03	6.70E+01
Wood	1.91E-01	3.99E-03	3.07E-03	2.30E-03	4.65E-04	5.05E-03	3.37E+01
Yoakum	8.05E-02	1.68E-03	1.29E-03	9.76E-04	1.97E-04	2.14E-03	1.42E+01
Young	1.28E-01	2.68E-03	2.06E-03	1.70E-03	3.27E-04	3.47E-03	2.26E+01
Zapata	2.74E-02	5.69E-04	4.35E-04	3.19E-04	6.39E-05	7.00E-04	4.81E+00
Zavala	9.56E-03	1.91E-04	1.36E-04	6.88E-05	1.21E-05	1.55E-04	1.62E+00

4.0 References

1. Federal Aviation Administration. Terminal Area Forecast (TAF). http://aspm.faa.gov/main/taf.asp. Accessed April 21, 2018.

Appendix A
Projection Factors

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
00R	GA	2017	2020	1	Airport/Aircraft Specific
00TA	GA	2017	2020	1.02438137	Aircraft Specific
00TE	GA	2017	2020	1.02438137	Aircraft Specific
00TS	GA	2017	2020	1.02438137	Aircraft Specific
00TX	AT	2017	2020	0.803340056	Aircraft Specific
00XS	GA	2017	2020	1.02438137	Aircraft Specific
01TA	GA	2017	2020	1.02438137	Aircraft Specific
01TE	GA	2017	2020	1.02438137	Aircraft Specific
01TX	GA	2017	2020	1.02438137	Aircraft Specific
01XA	GA	2017	2020	1.02438137	Aircraft Specific
01XS	GA	2017	2020	1.02438137	Aircraft Specific
02TA	GA	2017	2020	1.02438137	Aircraft Specific
02TE	GA	2017	2020	1.02438137	Aircraft Specific
02TX	GA	2017	2020	1.02438137	Aircraft Specific
02XS	GA	2017	2020	1.02438137	Aircraft Specific
03TE	GA	2017	2020	1.02438137	Aircraft Specific
03TS	GA	2017	2020	1.02438137	Aircraft Specific
03TX	GA	2017	2020	1.02438137	Aircraft Specific
03XS	GA	2017	2020	1.02438137	Aircraft Specific
04TA	GA	2017	2020	1.02438137	Aircraft Specific
04TE	GA	2017	2020	1.02438137	Aircraft Specific
04TS	GA	2017	2020	1.02438137	Aircraft Specific
04TX	GA	2017	2020	1.02438137	Aircraft Specific
04XS	GA	2017	2020	1.02438137	Aircraft Specific
05TA	GA	2017	2020	1.02438137	Aircraft Specific
05TE	GA	2017	2020	1.02438137	Aircraft Specific
05TS	GA	2017	2020	1.02438137	Aircraft Specific
05TX	GA	2017	2020	1.02438137	Aircraft Specific
06R	GA	2017	2020	1.02438137	Aircraft Specific
06TA	GA	2017	2020	1.02438137	Aircraft Specific
06TE	GA	2017	2020	1.02438137	Aircraft Specific
06TX	GA	2017	2020	1.02438137	Aircraft Specific
06XA	GA	2017	2020	1.02438137	Aircraft Specific
06XS	GA	2017	2020	1.02438137	Aircraft Specific
07F	AT	2017	2020	1	Airport/Aircraft Specific
07F	GA	2017	2020	1	Airport/Aircraft Specific
07R	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
07TA	GA	2017	2020	1.02438137	Aircraft Specific
07TE	GA	2017	2020	1.02438137	Aircraft Specific
07TS	GA	2017	2020	1.02438137	Aircraft Specific
07TX	GA	2017	2020	1.02438137	Aircraft Specific
07XS	GA	2017	2020	1.02438137	Aircraft Specific
08TA	GA	2017	2020	1.02438137	Aircraft Specific
08TE	GA	2017	2020	1.02438137	Aircraft Specific
08TX	GA	2017	2020	1.02438137	Aircraft Specific
08XS	GA	2017	2020	1.02438137	Aircraft Specific
09R	GA	2017	2020	1.02438137	Aircraft Specific
09T	GA	2017	2020	1.02438137	Aircraft Specific
09TE	GA	2017	2020	1.02438137	Aircraft Specific
09TS	GA	2017	2020	1.02438137	Aircraft Specific
09TX	GA	2017	2020	1.02438137	Aircraft Specific
09XS	GA	2017	2020	1.02438137	Aircraft Specific
0F2	AT	2017	2020	1	Airport/Aircraft Specific
0F2	GA	2017	2020	1	Airport/Aircraft Specific
0F2	MIL	2017	2020	1	Airport/Aircraft Specific
0T7	GA	2017	2020	1.02438137	Aircraft Specific
0TA0	GA	2017	2020	1.02438137	Aircraft Specific
0TA1	GA	2017	2020	1.02438137	Aircraft Specific
0TA2	GA	2017	2020	1.02438137	Aircraft Specific
0TA3	GA	2017	2020	1.02438137	Aircraft Specific
0TA4	GA	2017	2020	1.02438137	Aircraft Specific
0TA5	GA	2017	2020	1.02438137	Aircraft Specific
0TA6	GA	2017	2020	1.02438137	Aircraft Specific
0TA7	GA	2017	2020	1.02438137	Aircraft Specific
0TA8	GA	2017	2020	1.02438137	Aircraft Specific
0TA9	GA	2017	2020	1.02438137	Aircraft Specific
0TE0	GA	2017	2020	1.02438137	Aircraft Specific
0TE1	GA	2017	2020	1.02438137	Aircraft Specific
0TE2	GA	2017	2020	1.02438137	Aircraft Specific
0TE3	GA	2017	2020	1.02438137	Aircraft Specific
0TE4	GA	2017	2020	1.02438137	Aircraft Specific
0TE5	GA	2017	2020	1.02438137	Aircraft Specific
0TE6	GA	2017	2020	1.02438137	Aircraft Specific
0TE7	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
0TE8	GA	2017	2020	1.02438137	Aircraft Specific
0TE9	GA	2017	2020	1.02438137	Aircraft Specific
0TS1	GA	2017	2020	1.02438137	Aircraft Specific
0TS2	GA	2017	2020	1.02438137	Aircraft Specific
0TS3	GA	2017	2020	1.02438137	Aircraft Specific
0TS4	GA	2017	2020	1.02438137	Aircraft Specific
0TS5	GA	2017	2020	1.02438137	Aircraft Specific
0TS6	GA	2017	2020	1.02438137	Aircraft Specific
0TS7	GA	2017	2020	1.02438137	Aircraft Specific
0TS8	GA	2017	2020	1.02438137	Aircraft Specific
0TS9	GA	2017	2020	1.02438137	Aircraft Specific
0TX0	GA	2017	2020	1.02438137	Aircraft Specific
0TX1	GA	2017	2020	1.02438137	Aircraft Specific
0TX2	GA	2017	2020	1.02438137	Aircraft Specific
0TX3	GA	2017	2020	1.02438137	Aircraft Specific
0TX4	GA	2017	2020	1.02438137	Aircraft Specific
0TX5	GA	2017	2020	1.02438137	Aircraft Specific
0TX6	GA	2017	2020	1.02438137	Aircraft Specific
0TX7	GA	2017	2020	1.02438137	Aircraft Specific
0TX8	GA	2017	2020	1.02438137	Aircraft Specific
0TX9	GA	2017	2020	1.02438137	Aircraft Specific
0XA0	GA	2017	2020	1.02438137	Aircraft Specific
0XA1	GA	2017	2020	1.02438137	Aircraft Specific
0XA2	GA	2017	2020	1.02438137	Aircraft Specific
0XA3	GA	2017	2020	1.02438137	Aircraft Specific
0XA4	GA	2017	2020	1.02438137	Aircraft Specific
0XA5	GA	2017	2020	1.02438137	Aircraft Specific
0XA6	GA	2017	2020	1.02438137	Aircraft Specific
0XA7	GA	2017	2020	1.02438137	Aircraft Specific
0XA8	GA	2017	2020	1.02438137	Aircraft Specific
0XA9	GA	2017	2020	1.02438137	Aircraft Specific
0XS0	GA	2017	2020	1.02438137	Aircraft Specific
0XS1	GA	2017	2020	1.02438137	Aircraft Specific
0XS2	GA	2017	2020	1.02438137	Aircraft Specific
0XS3	GA	2017	2020	1.02438137	Aircraft Specific
0XS4	GA	2017	2020	1.02438137	Aircraft Specific
0XS5	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
0XS6	GA	2017	2020	1.02438137	Aircraft Specific
0XS7	GA	2017	2020	1.02438137	Aircraft Specific
0XS8	GA	2017	2020	1.02438137	Aircraft Specific
0XS9	GA	2017	2020	1.02438137	Aircraft Specific
10F	GA	2017	2020	1.02438137	Aircraft Specific
10TA	GA	2017	2020	1.02438137	Aircraft Specific
10TE	GA	2017	2020	1.02438137	Aircraft Specific
10TS	GA	2017	2020	1.02438137	Aircraft Specific
10TX	GA	2017	2020	1.02438137	Aircraft Specific
10XA	GA	2017	2020	1.02438137	Aircraft Specific
10XS	GA	2017	2020	1.02438137	Aircraft Specific
11R	GA	2017	2020	1	Airport/Aircraft Specific
11R	MIL	2017	2020	1	Airport/Aircraft Specific
11TA	GA	2017	2020	1.02438137	Aircraft Specific
11TE	GA	2017	2020	1.02438137	Aircraft Specific
11TS	GA	2017	2020	1.02438137	Aircraft Specific
11TX	GA	2017	2020	1.02438137	Aircraft Specific
11XA	GA	2017	2020	1.02438137	Aircraft Specific
12T	GA	2017	2020	1.02438137	Aircraft Specific
12TA	GA	2017	2020	1.02438137	Aircraft Specific
12TE	GA	2017	2020	1.02438137	Aircraft Specific
12TS	GA	2017	2020	1.02438137	Aircraft Specific
12TX	GA	2017	2020	1.02438137	Aircraft Specific
12XA	GA	2017	2020	1.02438137	Aircraft Specific
13TA	GA	2017	2020	1.02438137	Aircraft Specific
13TE	GA	2017	2020	1.02438137	Aircraft Specific
13TS	GA	2017	2020	1.02438137	Aircraft Specific
13TX	GA	2017	2020	1.02438137	Aircraft Specific
13XA	GA	2017	2020	1.02438137	Aircraft Specific
13XS	GA	2017	2020	1.02438137	Aircraft Specific
14F	GA	2017	2020	1.02438137	Aircraft Specific
14TA	GA	2017	2020	1.02438137	Aircraft Specific
14TE	GA	2017	2020	1.02438137	Aircraft Specific
14TS	GA	2017	2020	1.02438137	Aircraft Specific
14TX	GA	2017	2020	1.02438137	Aircraft Specific
14XA	GA	2017	2020	1.02438137	Aircraft Specific
14XS	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
15F	GA	2017	2020	1	Airport/Aircraft Specific
15TA	GA	2017	2020	1.02438137	Aircraft Specific
15TE	GA	2017	2020	1.02438137	Aircraft Specific
15TS	GA	2017	2020	1.02438137	Aircraft Specific
15TX	GA	2017	2020	1.02438137	Aircraft Specific
15XS	GA	2017	2020	1.02438137	Aircraft Specific
16TA	GA	2017	2020	1.02438137	Aircraft Specific
16TE	GA	2017	2020	1.02438137	Aircraft Specific
16TS	GA	2017	2020	1.02438137	Aircraft Specific
16TX	GA	2017	2020	1.02438137	Aircraft Specific
16X	GA	2017	2020	1.02438137	Aircraft Specific
16XA	GA	2017	2020	1.02438137	Aircraft Specific
16XS	GA	2017	2020	1.02438137	Aircraft Specific
17TA	GA	2017	2020	1.02438137	Aircraft Specific
17TE	GA	2017	2020	1.02438137	Aircraft Specific
17TS	GA	2017	2020	1.02438137	Aircraft Specific
17TX	GA	2017	2020	1.02438137	Aircraft Specific
17XA	GA	2017	2020	1.02438137	Aircraft Specific
17XS	GA	2017	2020	1.02438137	Aircraft Specific
18TA	GA	2017	2020	1.02438137	Aircraft Specific
18TE	GA	2017	2020	1.02438137	Aircraft Specific
18TS	GA	2017	2020	1.02438137	Aircraft Specific
18TX	GA	2017	2020	1.02438137	Aircraft Specific
18XS	GA	2017	2020	1.02438137	Aircraft Specific
19TA	GA	2017	2020	1.02438137	Aircraft Specific
19TE	GA	2017	2020	1.02438137	Aircraft Specific
19TS	GA	2017	2020	1.02438137	Aircraft Specific
19TX	GA	2017	2020	1.02438137	Aircraft Specific
19XA	GA	2017	2020	1.02438137	Aircraft Specific
19XS	GA	2017	2020	1.02438137	Aircraft Specific
1E2	GA	2017	2020	1.02438137	Aircraft Specific
1E4	GA	2017	2020	1.02438137	Aircraft Specific
1E7	GA	2017	2020	1.02438137	Aircraft Specific
1E9	GA	2017	2020	1.02438137	Aircraft Specific
1F7	GA	2017	2020	1.02438137	Aircraft Specific
1T7	GA	2017	2020	1.02438137	Aircraft Specific
1T8	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
1TA0	GA	2017	2020	1.02438137	Aircraft Specific
1TA1	GA	2017	2020	1.02438137	Aircraft Specific
1TA2	GA	2017	2020	1.02438137	Aircraft Specific
1TA3	GA	2017	2020	1.02438137	Aircraft Specific
1TA4	GA	2017	2020	1.02438137	Aircraft Specific
1TA5	GA	2017	2020	1.02438137	Aircraft Specific
1TA6	GA	2017	2020	1.02438137	Aircraft Specific
1TA7	GA	2017	2020	1.02438137	Aircraft Specific
1TA9	GA	2017	2020	1.02438137	Aircraft Specific
1TE0	GA	2017	2020	1.02438137	Aircraft Specific
1TE1	GA	2017	2020	1.02438137	Aircraft Specific
1TE3	GA	2017	2020	1.02438137	Aircraft Specific
1TE4	GA	2017	2020	1.02438137	Aircraft Specific
1TE5	GA	2017	2020	1.02438137	Aircraft Specific
1TE6	GA	2017	2020	1.02438137	Aircraft Specific
1TE7	GA	2017	2020	1.02438137	Aircraft Specific
1TE8	GA	2017	2020	1.02438137	Aircraft Specific
1TE9	GA	2017	2020	1.02438137	Aircraft Specific
1TS0	GA	2017	2020	1.02438137	Aircraft Specific
1TS1	GA	2017	2020	1.02438137	Aircraft Specific
1TS2	GA	2017	2020	1.02438137	Aircraft Specific
1TS3	GA	2017	2020	1.02438137	Aircraft Specific
1TS4	GA	2017	2020	1.02438137	Aircraft Specific
1TS5	GA	2017	2020	1.02438137	Aircraft Specific
1TS6	GA	2017	2020	1.02438137	Aircraft Specific
1TS7	GA	2017	2020	1.02438137	Aircraft Specific
1TS8	GA	2017	2020	1.02438137	Aircraft Specific
1TS9	GA	2017	2020	1.02438137	Aircraft Specific
1TX0	GA	2017	2020	1.02438137	Aircraft Specific
1TX1	GA	2017	2020	1.02438137	Aircraft Specific
1TX2	GA	2017	2020	1.02438137	Aircraft Specific
1TX3	GA	2017	2020	1.02438137	Aircraft Specific
1TX5	GA	2017	2020	1.02438137	Aircraft Specific
1TX6	GA	2017	2020	1.02438137	Aircraft Specific
1TX7	GA	2017	2020	1.02438137	Aircraft Specific
1TX8	GA	2017	2020	1.02438137	Aircraft Specific
1TX9	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
1X1	GA	2017	2020	1.02438137	Aircraft Specific
1XA0	GA	2017	2020	1.02438137	Aircraft Specific
1XA1	GA	2017	2020	1.02438137	Aircraft Specific
1XA2	GA	2017	2020	1.02438137	Aircraft Specific
1XA3	GA	2017	2020	1.02438137	Aircraft Specific
1XA4	GA	2017	2020	1.02438137	Aircraft Specific
1XA5	GA	2017	2020	1.02438137	Aircraft Specific
1XA6	GA	2017	2020	1.02438137	Aircraft Specific
1XA7	GA	2017	2020	1.02438137	Aircraft Specific
1XA8	GA	2017	2020	1.02438137	Aircraft Specific
1XA9	GA	2017	2020	1.02438137	Aircraft Specific
1XS0	GA	2017	2020	1.02438137	Aircraft Specific
1XS1	GA	2017	2020	1.02438137	Aircraft Specific
1XS2	GA	2017	2020	1.02438137	Aircraft Specific
1XS3	GA	2017	2020	1.02438137	Aircraft Specific
1XS5	GA	2017	2020	1.02438137	Aircraft Specific
1XS6	GA	2017	2020	1.02438137	Aircraft Specific
1XS7	GA	2017	2020	1.02438137	Aircraft Specific
1XS8	GA	2017	2020	1.02438137	Aircraft Specific
1XS9	GA	2017	2020	1.02438137	Aircraft Specific
20R	GA	2017	2020	1.02438137	Aircraft Specific
20TA	GA	2017	2020	1.02438137	Aircraft Specific
20TE	GA	2017	2020	1.02438137	Aircraft Specific
20TS	GA	2017	2020	1.02438137	Aircraft Specific
20TX	GA	2017	2020	1.02438137	Aircraft Specific
20XA	GA	2017	2020	1.02438137	Aircraft Specific
20XS	GA	2017	2020	1.02438137	Aircraft Specific
21F	GA	2017	2020	1	Airport/Aircraft Specific
21TA	GA	2017	2020	1.02438137	Aircraft Specific
21TE	GA	2017	2020	1.02438137	Aircraft Specific
21TS	GA	2017	2020	1.02438137	Aircraft Specific
21TX	GA	2017	2020	1.02438137	Aircraft Specific
21XS	GA	2017	2020	1.02438137	Aircraft Specific
22F	GA	2017	2020	1.02438137	Aircraft Specific
22TE	GA	2017	2020	1.02438137	Aircraft Specific
22TS	GA	2017	2020	1.02438137	Aircraft Specific
22TX	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
22XA	GA	2017	2020	1.02438137	Aircraft Specific
22XS	GA	2017	2020	1.02438137	Aircraft Specific
23R	GA	2017	2020	1	Airport/Aircraft Specific
23TA	GA	2017	2020	1.02438137	Aircraft Specific
23TE	GA	2017	2020	1.02438137	Aircraft Specific
23TS	GA	2017	2020	1.02438137	Aircraft Specific
23TX	GA	2017	2020	1.02438137	Aircraft Specific
23XA	GA	2017	2020	1.02438137	Aircraft Specific
23XS	GA	2017	2020	1.02438137	Aircraft Specific
24F	GA	2017	2020	1.02438137	Aircraft Specific
24R	GA	2017	2020	1.02438137	Aircraft Specific
24TA	GA	2017	2020	1.02438137	Aircraft Specific
24TE	GA	2017	2020	1.02438137	Aircraft Specific
24TS	GA	2017	2020	1.02438137	Aircraft Specific
24TX	GA	2017	2020	1.02438137	Aircraft Specific
24XA	GA	2017	2020	1.02438137	Aircraft Specific
24XS	GA	2017	2020	1.02438137	Aircraft Specific
25TA	GA	2017	2020	1.02438137	Aircraft Specific
25TE	GA	2017	2020	1.02438137	Aircraft Specific
25TS	GA	2017	2020	1.02438137	Aircraft Specific
25TX	GA	2017	2020	1.02438137	Aircraft Specific
25XA	GA	2017	2020	1.02438137	Aircraft Specific
25XS	GA	2017	2020	1.02438137	Aircraft Specific
26R	GA	2017	2020	1	Airport/Aircraft Specific
26R	MIL	2017	2020	1	Airport/Aircraft Specific
26TA	GA	2017	2020	1.02438137	Aircraft Specific
26TE	GA	2017	2020	1.02438137	Aircraft Specific
26TS	GA	2017	2020	1.02438137	Aircraft Specific
26TX	GA	2017	2020	1.02438137	Aircraft Specific
26XA	GA	2017	2020	1.02438137	Aircraft Specific
26XS	GA	2017	2020	1.02438137	Aircraft Specific
27R	GA	2017	2020	1.02438137	Aircraft Specific
27TA	GA	2017	2020	1.02438137	Aircraft Specific
27TE	GA	2017	2020	1.02438137	Aircraft Specific
27TS	GA	2017	2020	1.02438137	Aircraft Specific
27TX	GA	2017	2020	1.02438137	Aircraft Specific
27XA	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
27XS	GA	2017	2020	1.02438137	Aircraft Specific
28TA	GA	2017	2020	1.02438137	Aircraft Specific
28TE	GA	2017	2020	1.02438137	Aircraft Specific
28TX	GA	2017	2020	1.02438137	Aircraft Specific
28XA	GA	2017	2020	1.02438137	Aircraft Specific
28XS	GA	2017	2020	1.02438137	Aircraft Specific
29F	GA	2017	2020	1.02438137	Aircraft Specific
29TA	GA	2017	2020	1.02438137	Aircraft Specific
29TE	AT	2017	2020	0.803340056	Aircraft Specific
29TE	GA	2017	2020	1.02438137	Aircraft Specific
29TS	GA	2017	2020	1.02438137	Aircraft Specific
29TX	GA	2017	2020	1.02438137	Aircraft Specific
29XA	GA	2017	2020	1.02438137	Aircraft Specific
29XS	GA	2017	2020	1.02438137	Aircraft Specific
2E5	GA	2017	2020	1.02438137	Aircraft Specific
2E7	GA	2017	2020	1.02438137	Aircraft Specific
2F0	GA	2017	2020	1.02438137	Aircraft Specific
2F1	GA	2017	2020	1.02438137	Aircraft Specific
2F4	GA	2017	2020	1.02438137	Aircraft Specific
2F5	GA	2017	2020	1	Airport/Aircraft Specific
2F7	GA	2017	2020	1	Airport/Aircraft Specific
2H5	GA	2017	2020	1.02438137	Aircraft Specific
2KL	GA	2017	2020	1.02438137	Aircraft Specific
2R9	AC	2017	2020	1	Airport/Aircraft Specific
2R9	GA	2017	2020	1	Airport/Aircraft Specific
2R9	MIL	2017	2020	1	Airport/Aircraft Specific
2T1	GA	2017	2020	1	Airport/Aircraft Specific
2TA1	GA	2017	2020	1.02438137	Aircraft Specific
2TA2	GA	2017	2020	1.02438137	Aircraft Specific
2TA3	GA	2017	2020	1.02438137	Aircraft Specific
2TA4	GA	2017	2020	1.02438137	Aircraft Specific
2TA5	GA	2017	2020	1.02438137	Aircraft Specific
2TA6	GA	2017	2020	1.02438137	Aircraft Specific
2TA7	GA	2017	2020	1.02438137	Aircraft Specific
2TA8	GA	2017	2020	1.02438137	Aircraft Specific
2TE0	GA	2017	2020	1.02438137	Aircraft Specific
2TE1	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
2TE2	GA	2017	2020	1.02438137	Aircraft Specific
2TE3	GA	2017	2020	1.02438137	Aircraft Specific
2TE4	GA	2017	2020	1.02438137	Aircraft Specific
2TE5	GA	2017	2020	1.02438137	Aircraft Specific
2TE6	GA	2017	2020	1.02438137	Aircraft Specific
2TE7	GA	2017	2020	1.02438137	Aircraft Specific
2TE9	GA	2017	2020	1.02438137	Aircraft Specific
2TS0	GA	2017	2020	1.02438137	Aircraft Specific
2TS1	GA	2017	2020	1.02438137	Aircraft Specific
2TS2	GA	2017	2020	1.02438137	Aircraft Specific
2TS3	GA	2017	2020	1.02438137	Aircraft Specific
2TS4	GA	2017	2020	1.02438137	Aircraft Specific
2TS5	GA	2017	2020	1.02438137	Aircraft Specific
2TS6	GA	2017	2020	1.02438137	Aircraft Specific
2TS7	GA	2017	2020	1.02438137	Aircraft Specific
2TS8	GA	2017	2020	1.02438137	Aircraft Specific
2TS9	GA	2017	2020	1.02438137	Aircraft Specific
2TX0	GA	2017	2020	1.02438137	Aircraft Specific
2TX1	GA	2017	2020	1.02438137	Aircraft Specific
2TX2	GA	2017	2020	1.02438137	Aircraft Specific
2TX3	GA	2017	2020	1.02438137	Aircraft Specific
2TX4	GA	2017	2020	1.02438137	Aircraft Specific
2TX5	GA	2017	2020	1.02438137	Aircraft Specific
2TX6	GA	2017	2020	1.02438137	Aircraft Specific
2TX7	GA	2017	2020	1.02438137	Aircraft Specific
2TX8	GA	2017	2020	1.02438137	Aircraft Specific
2TX9	GA	2017	2020	1.02438137	Aircraft Specific
2XA0	GA	2017	2020	1.02438137	Aircraft Specific
2XA1	GA	2017	2020	1.02438137	Aircraft Specific
2XA2	GA	2017	2020	1.02438137	Aircraft Specific
2XA3	GA	2017	2020	1.02438137	Aircraft Specific
2XA4	GA	2017	2020	1.02438137	Aircraft Specific
2XA5	GA	2017	2020	1.02438137	Aircraft Specific
2XA6	GA	2017	2020	1.02438137	Aircraft Specific
2XA7	GA	2017	2020	1.02438137	Aircraft Specific
2XA8	GA	2017	2020	1.02438137	Aircraft Specific
2XA9	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
2XS0	GA	2017	2020	1.02438137	Aircraft Specific
2XS1	GA	2017	2020	1.02438137	Aircraft Specific
2XS2	GA	2017	2020	1.02438137	Aircraft Specific
2XS3	GA	2017	2020	1.02438137	Aircraft Specific
2XS4	GA	2017	2020	1.02438137	Aircraft Specific
2XS5	GA	2017	2020	1.02438137	Aircraft Specific
2XS6	GA	2017	2020	1.02438137	Aircraft Specific
2XS7	GA	2017	2020	1.02438137	Aircraft Specific
2XS8	GA	2017	2020	1.02438137	Aircraft Specific
2XS9	GA	2017	2020	1.02438137	Aircraft Specific
30F	GA	2017	2020	1.02438137	Aircraft Specific
30TA	GA	2017	2020	1.02438137	Aircraft Specific
30TE	GA	2017	2020	1.02438137	Aircraft Specific
30TS	GA	2017	2020	1.02438137	Aircraft Specific
30XA	GA	2017	2020	1.02438137	Aircraft Specific
30XS	GA	2017	2020	1.02438137	Aircraft Specific
31TA	GA	2017	2020	1.02438137	Aircraft Specific
31TE	GA	2017	2020	1.02438137	Aircraft Specific
31TS	GA	2017	2020	1.02438137	Aircraft Specific
31TX	GA	2017	2020	1.02438137	Aircraft Specific
31XA	GA	2017	2020	1.02438137	Aircraft Specific
31XS	GA	2017	2020	1.02438137	Aircraft Specific
32TA	GA	2017	2020	1.02438137	Aircraft Specific
32TE	GA	2017	2020	1.02438137	Aircraft Specific
32TS	GA	2017	2020	1.02438137	Aircraft Specific
32TX	GA	2017	2020	1.02438137	Aircraft Specific
32XA	GA	2017	2020	1.02438137	Aircraft Specific
32XS	GA	2017	2020	1.02438137	Aircraft Specific
33R	GA	2017	2020	1.02438137	Aircraft Specific
33TA	GA	2017	2020	1.02438137	Aircraft Specific
33TE	GA	2017	2020	1.02438137	Aircraft Specific
33TS	GA	2017	2020	1.02438137	Aircraft Specific
33TX	GA	2017	2020	1.02438137	Aircraft Specific
33XS	GA	2017	2020	1.02438137	Aircraft Specific
34R	GA	2017	2020	1.02438137	Aircraft Specific
34TA	GA	2017	2020	1.02438137	Aircraft Specific
34TE	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
34TS	GA	2017	2020	1.02438137	Aircraft Specific
34TX	GA	2017	2020	1.02438137	Aircraft Specific
34XS	GA	2017	2020	1.02438137	Aircraft Specific
35TA	GA	2017	2020	1.02438137	Aircraft Specific
35TE	GA	2017	2020	1.02438137	Aircraft Specific
35TS	GA	2017	2020	1.02438137	Aircraft Specific
35TX	GA	2017	2020	1.02438137	Aircraft Specific
35XS	GA	2017	2020	1.02438137	Aircraft Specific
36TA	GA	2017	2020	1.02438137	Aircraft Specific
36TE	GA	2017	2020	1.02438137	Aircraft Specific
36TS	GA	2017	2020	1.02438137	Aircraft Specific
36TX	GA	2017	2020	1.02438137	Aircraft Specific
36XS	GA	2017	2020	1.02438137	Aircraft Specific
37F	GA	2017	2020	1.02438137	Aircraft Specific
37TA	GA	2017	2020	1.02438137	Aircraft Specific
37TE	GA	2017	2020	1.02438137	Aircraft Specific
37TS	GA	2017	2020	1.02438137	Aircraft Specific
37TX	GA	2017	2020	1.02438137	Aircraft Specific
37XA	GA	2017	2020	1.02438137	Aircraft Specific
37XS	GA	2017	2020	1.02438137	Aircraft Specific
38TA	GA	2017	2020	1.02438137	Aircraft Specific
38TE	GA	2017	2020	1.02438137	Aircraft Specific
38TS	GA	2017	2020	1.02438137	Aircraft Specific
38TX	GA	2017	2020	1.02438137	Aircraft Specific
38XA	GA	2017	2020	1.02438137	Aircraft Specific
38XS	GA	2017	2020	1.02438137	Aircraft Specific
39R	GA	2017	2020	1.02438137	Aircraft Specific
39TA	AT	2017	2020	0.803340056	Aircraft Specific
39TA	GA	2017	2020	1.02438137	Aircraft Specific
39TE	GA	2017	2020	1.02438137	Aircraft Specific
39TS	GA	2017	2020	1.02438137	Aircraft Specific
39TX	GA	2017	2020	1.02438137	Aircraft Specific
3E0	GA	2017	2020	1.02438137	Aircraft Specific
3F2	GA	2017	2020	1.02438137	Aircraft Specific
3F6	GA	2017	2020	1.02438137	Aircraft Specific
3F9	GA	2017	2020	1.02438137	Aircraft Specific
3R9	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
3T0	GA	2017	2020	1.02438137	Aircraft Specific
3T2	GA	2017	2020	1.02438137	Aircraft Specific
3T5	GA	2017	2020	1	Airport/Aircraft Specific
3T6	GA	2017	2020	1.02438137	Aircraft Specific
3T8	GA	2017	2020	1.02438137	Aircraft Specific
3TA0	GA	2017	2020	1.02438137	Aircraft Specific
3TA1	GA	2017	2020	1.02438137	Aircraft Specific
3TA2	GA	2017	2020	1.02438137	Aircraft Specific
3TA3	GA	2017	2020	1.02438137	Aircraft Specific
3TA4	GA	2017	2020	1.02438137	Aircraft Specific
3TA5	GA	2017	2020	1.02438137	Aircraft Specific
3TA6	GA	2017	2020	1.02438137	Aircraft Specific
3TA7	GA	2017	2020	1.02438137	Aircraft Specific
3TA8	GA	2017	2020	1.02438137	Aircraft Specific
3TA9	GA	2017	2020	1.02438137	Aircraft Specific
3TE0	GA	2017	2020	1.02438137	Aircraft Specific
3TE1	GA	2017	2020	1.02438137	Aircraft Specific
3TE2	GA	2017	2020	1.02438137	Aircraft Specific
3TE3	GA	2017	2020	1.02438137	Aircraft Specific
3TE4	GA	2017	2020	1.02438137	Aircraft Specific
3TE5	GA	2017	2020	1.02438137	Aircraft Specific
3TE6	GA	2017	2020	1.02438137	Aircraft Specific
3TE8	GA	2017	2020	1.02438137	Aircraft Specific
3TE9	GA	2017	2020	1.02438137	Aircraft Specific
3TS0	GA	2017	2020	1.02438137	Aircraft Specific
3TS1	GA	2017	2020	1.02438137	Aircraft Specific
3TS2	GA	2017	2020	1.02438137	Aircraft Specific
3TS3	GA	2017	2020	1.02438137	Aircraft Specific
3TS4	GA	2017	2020	1.02438137	Aircraft Specific
3TS6	GA	2017	2020	1.02438137	Aircraft Specific
3TS7	GA	2017	2020	1.02438137	Aircraft Specific
3TS8	GA	2017	2020	1.02438137	Aircraft Specific
3TS9	GA	2017	2020	1.02438137	Aircraft Specific
3TX0	GA	2017	2020	1.02438137	Aircraft Specific
3TX1	GA	2017	2020	1.02438137	Aircraft Specific
3TX2	GA	2017	2020	1.02438137	Aircraft Specific
3TX3	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
3TX5	GA	2017	2020	1.02438137	Aircraft Specific
3TX6	GA	2017	2020	1.02438137	Aircraft Specific
3TX7	GA	2017	2020	1.02438137	Aircraft Specific
3TX8	GA	2017	2020	1.02438137	Aircraft Specific
3TX9	GA	2017	2020	1.02438137	Aircraft Specific
3XA0	GA	2017	2020	1.02438137	Aircraft Specific
3XA1	GA	2017	2020	1.02438137	Aircraft Specific
3XA2	GA	2017	2020	1.02438137	Aircraft Specific
3XA4	GA	2017	2020	1.02438137	Aircraft Specific
3XA5	GA	2017	2020	1.02438137	Aircraft Specific
3XA6	GA	2017	2020	1.02438137	Aircraft Specific
3XA7	GA	2017	2020	1.02438137	Aircraft Specific
3XA8	GA	2017	2020	1.02438137	Aircraft Specific
3XA9	GA	2017	2020	1.02438137	Aircraft Specific
3XS0	GA	2017	2020	1.02438137	Aircraft Specific
3XS1	GA	2017	2020	1.02438137	Aircraft Specific
3XS2	GA	2017	2020	1.02438137	Aircraft Specific
3XS3	GA	2017	2020	1.02438137	Aircraft Specific
3XS4	GA	2017	2020	1.02438137	Aircraft Specific
3XS5	GA	2017	2020	1.02438137	Aircraft Specific
3XS6	GA	2017	2020	1.02438137	Aircraft Specific
3XS7	GA	2017	2020	1.02438137	Aircraft Specific
3XS8	GA	2017	2020	1.02438137	Aircraft Specific
3XS9	GA	2017	2020	1.02438137	Aircraft Specific
40TA	GA	2017	2020	1.02438137	Aircraft Specific
40TE	GA	2017	2020	1.02438137	Aircraft Specific
40TS	GA	2017	2020	1.02438137	Aircraft Specific
40TX	GA	2017	2020	1.02438137	Aircraft Specific
40XS	GA	2017	2020	1.02438137	Aircraft Specific
41F	GA	2017	2020	1	Airport/Aircraft Specific
41TA	GA	2017	2020	1.02438137	Aircraft Specific
41TE	GA	2017	2020	1.02438137	Aircraft Specific
41TS	GA	2017	2020	1.02438137	Aircraft Specific
41TX	GA	2017	2020	1.02438137	Aircraft Specific
41XS	GA	2017	2020	1.02438137	Aircraft Specific
42TA	GA	2017	2020	1.02438137	Aircraft Specific
42TE	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
42TS	GA	2017	2020	1.02438137	Aircraft Specific
42TX	GA	2017	2020	1.02438137	Aircraft Specific
42XS	GA	2017	2020	1.02438137	Aircraft Specific
43TA	GA	2017	2020	1.02438137	Aircraft Specific
43TE	GA	2017	2020	1.02438137	Aircraft Specific
43TX	GA	2017	2020	1.02438137	Aircraft Specific
43XS	GA	2017	2020	1.02438137	Aircraft Specific
44TA	GA	2017	2020	1.02438137	Aircraft Specific
44TE	GA	2017	2020	1.02438137	Aircraft Specific
44TS	GA	2017	2020	1.02438137	Aircraft Specific
44TX	GA	2017	2020	1.02438137	Aircraft Specific
44XS	GA	2017	2020	1.02438137	Aircraft Specific
45R	GA	2017	2020	1	Airport/Aircraft Specific
45TA	GA	2017	2020	1.02438137	Aircraft Specific
45TE	GA	2017	2020	1.02438137	Aircraft Specific
45TS	GA	2017	2020	1.02438137	Aircraft Specific
45TX	GA	2017	2020	1.02438137	Aircraft Specific
45XA	GA	2017	2020	1.02438137	Aircraft Specific
45XS	GA	2017	2020	1.02438137	Aircraft Specific
46TA	GA	2017	2020	1.02438137	Aircraft Specific
46TE	GA	2017	2020	1.02438137	Aircraft Specific
46TS	GA	2017	2020	1.02438137	Aircraft Specific
46TX	GA	2017	2020	1.02438137	Aircraft Specific
46XA	GA	2017	2020	1.02438137	Aircraft Specific
46XS	GA	2017	2020	1.02438137	Aircraft Specific
47TA	GA	2017	2020	1.02438137	Aircraft Specific
47TE	GA	2017	2020	1.02438137	Aircraft Specific
47TS	GA	2017	2020	1.02438137	Aircraft Specific
47TX	GA	2017	2020	1.02438137	Aircraft Specific
47XA	GA	2017	2020	1.02438137	Aircraft Specific
47XS	GA	2017	2020	1.02438137	Aircraft Specific
48TA	GA	2017	2020	1.02438137	Aircraft Specific
48TE	GA	2017	2020	1.02438137	Aircraft Specific
48TS	GA	2017	2020	1.02438137	Aircraft Specific
48TX	GA	2017	2020	1.02438137	Aircraft Specific
48XS	GA	2017	2020	1.02438137	Aircraft Specific
49F	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
49R	GA	2017	2020	1.02438137	Aircraft Specific
49T	GA	2017	2020	1	Airport/Aircraft Specific
49TA	GA	2017	2020	1.02438137	Aircraft Specific
49TS	GA	2017	2020	1.02438137	Aircraft Specific
49TX	GA	2017	2020	1.02438137	Aircraft Specific
49XS	GA	2017	2020	1.02438137	Aircraft Specific
4F2	GA	2017	2020	1	Airport/Aircraft Specific
4F2	MIL	2017	2020	1	Airport/Aircraft Specific
4T2	GA	2017	2020	1.02438137	Aircraft Specific
4T7	GA	2017	2020	1.02438137	Aircraft Specific
4TA0	GA	2017	2020	1.02438137	Aircraft Specific
4TA1	GA	2017	2020	1.02438137	Aircraft Specific
4TA3	GA	2017	2020	1.02438137	Aircraft Specific
4TA4	GA	2017	2020	1.02438137	Aircraft Specific
4TA5	GA	2017	2020	1.02438137	Aircraft Specific
4TA6	GA	2017	2020	1.02438137	Aircraft Specific
4TA7	GA	2017	2020	1.02438137	Aircraft Specific
4TA8	GA	2017	2020	1.02438137	Aircraft Specific
4TA9	GA	2017	2020	1.02438137	Aircraft Specific
4TE1	GA	2017	2020	1.02438137	Aircraft Specific
4TE2	GA	2017	2020	1.02438137	Aircraft Specific
4TE3	GA	2017	2020	1.02438137	Aircraft Specific
4TE4	GA	2017	2020	1.02438137	Aircraft Specific
4TE5	GA	2017	2020	1.02438137	Aircraft Specific
4TE7	GA	2017	2020	1.02438137	Aircraft Specific
4TE8	GA	2017	2020	1.02438137	Aircraft Specific
4TE9	GA	2017	2020	1.02438137	Aircraft Specific
4TS0	GA	2017	2020	1.02438137	Aircraft Specific
4TS1	GA	2017	2020	1.02438137	Aircraft Specific
4TS2	GA	2017	2020	1.02438137	Aircraft Specific
4TS3	GA	2017	2020	1.02438137	Aircraft Specific
4TS4	GA	2017	2020	1.02438137	Aircraft Specific
4TS5	GA	2017	2020	1.02438137	Aircraft Specific
4TS6	GA	2017	2020	1.02438137	Aircraft Specific
4TS7	GA	2017	2020	1.02438137	Aircraft Specific
4TS8	GA	2017	2020	1.02438137	Aircraft Specific
4TS9	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
4TX0	GA	2017	2020	1.02438137	Aircraft Specific
4TX1	GA	2017	2020	1.02438137	Aircraft Specific
4TX2	GA	2017	2020	1.02438137	Aircraft Specific
4TX3	GA	2017	2020	1.02438137	Aircraft Specific
4TX4	GA	2017	2020	1.02438137	Aircraft Specific
4TX5	GA	2017	2020	1.02438137	Aircraft Specific
4TX6	GA	2017	2020	1.02438137	Aircraft Specific
4TX7	GA	2017	2020	1.02438137	Aircraft Specific
4TX8	GA	2017	2020	1.02438137	Aircraft Specific
4XA2	GA	2017	2020	1.02438137	Aircraft Specific
4XA3	GA	2017	2020	1.02438137	Aircraft Specific
4XA4	GA	2017	2020	1.02438137	Aircraft Specific
4XA5	GA	2017	2020	1.02438137	Aircraft Specific
4XA6	GA	2017	2020	1.02438137	Aircraft Specific
4XA7	GA	2017	2020	1.02438137	Aircraft Specific
4XA8	GA	2017	2020	1.02438137	Aircraft Specific
4XS0	GA	2017	2020	1.02438137	Aircraft Specific
4XS1	GA	2017	2020	1.02438137	Aircraft Specific
4XS2	GA	2017	2020	1.02438137	Aircraft Specific
4XS3	GA	2017	2020	1.02438137	Aircraft Specific
4XS4	GA	2017	2020	1.02438137	Aircraft Specific
4XS5	GA	2017	2020	1.02438137	Aircraft Specific
4XS6	GA	2017	2020	1.02438137	Aircraft Specific
4XS8	GA	2017	2020	1.02438137	Aircraft Specific
4XS9	GA	2017	2020	1.02438137	Aircraft Specific
50F	GA	2017	2020	1.02438137	Aircraft Specific
50R	GA	2017	2020	1	Airport/Aircraft Specific
50TA	GA	2017	2020	1.02438137	Aircraft Specific
50TE	GA	2017	2020	1.02438137	Aircraft Specific
50TS	GA	2017	2020	1.02438137	Aircraft Specific
50TX	GA	2017	2020	1.02438137	Aircraft Specific
50XS	GA	2017	2020	1.02438137	Aircraft Specific
51R	GA	2017	2020	1.02438137	Aircraft Specific
51TA	GA	2017	2020	1.02438137	Aircraft Specific
51TE	GA	2017	2020	1.02438137	Aircraft Specific
51TS	GA	2017	2020	1.02438137	Aircraft Specific
51TX	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
51XS	GA	2017	2020	1.02438137	Aircraft Specific
52F	AT	2017	2020	0.803340056	Aircraft Specific
52F	GA	2017	2020	1.02438137	Aircraft Specific
52TA	GA	2017	2020	1.02438137	Aircraft Specific
52TE	GA	2017	2020	1.02438137	Aircraft Specific
52TS	GA	2017	2020	1.02438137	Aircraft Specific
52TX	GA	2017	2020	1.02438137	Aircraft Specific
52XS	GA	2017	2020	1.02438137	Aircraft Specific
53T	GA	2017	2020	1.02438137	Aircraft Specific
53TA	GA	2017	2020	1.02438137	Aircraft Specific
53TE	GA	2017	2020	1.02438137	Aircraft Specific
53TS	GA	2017	2020	1.02438137	Aircraft Specific
53TX	GA	2017	2020	1.02438137	Aircraft Specific
53XS	GA	2017	2020	1.02438137	Aircraft Specific
54F	GA	2017	2020	1.02438137	Aircraft Specific
54T	GA	2017	2020	1.02438137	Aircraft Specific
54TA	GA	2017	2020	1.02438137	Aircraft Specific
54TS	GA	2017	2020	1.02438137	Aircraft Specific
54TX	GA	2017	2020	1.02438137	Aircraft Specific
55T	GA	2017	2020	1.02438137	Aircraft Specific
55TA	GA	2017	2020	1.02438137	Aircraft Specific
55TE	GA	2017	2020	1.02438137	Aircraft Specific
55TX	GA	2017	2020	1.02438137	Aircraft Specific
55XS	GA	2017	2020	1.02438137	Aircraft Specific
56F	GA	2017	2020	1.02438137	Aircraft Specific
56TA	GA	2017	2020	1.02438137	Aircraft Specific
56TS	GA	2017	2020	1.02438137	Aircraft Specific
56TX	GA	2017	2020	1.02438137	Aircraft Specific
56XS	GA	2017	2020	1.02438137	Aircraft Specific
57TA	GA	2017	2020	1.02438137	Aircraft Specific
57TE	GA	2017	2020	1.02438137	Aircraft Specific
57TX	GA	2017	2020	1.02438137	Aircraft Specific
57XS	GA	2017	2020	1.02438137	Aircraft Specific
58F	GA	2017	2020	1.02438137	Aircraft Specific
58T	GA	2017	2020	1.02438137	Aircraft Specific
58TE	GA	2017	2020	1.02438137	Aircraft Specific
58TS	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
58TX	GA	2017	2020	1.02438137	Aircraft Specific
58XS	GA	2017	2020	1.02438137	Aircraft Specific
59TA	GA	2017	2020	1.02438137	Aircraft Specific
59TE	GA	2017	2020	1.02438137	Aircraft Specific
59TS	GA	2017	2020	1.02438137	Aircraft Specific
59TX	GA	2017	2020	1.02438137	Aircraft Specific
59XA	GA	2017	2020	1.02438137	Aircraft Specific
59XS	GA	2017	2020	1.02438137	Aircraft Specific
5C1	GA	2017	2020	1.02438137	Aircraft Specific
5F1	GA	2017	2020	1	Airport/Aircraft Specific
5T0	GA	2017	2020	1.02438137	Aircraft Specific
5T9	GA	2017	2020	1	Airport/Aircraft Specific
5TA0	GA	2017	2020	1.02438137	Aircraft Specific
5TA1	GA	2017	2020	1.02438137	Aircraft Specific
5TA2	GA	2017	2020	1.02438137	Aircraft Specific
5TA3	GA	2017	2020	1.02438137	Aircraft Specific
5TA4	GA	2017	2020	1.02438137	Aircraft Specific
5TA5	GA	2017	2020	1.02438137	Aircraft Specific
5TA6	GA	2017	2020	1.02438137	Aircraft Specific
5TA7	GA	2017	2020	1.02438137	Aircraft Specific
5TA8	GA	2017	2020	1.02438137	Aircraft Specific
5TA9	GA	2017	2020	1.02438137	Aircraft Specific
5TE0	GA	2017	2020	1.02438137	Aircraft Specific
5TE1	GA	2017	2020	1.02438137	Aircraft Specific
5TE2	GA	2017	2020	1.02438137	Aircraft Specific
5TE3	GA	2017	2020	1.02438137	Aircraft Specific
5TE5	GA	2017	2020	1.02438137	Aircraft Specific
5TE6	GA	2017	2020	1.02438137	Aircraft Specific
5TE7	GA	2017	2020	1.02438137	Aircraft Specific
5TE8	GA	2017	2020	1.02438137	Aircraft Specific
5TE9	GA	2017	2020	1.02438137	Aircraft Specific
5TS0	GA	2017	2020	1.02438137	Aircraft Specific
5TS1	GA	2017	2020	1.02438137	Aircraft Specific
5TS2	GA	2017	2020	1.02438137	Aircraft Specific
5TS3	GA	2017	2020	1.02438137	Aircraft Specific
5TS4	GA	2017	2020	1.02438137	Aircraft Specific
5TS5	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
5TS6	GA	2017	2020	1.02438137	Aircraft Specific
5TS7	GA	2017	2020	1.02438137	Aircraft Specific
5TS8	GA	2017	2020	1.02438137	Aircraft Specific
5TS9	GA	2017	2020	1.02438137	Aircraft Specific
5TX0	GA	2017	2020	1.02438137	Aircraft Specific
5TX1	GA	2017	2020	1.02438137	Aircraft Specific
5TX2	GA	2017	2020	1.02438137	Aircraft Specific
5TX3	GA	2017	2020	1.02438137	Aircraft Specific
5TX4	GA	2017	2020	1.02438137	Aircraft Specific
5TX5	GA	2017	2020	1.02438137	Aircraft Specific
5TX6	GA	2017	2020	1.02438137	Aircraft Specific
5TX7	GA	2017	2020	1.02438137	Aircraft Specific
5TX8	GA	2017	2020	1.02438137	Aircraft Specific
5XA0	GA	2017	2020	1.02438137	Aircraft Specific
5XA6	GA	2017	2020	1.02438137	Aircraft Specific
5XA9	GA	2017	2020	1.02438137	Aircraft Specific
5XS0	GA	2017	2020	1.02438137	Aircraft Specific
5XS1	GA	2017	2020	1.02438137	Aircraft Specific
5XS2	GA	2017	2020	1.02438137	Aircraft Specific
5XS3	GA	2017	2020	1.02438137	Aircraft Specific
5XS5	GA	2017	2020	1.02438137	Aircraft Specific
5XS6	GA	2017	2020	1.02438137	Aircraft Specific
5XS7	GA	2017	2020	1.02438137	Aircraft Specific
5XS8	GA	2017	2020	1.02438137	Aircraft Specific
5XS9	GA	2017	2020	1.02438137	Aircraft Specific
60F	GA	2017	2020	1	Airport/Aircraft Specific
60R	GA	2017	2020	1.02438137	Aircraft Specific
60TA	GA	2017	2020	1.02438137	Aircraft Specific
60TE	GA	2017	2020	1.02438137	Aircraft Specific
60TS	GA	2017	2020	1.02438137	Aircraft Specific
60TX	GA	2017	2020	1.02438137	Aircraft Specific
60XS	GA	2017	2020	1.02438137	Aircraft Specific
61R	GA	2017	2020	1.02438137	Aircraft Specific
61TA	GA	2017	2020	1.02438137	Aircraft Specific
61TE	GA	2017	2020	1.02438137	Aircraft Specific
61TS	GA	2017	2020	1.02438137	Aircraft Specific
61TX	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
61XS	GA	2017	2020	1.02438137	Aircraft Specific
62TA	GA	2017	2020	1.02438137	Aircraft Specific
62TE	GA	2017	2020	1.02438137	Aircraft Specific
62TS	GA	2017	2020	1.02438137	Aircraft Specific
62XS	GA	2017	2020	1.02438137	Aircraft Specific
63F	GA	2017	2020	1.02438137	Aircraft Specific
63TA	GA	2017	2020	1.02438137	Aircraft Specific
63TE	GA	2017	2020	1.02438137	Aircraft Specific
63TS	GA	2017	2020	1.02438137	Aircraft Specific
63TX	GA	2017	2020	1.02438137	Aircraft Specific
63XS	GA	2017	2020	1.02438137	Aircraft Specific
64F	GA	2017	2020	1.02438137	Aircraft Specific
64TA	GA	2017	2020	1.02438137	Aircraft Specific
64TE	GA	2017	2020	1.02438137	Aircraft Specific
64TS	GA	2017	2020	1.02438137	Aircraft Specific
64TX	GA	2017	2020	1.02438137	Aircraft Specific
64XS	GA	2017	2020	1.02438137	Aircraft Specific
65TE	GA	2017	2020	1.02438137	Aircraft Specific
65TS	GA	2017	2020	1.02438137	Aircraft Specific
65TX	GA	2017	2020	1.02438137	Aircraft Specific
65XS	GA	2017	2020	1.02438137	Aircraft Specific
66R	GA	2017	2020	1.02438137	Aircraft Specific
66TA	GA	2017	2020	1.02438137	Aircraft Specific
66TE	GA	2017	2020	1.02438137	Aircraft Specific
66TS	GA	2017	2020	1.02438137	Aircraft Specific
66TX	GA	2017	2020	1.02438137	Aircraft Specific
66XS	GA	2017	2020	1.02438137	Aircraft Specific
67R	GA	2017	2020	1.02438137	Aircraft Specific
67T	GA	2017	2020	1.02438137	Aircraft Specific
67TA	GA	2017	2020	1.02438137	Aircraft Specific
67TE	GA	2017	2020	1.02438137	Aircraft Specific
67TS	GA	2017	2020	1.02438137	Aircraft Specific
67TX	GA	2017	2020	1.02438137	Aircraft Specific
67XS	GA	2017	2020	1.02438137	Aircraft Specific
68F	GA	2017	2020	1.02438137	Aircraft Specific
68TA	GA	2017	2020	1.02438137	Aircraft Specific
68TE	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
68TS	GA	2017	2020	1.02438137	Aircraft Specific
68TX	GA	2017	2020	1.02438137	Aircraft Specific
68XS	GA	2017	2020	1.02438137	Aircraft Specific
69TA	GA	2017	2020	1.02438137	Aircraft Specific
69TE	GA	2017	2020	1.02438137	Aircraft Specific
69TS	GA	2017	2020	1.02438137	Aircraft Specific
69TX	GA	2017	2020	1.02438137	Aircraft Specific
69XA	GA	2017	2020	1.02438137	Aircraft Specific
69XS	GA	2017	2020	1.02438137	Aircraft Specific
6F7	GA	2017	2020	1.02438137	Aircraft Specific
6R3	GA	2017	2020	1	Airport/Aircraft Specific
6R3	MIL	2017	2020	1	Airport/Aircraft Specific
6R5	GA	2017	2020	1.02438137	Aircraft Specific
6R6	GA	2017	2020	1.02438137	Aircraft Specific
6TA0	GA	2017	2020	1.02438137	Aircraft Specific
6TA1	GA	2017	2020	1.02438137	Aircraft Specific
6TA2	GA	2017	2020	1.02438137	Aircraft Specific
6TA3	GA	2017	2020	1.02438137	Aircraft Specific
6TA5	AT	2017	2020	0.803340056	Aircraft Specific
6TA5	GA	2017	2020	1.02438137	Aircraft Specific
6TA6	GA	2017	2020	1.02438137	Aircraft Specific
6TA7	GA	2017	2020	1.02438137	Aircraft Specific
6TA8	GA	2017	2020	1.02438137	Aircraft Specific
6TE0	GA	2017	2020	1.02438137	Aircraft Specific
6TE1	GA	2017	2020	1.02438137	Aircraft Specific
6TE2	GA	2017	2020	1.02438137	Aircraft Specific
6TE3	GA	2017	2020	1.02438137	Aircraft Specific
6TE5	GA	2017	2020	1.02438137	Aircraft Specific
6TE6	GA	2017	2020	1.02438137	Aircraft Specific
6TE7	GA	2017	2020	1.02438137	Aircraft Specific
6TE8	GA	2017	2020	1.02438137	Aircraft Specific
6TE9	GA	2017	2020	1.02438137	Aircraft Specific
6TS0	GA	2017	2020	1.02438137	Aircraft Specific
6TS1	GA	2017	2020	1.02438137	Aircraft Specific
6TS2	GA	2017	2020	1.02438137	Aircraft Specific
6TS4	GA	2017	2020	1.02438137	Aircraft Specific
6TS5	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
6TS6	GA	2017	2020	1.02438137	Aircraft Specific
6TS7	GA	2017	2020	1.02438137	Aircraft Specific
6TS8	GA	2017	2020	1.02438137	Aircraft Specific
6TS9	GA	2017	2020	1.02438137	Aircraft Specific
6TX0	GA	2017	2020	1.02438137	Aircraft Specific
6TX1	GA	2017	2020	1.02438137	Aircraft Specific
6TX2	GA	2017	2020	1.02438137	Aircraft Specific
6TX4	GA	2017	2020	1.02438137	Aircraft Specific
6TX5	GA	2017	2020	1.02438137	Aircraft Specific
6TX6	GA	2017	2020	1.02438137	Aircraft Specific
6TX7	GA	2017	2020	1.02438137	Aircraft Specific
6TX8	GA	2017	2020	1.02438137	Aircraft Specific
6TX9	GA	2017	2020	1.02438137	Aircraft Specific
6X0	GA	2017	2020	1.02438137	Aircraft Specific
6X8	GA	2017	2020	1.02438137	Aircraft Specific
6XA0	GA	2017	2020	1.02438137	Aircraft Specific
6XA4	GA	2017	2020	1.02438137	Aircraft Specific
6XS0	GA	2017	2020	1.02438137	Aircraft Specific
6XS1	GA	2017	2020	1.02438137	Aircraft Specific
6XS2	GA	2017	2020	1.02438137	Aircraft Specific
6XS3	GA	2017	2020	1.02438137	Aircraft Specific
6XS4	GA	2017	2020	1.02438137	Aircraft Specific
6XS5	GA	2017	2020	1.02438137	Aircraft Specific
6XS6	GA	2017	2020	1.02438137	Aircraft Specific
6XS7	GA	2017	2020	1.02438137	Aircraft Specific
6XS9	GA	2017	2020	1.02438137	Aircraft Specific
70TA	GA	2017	2020	1.02438137	Aircraft Specific
70TE	GA	2017	2020	1.02438137	Aircraft Specific
70TS	GA	2017	2020	1.02438137	Aircraft Specific
70TX	GA	2017	2020	1.02438137	Aircraft Specific
70XS	GA	2017	2020	1.02438137	Aircraft Specific
71TA	GA	2017	2020	1.02438137	Aircraft Specific
71TE	GA	2017	2020	1.02438137	Aircraft Specific
71TX	GA	2017	2020	1.02438137	Aircraft Specific
72F	GA	2017	2020	1.02438137	Aircraft Specific
72TA	GA	2017	2020	1.02438137	Aircraft Specific
72TE	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
72TS	GA	2017	2020	1.02438137	Aircraft Specific
72TX	GA	2017	2020	1.02438137	Aircraft Specific
72XS	GA	2017	2020	1.02438137	Aircraft Specific
73F	GA	2017	2020	1.02438137	Aircraft Specific
73TA	GA	2017	2020	1.02438137	Aircraft Specific
73TE	GA	2017	2020	1.02438137	Aircraft Specific
73TS	GA	2017	2020	1.02438137	Aircraft Specific
73TX	GA	2017	2020	1.02438137	Aircraft Specific
73XS	GA	2017	2020	1.02438137	Aircraft Specific
74R	GA	2017	2020	1.02438137	Aircraft Specific
74TA	GA	2017	2020	1.02438137	Aircraft Specific
74TE	GA	2017	2020	1.02438137	Aircraft Specific
74TS	GA	2017	2020	1.02438137	Aircraft Specific
74TX	GA	2017	2020	1.02438137	Aircraft Specific
74XS	GA	2017	2020	1.02438137	Aircraft Specific
75TA	GA	2017	2020	1.02438137	Aircraft Specific
75TE	GA	2017	2020	1.02438137	Aircraft Specific
75TS	GA	2017	2020	1.02438137	Aircraft Specific
75TX	GA	2017	2020	1.02438137	Aircraft Specific
75XS	GA	2017	2020	1.02438137	Aircraft Specific
76F	GA	2017	2020	1.02438137	Aircraft Specific
76T	GA	2017	2020	1.02438137	Aircraft Specific
76TA	GA	2017	2020	1.02438137	Aircraft Specific
76TE	GA	2017	2020	1.02438137	Aircraft Specific
76TS	GA	2017	2020	1.02438137	Aircraft Specific
76TX	GA	2017	2020	1.02438137	Aircraft Specific
76XA	GA	2017	2020	1.02438137	Aircraft Specific
76XS	GA	2017	2020	1.02438137	Aircraft Specific
77F	GA	2017	2020	1.02438137	Aircraft Specific
77T	GA	2017	2020	1.02438137	Aircraft Specific
77TA	GA	2017	2020	1.02438137	Aircraft Specific
77TE	GA	2017	2020	1.02438137	Aircraft Specific
77TS	GA	2017	2020	1.02438137	Aircraft Specific
77TX	GA	2017	2020	1.02438137	Aircraft Specific
77XS	GA	2017	2020	1.02438137	Aircraft Specific
78R	GA	2017	2020	1.02438137	Aircraft Specific
78TA	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
78TE	GA	2017	2020	1.02438137	Aircraft Specific
78TS	GA	2017	2020	1.02438137	Aircraft Specific
78TX	GA	2017	2020	1.02438137	Aircraft Specific
78XS	GA	2017	2020	1.02438137	Aircraft Specific
79TA	GA	2017	2020	1.02438137	Aircraft Specific
79TE	GA	2017	2020	1.02438137	Aircraft Specific
79TS	GA	2017	2020	1.02438137	Aircraft Specific
79XS	GA	2017	2020	1.02438137	Aircraft Specific
7F3	GA	2017	2020	1	Airport/Aircraft Specific
7F5	GA	2017	2020	1.02438137	Aircraft Specific
7F7	GA	2017	2020	1	Airport/Aircraft Specific
7R9	GA	2017	2020	1.02438137	Aircraft Specific
7T0	GA	2017	2020	1.02438137	Aircraft Specific
7T7	GA	2017	2020	1.02438137	Aircraft Specific
7TA0	GA	2017	2020	1.02438137	Aircraft Specific
7TA1	GA	2017	2020	1.02438137	Aircraft Specific
7TA2	GA	2017	2020	1.02438137	Aircraft Specific
7TA3	GA	2017	2020	1.02438137	Aircraft Specific
7TA4	GA	2017	2020	1.02438137	Aircraft Specific
7TA5	GA	2017	2020	1.02438137	Aircraft Specific
7TA6	GA	2017	2020	1.02438137	Aircraft Specific
7TA7	GA	2017	2020	1.02438137	Aircraft Specific
7TA8	GA	2017	2020	1.02438137	Aircraft Specific
7TA9	GA	2017	2020	1.02438137	Aircraft Specific
7TE0	GA	2017	2020	1.02438137	Aircraft Specific
7TE1	GA	2017	2020	1.02438137	Aircraft Specific
7TE2	GA	2017	2020	1.02438137	Aircraft Specific
7TE3	GA	2017	2020	1.02438137	Aircraft Specific
7TE4	GA	2017	2020	1.02438137	Aircraft Specific
7TE5	GA	2017	2020	1.02438137	Aircraft Specific
7TE6	GA	2017	2020	1.02438137	Aircraft Specific
7TE7	GA	2017	2020	1.02438137	Aircraft Specific
7TE8	GA	2017	2020	1.02438137	Aircraft Specific
7TE9	GA	2017	2020	1.02438137	Aircraft Specific
7TS0	GA	2017	2020	1.02438137	Aircraft Specific
7TS1	GA	2017	2020	1.02438137	Aircraft Specific
7TS2	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
7TS3	GA	2017	2020	1.02438137	Aircraft Specific
7TS4	GA	2017	2020	1.02438137	Aircraft Specific
7TS5	GA	2017	2020	1.02438137	Aircraft Specific
7TS6	GA	2017	2020	1.02438137	Aircraft Specific
7TS7	GA	2017	2020	1.02438137	Aircraft Specific
7TS8	GA	2017	2020	1.02438137	Aircraft Specific
7TS9	GA	2017	2020	1.02438137	Aircraft Specific
7TX0	GA	2017	2020	1.02438137	Aircraft Specific
7TX1	GA	2017	2020	1.02438137	Aircraft Specific
7TX2	GA	2017	2020	1.02438137	Aircraft Specific
7TX3	GA	2017	2020	1.02438137	Aircraft Specific
7TX4	GA	2017	2020	1.02438137	Aircraft Specific
7TX5	GA	2017	2020	1.02438137	Aircraft Specific
7TX6	GA	2017	2020	1.02438137	Aircraft Specific
7TX7	GA	2017	2020	1.02438137	Aircraft Specific
7TX8	GA	2017	2020	1.02438137	Aircraft Specific
7TX9	GA	2017	2020	1.02438137	Aircraft Specific
7XA0	GA	2017	2020	1.02438137	Aircraft Specific
7XS0	GA	2017	2020	1.02438137	Aircraft Specific
7XS1	GA	2017	2020	1.02438137	Aircraft Specific
7XS3	GA	2017	2020	1.02438137	Aircraft Specific
7XS4	GA	2017	2020	1.02438137	Aircraft Specific
7XS5	GA	2017	2020	1.02438137	Aircraft Specific
7XS6	GA	2017	2020	1.02438137	Aircraft Specific
7XS7	GA	2017	2020	1.02438137	Aircraft Specific
7XS8	GA	2017	2020	1.02438137	Aircraft Specific
7XS9	GA	2017	2020	1.02438137	Aircraft Specific
80TA	GA	2017	2020	1.02438137	Aircraft Specific
80TE	GA	2017	2020	1.02438137	Aircraft Specific
80TS	GA	2017	2020	1.02438137	Aircraft Specific
80TX	GA	2017	2020	1.02438137	Aircraft Specific
80XS	GA	2017	2020	1.02438137	Aircraft Specific
81D	GA	2017	2020	1.02438137	Aircraft Specific
81R	GA	2017	2020	1.02438137	Aircraft Specific
81TA	GA	2017	2020	1.02438137	Aircraft Specific
81TE	GA	2017	2020	1.02438137	Aircraft Specific
81TS	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
81TX	GA	2017	2020	1.02438137	Aircraft Specific
81XA	GA	2017	2020	1.02438137	Aircraft Specific
81XS	GA	2017	2020	1.02438137	Aircraft Specific
82TA	GA	2017	2020	1.02438137	Aircraft Specific
82TE	GA	2017	2020	1.02438137	Aircraft Specific
82TS	GA	2017	2020	1.02438137	Aircraft Specific
82TX	GA	2017	2020	1.02438137	Aircraft Specific
82XS	GA	2017	2020	1.02438137	Aircraft Specific
83TA	GA	2017	2020	1.02438137	Aircraft Specific
83TE	GA	2017	2020	1.02438137	Aircraft Specific
83TS	GA	2017	2020	1.02438137	Aircraft Specific
83TX	GA	2017	2020	1.02438137	Aircraft Specific
83XS	GA	2017	2020	1.02438137	Aircraft Specific
84TA	GA	2017	2020	1.02438137	Aircraft Specific
84TE	GA	2017	2020	1.02438137	Aircraft Specific
84TS	GA	2017	2020	1.02438137	Aircraft Specific
84TX	GA	2017	2020	1.02438137	Aircraft Specific
84XS	GA	2017	2020	1.02438137	Aircraft Specific
85TA	GA	2017	2020	1.02438137	Aircraft Specific
85TE	GA	2017	2020	1.02438137	Aircraft Specific
85TS	GA	2017	2020	1.02438137	Aircraft Specific
85TX	GA	2017	2020	1.02438137	Aircraft Specific
85XA	GA	2017	2020	1.02438137	Aircraft Specific
85XS	GA	2017	2020	1.02438137	Aircraft Specific
86TA	GA	2017	2020	1.02438137	Aircraft Specific
86TE	GA	2017	2020	1.02438137	Aircraft Specific
86TS	GA	2017	2020	1.02438137	Aircraft Specific
86TX	GA	2017	2020	1.02438137	Aircraft Specific
86XS	GA	2017	2020	1.02438137	Aircraft Specific
87TA	GA	2017	2020	1.02438137	Aircraft Specific
87TE	GA	2017	2020	1.02438137	Aircraft Specific
87TS	GA	2017	2020	1.02438137	Aircraft Specific
87TX	GA	2017	2020	1.02438137	Aircraft Specific
87XS	GA	2017	2020	1.02438137	Aircraft Specific
88R	GA	2017	2020	1.02438137	Aircraft Specific
88TA	GA	2017	2020	1.02438137	Aircraft Specific
88TE	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
88TS	GA	2017	2020	1.02438137	Aircraft Specific
88TX	GA	2017	2020	1.02438137	Aircraft Specific
88XS	GA	2017	2020	1.02438137	Aircraft Specific
89TA	GA	2017	2020	1.02438137	Aircraft Specific
89TE	GA	2017	2020	1.02438137	Aircraft Specific
89TS	GA	2017	2020	1.02438137	Aircraft Specific
89TX	GA	2017	2020	1.02438137	Aircraft Specific
89XS	GA	2017	2020	1.02438137	Aircraft Specific
8F3	GA	2017	2020	1.02438137	Aircraft Specific
8F5	GA	2017	2020	1.02438137	Aircraft Specific
8T6	GA	2017	2020	1.02438137	Aircraft Specific
8T8	GA	2017	2020	1.02438137	Aircraft Specific
8TA0	GA	2017	2020	1.02438137	Aircraft Specific
8TA1	GA	2017	2020	1.02438137	Aircraft Specific
8TA2	GA	2017	2020	1.02438137	Aircraft Specific
8TA3	GA	2017	2020	1.02438137	Aircraft Specific
8TA4	GA	2017	2020	1.02438137	Aircraft Specific
8TA5	GA	2017	2020	1.02438137	Aircraft Specific
8TA6	GA	2017	2020	1.02438137	Aircraft Specific
8TA7	GA	2017	2020	1.02438137	Aircraft Specific
8TA8	GA	2017	2020	1.02438137	Aircraft Specific
8TE2	GA	2017	2020	1.02438137	Aircraft Specific
8TE4	GA	2017	2020	1.02438137	Aircraft Specific
8TE5	GA	2017	2020	1.02438137	Aircraft Specific
8TE6	GA	2017	2020	1.02438137	Aircraft Specific
8TE7	GA	2017	2020	1.02438137	Aircraft Specific
8TE8	GA	2017	2020	1.02438137	Aircraft Specific
8TE9	GA	2017	2020	1.02438137	Aircraft Specific
8TS0	GA	2017	2020	1.02438137	Aircraft Specific
8TS1	GA	2017	2020	1.02438137	Aircraft Specific
8TS2	GA	2017	2020	1.02438137	Aircraft Specific
8TS3	GA	2017	2020	1.02438137	Aircraft Specific
8TS4	GA	2017	2020	1.02438137	Aircraft Specific
8TS5	GA	2017	2020	1.02438137	Aircraft Specific
8TS6	GA	2017	2020	1.02438137	Aircraft Specific
8TS7	GA	2017	2020	1.02438137	Aircraft Specific
8TS8	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
8TS9	GA	2017	2020	1.02438137	Aircraft Specific
8TX0	GA	2017	2020	1.02438137	Aircraft Specific
8TX1	GA	2017	2020	1.02438137	Aircraft Specific
8TX2	GA	2017	2020	1.02438137	Aircraft Specific
8TX3	GA	2017	2020	1.02438137	Aircraft Specific
8TX4	GA	2017	2020	1.02438137	Aircraft Specific
8TX5	GA	2017	2020	1.02438137	Aircraft Specific
8TX6	GA	2017	2020	1.02438137	Aircraft Specific
8TX8	GA	2017	2020	1.02438137	Aircraft Specific
8TX9	GA	2017	2020	1.02438137	Aircraft Specific
8XA7	GA	2017	2020	1.02438137	Aircraft Specific
8XS0	GA	2017	2020	1.02438137	Aircraft Specific
8XS2	GA	2017	2020	1.02438137	Aircraft Specific
8XS3	GA	2017	2020	1.02438137	Aircraft Specific
8XS4	GA	2017	2020	1.02438137	Aircraft Specific
8XS5	GA	2017	2020	1.02438137	Aircraft Specific
8XS6	GA	2017	2020	1.02438137	Aircraft Specific
8XS7	GA	2017	2020	1.02438137	Aircraft Specific
8XS8	GA	2017	2020	1.02438137	Aircraft Specific
8XS9	GA	2017	2020	1.02438137	Aircraft Specific
90TA	GA	2017	2020	1.02438137	Aircraft Specific
90TE	GA	2017	2020	1.02438137	Aircraft Specific
90TS	GA	2017	2020	1.02438137	Aircraft Specific
90TX	GA	2017	2020	1.02438137	Aircraft Specific
90XS	GA	2017	2020	1.02438137	Aircraft Specific
91TA	GA	2017	2020	1.02438137	Aircraft Specific
91TE	GA	2017	2020	1.02438137	Aircraft Specific
91TS	GA	2017	2020	1.02438137	Aircraft Specific
91TX	GA	2017	2020	1.02438137	Aircraft Specific
91XA	GA	2017	2020	1.02438137	Aircraft Specific
91XS	GA	2017	2020	1.02438137	Aircraft Specific
92R	GA	2017	2020	1.02438137	Aircraft Specific
92TA	GA	2017	2020	1.02438137	Aircraft Specific
92TE	GA	2017	2020	1.02438137	Aircraft Specific
92TS	GA	2017	2020	1.02438137	Aircraft Specific
92TX	GA	2017	2020	1.02438137	Aircraft Specific
92XS	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
93TA	GA	2017	2020	1.02438137	Aircraft Specific
93TE	GA	2017	2020	1.02438137	Aircraft Specific
93TS	GA	2017	2020	1.02438137	Aircraft Specific
93TX	GA	2017	2020	1.02438137	Aircraft Specific
93XS	GA	2017	2020	1.02438137	Aircraft Specific
94R	GA	2017	2020	1.02438137	Aircraft Specific
94TA	GA	2017	2020	1.02438137	Aircraft Specific
94TE	GA	2017	2020	1.02438137	Aircraft Specific
94TS	GA	2017	2020	1.02438137	Aircraft Specific
94TX	GA	2017	2020	1.02438137	Aircraft Specific
94XS	GA	2017	2020	1.02438137	Aircraft Specific
95TA	GA	2017	2020	1.02438137	Aircraft Specific
95TE	GA	2017	2020	1.02438137	Aircraft Specific
95TS	GA	2017	2020	1.02438137	Aircraft Specific
95TX	GA	2017	2020	1.02438137	Aircraft Specific
95XS	GA	2017	2020	1.02438137	Aircraft Specific
96TA	GA	2017	2020	1.02438137	Aircraft Specific
96TX	GA	2017	2020	1.02438137	Aircraft Specific
96XS	GA	2017	2020	1.02438137	Aircraft Specific
97TA	GA	2017	2020	1.02438137	Aircraft Specific
97TE	GA	2017	2020	1.02438137	Aircraft Specific
97TS	GA	2017	2020	1.02438137	Aircraft Specific
97TX	GA	2017	2020	1.02438137	Aircraft Specific
97XS	GA	2017	2020	1.02438137	Aircraft Specific
98TA	GA	2017	2020	1.02438137	Aircraft Specific
98TS	GA	2017	2020	1.02438137	Aircraft Specific
98TX	GA	2017	2020	1.02438137	Aircraft Specific
98XS	GA	2017	2020	1.02438137	Aircraft Specific
99TA	GA	2017	2020	1.02438137	Aircraft Specific
99TE	GA	2017	2020	1.02438137	Aircraft Specific
99TS	GA	2017	2020	1.02438137	Aircraft Specific
99TX	GA	2017	2020	1.02438137	Aircraft Specific
99XS	GA	2017	2020	1.02438137	Aircraft Specific
9F0	GA	2017	2020	1.02438137	Aircraft Specific
9F1	GA	2017	2020	1.02438137	Aircraft Specific
9F5	GA	2017	2020	1.02438137	Aircraft Specific
9F9	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
9R5	GA	2017	2020	1.02438137	Aircraft Specific
9R7	GA	2017	2020	1.02438137	Aircraft Specific
9TA0	GA	2017	2020	1.02438137	Aircraft Specific
9TA1	GA	2017	2020	1.02438137	Aircraft Specific
9TA3	GA	2017	2020	1.02438137	Aircraft Specific
9TA4	GA	2017	2020	1.02438137	Aircraft Specific
9TA5	GA	2017	2020	1.02438137	Aircraft Specific
9TA6	GA	2017	2020	1.02438137	Aircraft Specific
9TA7	GA	2017	2020	1.02438137	Aircraft Specific
9TA8	GA	2017	2020	1.02438137	Aircraft Specific
9TA9	GA	2017	2020	1.02438137	Aircraft Specific
9TE0	GA	2017	2020	1.02438137	Aircraft Specific
9TE1	GA	2017	2020	1.02438137	Aircraft Specific
9TE3	GA	2017	2020	1.02438137	Aircraft Specific
9TE4	GA	2017	2020	1.02438137	Aircraft Specific
9TE5	GA	2017	2020	1.02438137	Aircraft Specific
9TE6	GA	2017	2020	1.02438137	Aircraft Specific
9TE7	GA	2017	2020	1.02438137	Aircraft Specific
9TE8	GA	2017	2020	1.02438137	Aircraft Specific
9TE9	GA	2017	2020	1.02438137	Aircraft Specific
9TS0	GA	2017	2020	1.02438137	Aircraft Specific
9TS1	GA	2017	2020	1.02438137	Aircraft Specific
9TS2	GA	2017	2020	1.02438137	Aircraft Specific
9TS3	GA	2017	2020	1.02438137	Aircraft Specific
9TS4	GA	2017	2020	1.02438137	Aircraft Specific
9TS5	GA	2017	2020	1.02438137	Aircraft Specific
9TS6	GA	2017	2020	1.02438137	Aircraft Specific
9TS7	GA	2017	2020	1.02438137	Aircraft Specific
9TS8	GA	2017	2020	1.02438137	Aircraft Specific
9TS9	GA	2017	2020	1.02438137	Aircraft Specific
9TX0	GA	2017	2020	1.02438137	Aircraft Specific
9TX1	GA	2017	2020	1.02438137	Aircraft Specific
9TX2	GA	2017	2020	1.02438137	Aircraft Specific
9TX3	GA	2017	2020	1.02438137	Aircraft Specific
9TX4	GA	2017	2020	1.02438137	Aircraft Specific
9TX5	GA	2017	2020	1.02438137	Aircraft Specific
9TX6	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
9TX7	GA	2017	2020	1.02438137	Aircraft Specific
9TX8	GA	2017	2020	1.02438137	Aircraft Specific
9TX9	GA	2017	2020	1.02438137	Aircraft Specific
9X1	GA	2017	2020	1.02438137	Aircraft Specific
9X9	GA	2017	2020	1.02438137	Aircraft Specific
9XA4	GA	2017	2020	1.02438137	Aircraft Specific
9XS0	GA	2017	2020	1.02438137	Aircraft Specific
9XS1	GA	2017	2020	1.02438137	Aircraft Specific
9XS2	GA	2017	2020	1.02438137	Aircraft Specific
9XS3	GA	2017	2020	1.02438137	Aircraft Specific
9XS4	GA	2017	2020	1.02438137	Aircraft Specific
9XS5	GA	2017	2020	1.02438137	Aircraft Specific
9XS6	GA	2017	2020	1.02438137	Aircraft Specific
9XS7	GA	2017	2020	1.02438137	Aircraft Specific
9XS8	GA	2017	2020	1.02438137	Aircraft Specific
9XS9	GA	2017	2020	1.02438137	Aircraft Specific
ABI	AC	2017	2020	1	Airport/Aircraft Specific
ABI	AT	2017	2020	1.020166647	Airport/Aircraft Specific
ABI	GA	2017	2020	1.016258455	Airport/Aircraft Specific
ABI	MIL	2017	2020	1	Airport/Aircraft Specific
ACT	AC	2017	2020	1	Airport/Aircraft Specific
ACT	AT	2017	2020	1.030811056	Airport/Aircraft Specific
ACT	GA	2017	2020	1.041262498	Airport/Aircraft Specific
ACT	MIL	2017	2020	1	Airport/Aircraft Specific
ADS	AC	2017	2020	1	Airport/Aircraft Specific
ADS	AT	2017	2020	1	Airport/Aircraft Specific
ADS	GA	2017	2020	0.981080518	Airport/Aircraft Specific
ADS	MIL	2017	2020	1	Airport/Aircraft Specific
AFW	AC	2017	2020	1.045785248	Airport/Aircraft Specific
AFW	AT	2017	2020	1.03216692	Airport/Aircraft Specific
AFW	GA	2017	2020	1.015489605	Airport/Aircraft Specific
AFW	MIL	2017	2020	1	Airport/Aircraft Specific
ALI	GA	2017	2020	1	Airport/Aircraft Specific
ALI	MIL	2017	2020	1	Airport/Aircraft Specific
AMA	AC	2017	2020	1.100922561	Airport/Aircraft Specific
AMA	AT	2017	2020	0.81385214	Airport/Aircraft Specific
AMA	GA	2017	2020	1.016547558	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
AMA	MIL	2017	2020	1	Airport/Aircraft Specific
APY	GA	2017	2020	1.02438137	Aircraft Specific
AQO	GA	2017	2020	1	Airport/Aircraft Specific
AQO	MIL	2017	2020	1	Airport/Aircraft Specific
ARM	GA	2017	2020	1	Airport/Aircraft Specific
ARM	MIL	2017	2020	1	Airport/Aircraft Specific
ASL	GA	2017	2020	1	Airport/Aircraft Specific
ATA	GA	2017	2020	1	Airport/Aircraft Specific
AUS	AC	2017	2020	1.171919961	Airport/Aircraft Specific
AUS	AT	2017	2020	1.003952309	Airport/Aircraft Specific
AUS	GA	2017	2020	1.004686107	Airport/Aircraft Specific
AUS	MIL	2017	2020	1	Airport/Aircraft Specific
AXH	AT	2017	2020	1	Airport/Aircraft Specific
AXH	GA	2017	2020	1.079596316	Airport/Aircraft Specific
AXH	MIL	2017	2020	1	Airport/Aircraft Specific
BAZ	AC	2017	2020	1	Airport/Aircraft Specific
BAZ	AT	2017	2020	1	Airport/Aircraft Specific
BAZ	GA	2017	2020	1.146599071	Airport/Aircraft Specific
BAZ	MIL	2017	2020	1	Airport/Aircraft Specific
BBD	AT	2017	2020	1	Airport/Aircraft Specific
BBD	GA	2017	2020	1	Airport/Aircraft Specific
BBD	MIL	2017	2020	1	Airport/Aircraft Specific
BEA	GA	2017	2020	1	Airport/Aircraft Specific
BFE	GA	2017	2020	1	Airport/Aircraft Specific
BGD	GA	2017	2020	1	Airport/Aircraft Specific
BGD	MIL	2017	2020	1	Airport/Aircraft Specific
BIF	AC	2017	2020	1.133308569	Aircraft Specific
BIF	GA	2017	2020	1.02438137	Aircraft Specific
BKD	GA	2017	2020	1	Airport/Aircraft Specific
BKS	GA	2017	2020	1	Airport/Aircraft Specific
BMQ	GA	2017	2020	1	Airport/Aircraft Specific
BMQ	MIL	2017	2020	1	Airport/Aircraft Specific
BMT	GA	2017	2020	1	Airport/Aircraft Specific
BMT	MIL	2017	2020	1	Airport/Aircraft Specific
BPG	GA	2017	2020	1	Airport/Aircraft Specific
BPG	MIL	2017	2020	1	Airport/Aircraft Specific
BPT	AT	2017	2020	1.005192557	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
BPT	GA	2017	2020	1.061366181	Airport/Aircraft Specific
BPT	MIL	2017	2020	1	Airport/Aircraft Specific
BRO	AC	2017	2020	1.829051988	Airport/Aircraft Specific
BRO	AT	2017	2020	0.830183193	Airport/Aircraft Specific
BRO	GA	2017	2020	0.97092927	Airport/Aircraft Specific
BRO	MIL	2017	2020	1	Airport/Aircraft Specific
BWD	AT	2017	2020	1	Airport/Aircraft Specific
BWD	GA	2017	2020	1	Airport/Aircraft Specific
BWD	MIL	2017	2020	1	Airport/Aircraft Specific
BYY	GA	2017	2020	1	Airport/Aircraft Specific
BYY	MIL	2017	2020	1	Airport/Aircraft Specific
CDS	GA	2017	2020	1.02438137	Aircraft Specific
CFD	GA	2017	2020	1	Airport/Aircraft Specific
CLL	AC	2017	2020	1	Airport/Aircraft Specific
CLL	AT	2017	2020	1.039782651	Airport/Aircraft Specific
CLL	GA	2017	2020	0.990006387	Airport/Aircraft Specific
CLL	MIL	2017	2020	1	Airport/Aircraft Specific
CNW	AC	2017	2020	1	Airport/Aircraft Specific
CNW	AT	2017	2020	1	Airport/Aircraft Specific
CNW	GA	2017	2020	1.024571164	Airport/Aircraft Specific
CNW	MIL	2017	2020	1	Airport/Aircraft Specific
COM	GA	2017	2020	1	Airport/Aircraft Specific
COT	AT	2017	2020	1	Airport/Aircraft Specific
COT	GA	2017	2020	1	Airport/Aircraft Specific
COT	MIL	2017	2020	1	Airport/Aircraft Specific
CPT	AT	2017	2020	1	Airport/Aircraft Specific
CPT	GA	2017	2020	1.027943931	Airport/Aircraft Specific
CPT	MIL	2017	2020	1	Airport/Aircraft Specific
CRP	AC	2017	2020	1.156454569	Airport/Aircraft Specific
CRP	AT	2017	2020	0.865254923	Airport/Aircraft Specific
CRP	GA	2017	2020	0.977113472	Airport/Aircraft Specific
CRP	MIL	2017	2020	1	Airport/Aircraft Specific
CRS	GA	2017	2020	1	Airport/Aircraft Specific
CVB	AC	2017	2020	1	Airport/Aircraft Specific
CVB	GA	2017	2020	1	Airport/Aircraft Specific
CWC	AT	2017	2020	1	Airport/Aircraft Specific
CWC	GA	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
CWC	MIL	2017	2020	1	Airport/Aircraft Specific
CXO	AT	2017	2020	1.062440419	Airport/Aircraft Specific
CXO	GA	2017	2020	0.9612191	Airport/Aircraft Specific
CXO	MIL	2017	2020	1	Airport/Aircraft Specific
CZT	GA	2017	2020	1	Airport/Aircraft Specific
DAL	AC	2017	2020	1.050033826	Airport/Aircraft Specific
DAL	AT	2017	2020	1.030309851	Airport/Aircraft Specific
DAL	GA	2017	2020	1.002217933	Airport/Aircraft Specific
DAL	MIL	2017	2020	1	Airport/Aircraft Specific
DFW	AC	2017	2020	1.164748199	Airport/Aircraft Specific
DFW	AT	2017	2020	0.483581128	Airport/Aircraft Specific
DFW	GA	2017	2020	1.048317771	Airport/Aircraft Specific
DHT	GA	2017	2020	1	Airport/Aircraft Specific
DHT	MIL	2017	2020	1	Airport/Aircraft Specific
DKR	GA	2017	2020	1	Airport/Aircraft Specific
DLF	GA	2017	2020	1.02438137	Aircraft Specific
DRT	AC	2017	2020	1	Airport/Aircraft Specific
DRT	AT	2017	2020	1	Airport/Aircraft Specific
DRT	GA	2017	2020	1	Airport/Aircraft Specific
DTO	AC	2017	2020	1	Airport/Aircraft Specific
DTO	AT	2017	2020	1	Airport/Aircraft Specific
DTO	GA	2017	2020	1.015608207	Airport/Aircraft Specific
DTO	MIL	2017	2020	1	Airport/Aircraft Specific
DUX	GA	2017	2020	1	Airport/Aircraft Specific
DUX	MIL	2017	2020	1	Airport/Aircraft Specific
DWH	AC	2017	2020	1	Airport/Aircraft Specific
DWH	AT	2017	2020	1	Airport/Aircraft Specific
DWH	GA	2017	2020	1.051503956	Airport/Aircraft Specific
DWH	MIL	2017	2020	1	Airport/Aircraft Specific
DYS	AC	2017	2020	1.133308569	Aircraft Specific
DYS	GA	2017	2020	1.02438137	Aircraft Specific
DZB	AT	2017	2020	0.803340056	Aircraft Specific
DZB	GA	2017	2020	1.02438137	Aircraft Specific
E01	GA	2017	2020	1	Airport/Aircraft Specific
E11	GA	2017	2020	1	Airport/Aircraft Specific
E13	GA	2017	2020	1.02438137	Aircraft Specific
E19	GA	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
E30	AT	2017	2020	0.803340056	Aircraft Specific
E30	GA	2017	2020	1.02438137	Aircraft Specific
E34	GA	2017	2020	1.02438137	Aircraft Specific
E35	GA	2017	2020	1	Airport/Aircraft Specific
E38	GA	2017	2020	1	Airport/Aircraft Specific
E38	MIL	2017	2020	1	Airport/Aircraft Specific
E41	GA	2017	2020	1.02438137	Aircraft Specific
E42	GA	2017	2020	1	Airport/Aircraft Specific
E48	GA	2017	2020	1.02438137	Aircraft Specific
E52	GA	2017	2020	1	Airport/Aircraft Specific
E57	GA	2017	2020	1.02438137	Aircraft Specific
E58	GA	2017	2020	1.02438137	Aircraft Specific
E70	GA	2017	2020	1.02438137	Aircraft Specific
EBG	GA	2017	2020	1	Airport/Aircraft Specific
EBG	MIL	2017	2020	1	Airport/Aircraft Specific
ECU	GA	2017	2020	1.02438137	Aircraft Specific
EDC	GA	2017	2020	1.02438137	Aircraft Specific
EFD	AC	2017	2020	1	Airport/Aircraft Specific
EFD	AT	2017	2020	1	Airport/Aircraft Specific
EFD	GA	2017	2020	1	Airport/Aircraft Specific
EFD	MIL	2017	2020	1	Airport/Aircraft Specific
ELA	GA	2017	2020	1	Airport/Aircraft Specific
ELP	AC	2017	2020	1.078123262	Airport/Aircraft Specific
ELP	AT	2017	2020	0.913625393	Airport/Aircraft Specific
ELP	GA	2017	2020	1.000118462	Airport/Aircraft Specific
ELP	MIL	2017	2020	1	Airport/Aircraft Specific
ERV	GA	2017	2020	1.07163984	Airport/Aircraft Specific
ETN	GA	2017	2020	1	Airport/Aircraft Specific
EYQ	GA	2017	2020	1.02438137	Aircraft Specific
F00	GA	2017	2020	1	Airport/Aircraft Specific
F01	GA	2017	2020	1	Airport/Aircraft Specific
F05	GA	2017	2020	1	Airport/Aircraft Specific
F05	MIL	2017	2020	1	Airport/Aircraft Specific
F06	GA	2017	2020	1	Airport/Aircraft Specific
F06	MIL	2017	2020	1	Airport/Aircraft Specific
F14	GA	2017	2020	1.02438137	Aircraft Specific
F17	GA	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
F17	MIL	2017	2020	1	Airport/Aircraft Specific
F21	GA	2017	2020	1	Airport/Aircraft Specific
F23	GA	2017	2020	1.02438137	Aircraft Specific
F35	GA	2017	2020	1.02438137	Aircraft Specific
F41	GA	2017	2020	1	Airport/Aircraft Specific
F41	MIL	2017	2020	1	Airport/Aircraft Specific
F44	AT	2017	2020	1	Airport/Aircraft Specific
F44	GA	2017	2020	1	Airport/Aircraft Specific
F44	MIL	2017	2020	1	Airport/Aircraft Specific
F46	GA	2017	2020	1	Airport/Aircraft Specific
F46	MIL	2017	2020	1	Airport/Aircraft Specific
F49	GA	2017	2020	1	Airport/Aircraft Specific
F49	MIL	2017	2020	1	Airport/Aircraft Specific
F50	GA	2017	2020	1.02438137	Aircraft Specific
F51	GA	2017	2020	1	Airport/Aircraft Specific
F53	GA	2017	2020	1	Airport/Aircraft Specific
F56	GA	2017	2020	1	Airport/Aircraft Specific
F69	GA	2017	2020	1.02438137	Aircraft Specific
F75	GA	2017	2020	1.02438137	Aircraft Specific
F78	GA	2017	2020	1.02438137	Aircraft Specific
F82	GA	2017	2020	1.02438137	Aircraft Specific
F83	GA	2017	2020	1.02438137	Aircraft Specific
F85	GA	2017	2020	1	Airport/Aircraft Specific
F97	GA	2017	2020	1.02438137	Aircraft Specific
F98	GA	2017	2020	1.02438137	Aircraft Specific
FST	AT	2017	2020	1	Airport/Aircraft Specific
FST	GA	2017	2020	1	Airport/Aircraft Specific
FST	MIL	2017	2020	1	Airport/Aircraft Specific
FTW	AC	2017	2020	1	Airport/Aircraft Specific
FTW	AT	2017	2020	1.029770445	Airport/Aircraft Specific
FTW	GA	2017	2020	1.063598293	Airport/Aircraft Specific
FTW	MIL	2017	2020	1	Airport/Aircraft Specific
FWS	AT	2017	2020	1.076759062	Airport/Aircraft Specific
FWS	GA	2017	2020	1.03350213	Airport/Aircraft Specific
FWS	MIL	2017	2020	1	Airport/Aircraft Specific
GDJ	GA	2017	2020	1	Airport/Aircraft Specific
GGG	AC	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
GGG	AT	2017	2020	1.014745783	Airport/Aircraft Specific
GGG	GA	2017	2020	1.02178241	Airport/Aircraft Specific
GGG	MIL	2017	2020	1	Airport/Aircraft Specific
GKY	AC	2017	2020	1	Airport/Aircraft Specific
GKY	AT	2017	2020	1	Airport/Aircraft Specific
GKY	GA	2017	2020	0.991772373	Airport/Aircraft Specific
GKY	MIL	2017	2020	1	Airport/Aircraft Specific
GLE	GA	2017	2020	1	Airport/Aircraft Specific
GLE	MIL	2017	2020	1	Airport/Aircraft Specific
GLS	AC	2017	2020	1	Airport/Aircraft Specific
GLS	AT	2017	2020	1.030379747	Airport/Aircraft Specific
GLS	GA	2017	2020	1.013449806	Airport/Aircraft Specific
GLS	MIL	2017	2020	1	Airport/Aircraft Specific
GNC	AT	2017	2020	1	Airport/Aircraft Specific
GNC	GA	2017	2020	1	Airport/Aircraft Specific
GOP	GA	2017	2020	1	Airport/Aircraft Specific
GOP	MIL	2017	2020	1	Airport/Aircraft Specific
GPM	AT	2017	2020	1	Airport/Aircraft Specific
GPM	GA	2017	2020	1.047764999	Airport/Aircraft Specific
GPM	MIL	2017	2020	1	Airport/Aircraft Specific
GRK	AC	2017	2020	1.284463277	Airport/Aircraft Specific
GRK	AT	2017	2020	0.646396396	Airport/Aircraft Specific
GRK	GA	2017	2020	1	Airport/Aircraft Specific
GRK	MIL	2017	2020	1	Airport/Aircraft Specific
GTU	AT	2017	2020	1	Airport/Aircraft Specific
GTU	GA	2017	2020	1.065881838	Airport/Aircraft Specific
GTU	MIL	2017	2020	1	Airport/Aircraft Specific
GVT	GA	2017	2020	1	Airport/Aircraft Specific
GVT	MIL	2017	2020	1	Airport/Aircraft Specific
GYB	GA	2017	2020	1	Airport/Aircraft Specific
GYB	MIL	2017	2020	1	Airport/Aircraft Specific
GYI	AT	2017	2020	1.063829787	Airport/Aircraft Specific
GYI	GA	2017	2020	1.0518932	Airport/Aircraft Specific
GYI	MIL	2017	2020	1	Airport/Aircraft Specific
H70	GA	2017	2020	1.02438137	Aircraft Specific
HBV	GA	2017	2020	1	Airport/Aircraft Specific
HDO	GA	2017	2020	1.028116429	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
HHF	GA	2017	2020	1	Airport/Aircraft Specific
HLR	GA	2017	2020	1.02438137	Aircraft Specific
HOU	AC	2017	2020	1.092001728	Airport/Aircraft Specific
HOU	AT	2017	2020	0.993956	Airport/Aircraft Specific
HOU	GA	2017	2020	1.030313978	Airport/Aircraft Specific
HOU	MIL	2017	2020	1	Airport/Aircraft Specific
HPY	GA	2017	2020	1.02438137	Aircraft Specific
HQZ	AT	2017	2020	1	Airport/Aircraft Specific
HQZ	GA	2017	2020	1.138867642	Airport/Aircraft Specific
HQZ	MIL	2017	2020	1	Airport/Aircraft Specific
HRL	AC	2017	2020	1.077537858	Airport/Aircraft Specific
HRL	AT	2017	2020	0.899865591	Airport/Aircraft Specific
HRL	GA	2017	2020	1.038779361	Airport/Aircraft Specific
HRL	MIL	2017	2020	1	Airport/Aircraft Specific
HRX	AT	2017	2020	1	Airport/Aircraft Specific
HRX	GA	2017	2020	1	Airport/Aircraft Specific
HRX	MIL	2017	2020	1	Airport/Aircraft Specific
HYI	AC	2017	2020	1	Airport/Aircraft Specific
HYI	AT	2017	2020	1	Airport/Aircraft Specific
HYI	GA	2017	2020	1.211676822	Airport/Aircraft Specific
HYI	MIL	2017	2020	1	Airport/Aircraft Specific
I06	GA	2017	2020	1	Airport/Aircraft Specific
IAH	AC	2017	2020	1.124387732	Airport/Aircraft Specific
IAH	AT	2017	2020	0.627117352	Airport/Aircraft Specific
IAH	GA	2017	2020	1.031731178	Airport/Aircraft Specific
IAH	MIL	2017	2020	1	Airport/Aircraft Specific
IKG	AT	2017	2020	1	Airport/Aircraft Specific
IKG	GA	2017	2020	1	Airport/Aircraft Specific
IKG	MIL	2017	2020	1	Airport/Aircraft Specific
ILE	GA	2017	2020	1	Airport/Aircraft Specific
ILE	MIL	2017	2020	1	Airport/Aircraft Specific
INJ	GA	2017	2020	1	Airport/Aircraft Specific
INK	GA	2017	2020	1	Airport/Aircraft Specific
INK	MIL	2017	2020	1	Airport/Aircraft Specific
IWS	AT	2017	2020	1	Airport/Aircraft Specific
IWS	GA	2017	2020	1.043897206	Airport/Aircraft Specific
JAS	GA	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
JCT	GA	2017	2020	1	Airport/Aircraft Specific
JCT	MIL	2017	2020	1	Airport/Aircraft Specific
JDD	GA	2017	2020	1.02438137	Aircraft Specific
JSO	GA	2017	2020	1	Airport/Aircraft Specific
JSO	MIL	2017	2020	1	Airport/Aircraft Specific
JWY	GA	2017	2020	1	Airport/Aircraft Specific
JWY	MIL	2017	2020	1	Airport/Aircraft Specific
JXI	GA	2017	2020	1	Airport/Aircraft Specific
JZT	AC	2017	2020	1	Airport/Aircraft Specific
JZT	AT	2017	2020	1	Airport/Aircraft Specific
JZT	GA	2017	2020	0.991772373	Airport/Aircraft Specific
K84R	GA	2017	2020	1.02438137	Aircraft Specific
KLBB	AC	2017	2020	1.133308569	Aircraft Specific
KLBB	AT	2017	2020	0.803340056	Aircraft Specific
KLBB	GA	2017	2020	1.02438137	Aircraft Specific
KLOI	AC	2017	2020	1.133308569	Aircraft Specific
KLOI	AT	2017	2020	0.803340056	Aircraft Specific
KLOI	GA	2017	2020	1.02438137	Aircraft Specific
KLOI	MIL	2017	2020	1	Aircraft Specific
KMAF	AC	2017	2020	1.133308569	Aircraft Specific
KMAF	AT	2017	2020	0.803340056	Aircraft Specific
KMAF	GA	2017	2020	1.02438137	Aircraft Specific
KMDD	GA	2017	2020	1.02438137	Aircraft Specific
KMFE	AC	2017	2020	1.133308569	Aircraft Specific
KMFE	AT	2017	2020	0.803340056	Aircraft Specific
KMFE	GA	2017	2020	1.02438137	Aircraft Specific
KMRF	GA	2017	2020	1.02438137	Aircraft Specific
KSAT	AC	2017	2020	1.133308569	Aircraft Specific
KSAT	AT	2017	2020	0.803340056	Aircraft Specific
KSAT	GA	2017	2020	1.02438137	Aircraft Specific
KSAT	MIL	2017	2020	1	Aircraft Specific
KSGR	GA	2017	2020	1.02438137	Aircraft Specific
KSJT	AC	2017	2020	1.133308569	Aircraft Specific
KSJT	AT	2017	2020	0.803340056	Aircraft Specific
KSKF	AC	2017	2020	1.133308569	Aircraft Specific
KSKF	GA	2017	2020	1.02438137	Aircraft Specific
KSPS	AC	2017	2020	1.133308569	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
KSPS	AT	2017	2020	0.803340056	Aircraft Specific
KTYR	AC	2017	2020	1.133308569	Aircraft Specific
KTYR	AT	2017	2020	0.803340056	Aircraft Specific
KUVA	GA	2017	2020	1.02438137	Aircraft Specific
KVCT	GA	2017	2020	1.02438137	Aircraft Specific
LBB	AT	2017	2020	0.957310009	Airport/Aircraft Specific
LBB	GA	2017	2020	1.021877604	Airport/Aircraft Specific
LBB	MIL	2017	2020	1	Airport/Aircraft Specific
LBR	GA	2017	2020	1	Airport/Aircraft Specific
LBX	AC	2017	2020	1	Airport/Aircraft Specific
LBX	AT	2017	2020	1	Airport/Aircraft Specific
LBX	GA	2017	2020	1.071579423	Airport/Aircraft Specific
LBX	MIL	2017	2020	1	Airport/Aircraft Specific
LFK	AT	2017	2020	1	Airport/Aircraft Specific
LFK	GA	2017	2020	1	Airport/Aircraft Specific
LFK	MIL	2017	2020	1	Airport/Aircraft Specific
LHB	GA	2017	2020	1	Airport/Aircraft Specific
LIU	GA	2017	2020	1	Airport/Aircraft Specific
LIU	MIL	2017	2020	1	Airport/Aircraft Specific
LLN	AT	2017	2020	1	Airport/Aircraft Specific
LLN	GA	2017	2020	1	Airport/Aircraft Specific
LNC	GA	2017	2020	1.044263139	Airport/Aircraft Specific
LNC	MIL	2017	2020	1	Airport/Aircraft Specific
LRD	AT	2017	2020	0.681501278	Airport/Aircraft Specific
LRD	GA	2017	2020	1.017357002	Airport/Aircraft Specific
LRD	MIL	2017	2020	1	Airport/Aircraft Specific
LUD	GA	2017	2020	1	Airport/Aircraft Specific
LVJ	AT	2017	2020	1	Airport/Aircraft Specific
LVJ	GA	2017	2020	1.05787952	Airport/Aircraft Specific
LXY	GA	2017	2020	1	Airport/Aircraft Specific
LZZ	GA	2017	2020	1	Airport/Aircraft Specific
MAF	AT	2017	2020	0.745252991	Airport/Aircraft Specific
MAF	GA	2017	2020	1.061315929	Airport/Aircraft Specific
MAF	MIL	2017	2020	1	Airport/Aircraft Specific
MDA	GA	2017	2020	1.02438137	Aircraft Specific
MDD	AT	2017	2020	1	Airport/Aircraft Specific
MDD	GA	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
MDD	MIL	2017	2020	1	Airport/Aircraft Specific
MFE	AT	2017	2020	1.066934894	Airport/Aircraft Specific
MFE	GA	2017	2020	0.999342676	Airport/Aircraft Specific
MFE	MIL	2017	2020	1	Airport/Aircraft Specific
MKN	GA	2017	2020	1	Airport/Aircraft Specific
MNZ	AT	2017	2020	1	Airport/Aircraft Specific
MNZ	GA	2017	2020	1	Airport/Aircraft Specific
MRF	GA	2017	2020	1	Airport/Aircraft Specific
MWL	GA	2017	2020	1	Airport/Aircraft Specific
MWL	MIL	2017	2020	1	Airport/Aircraft Specific
NFW	GA	2017	2020	1.02438137	Aircraft Specific
NGP	GA	2017	2020	1.02438137	Aircraft Specific
NGW	GA	2017	2020	1.02438137	Aircraft Specific
NOG	GA	2017	2020	1.02438137	Aircraft Specific
NQI	GA	2017	2020	1.02438137	Aircraft Specific
NWL	GA	2017	2020	1.02438137	Aircraft Specific
O07	GA	2017	2020	1.02438137	Aircraft Specific
OCH	GA	2017	2020	1	Airport/Aircraft Specific
OCH	MIL	2017	2020	1	Airport/Aircraft Specific
ODO	GA	2017	2020	1.028209433	Airport/Aircraft Specific
ONY	GA	2017	2020	1	Airport/Aircraft Specific
ORG	AT	2017	2020	1	Airport/Aircraft Specific
ORG	GA	2017	2020	1	Airport/Aircraft Specific
OSA	GA	2017	2020	1	Airport/Aircraft Specific
OZA	GA	2017	2020	1	Airport/Aircraft Specific
OZA	MIL	2017	2020	1	Airport/Aircraft Specific
PEQ	AT	2017	2020	1	Airport/Aircraft Specific
PEQ	GA	2017	2020	1	Airport/Aircraft Specific
PEQ	MIL	2017	2020	1	Airport/Aircraft Specific
PEZ	AT	2017	2020	1	Airport/Aircraft Specific
PEZ	GA	2017	2020	1	Airport/Aircraft Specific
PEZ	MIL	2017	2020	1	Airport/Aircraft Specific
PIL	AT	2017	2020	1	Airport/Aircraft Specific
PIL	GA	2017	2020	1	Airport/Aircraft Specific
PIL	MIL	2017	2020	1	Airport/Aircraft Specific
PKV	GA	2017	2020	1	Airport/Aircraft Specific
PKV	MIL	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
PNX	GA	2017	2020	1.02438137	Aircraft Specific
PPA	GA	2017	2020	1	Airport/Aircraft Specific
PRX	AT	2017	2020	1	Airport/Aircraft Specific
PRX	GA	2017	2020	1	Airport/Aircraft Specific
PRX	MIL	2017	2020	1	Airport/Aircraft Specific
PSN	GA	2017	2020	1	Airport/Aircraft Specific
PSN	MIL	2017	2020	1	Airport/Aircraft Specific
PSX	GA	2017	2020	1	Airport/Aircraft Specific
PSX	MIL	2017	2020	1	Airport/Aircraft Specific
PVW	GA	2017	2020	1.028378322	Airport/Aircraft Specific
PVW	MIL	2017	2020	1	Airport/Aircraft Specific
PWG	AT	2017	2020	1.085603113	Airport/Aircraft Specific
PWG	GA	2017	2020	1.073674217	Airport/Aircraft Specific
PWG	MIL	2017	2020	1	Airport/Aircraft Specific
PYX	GA	2017	2020	1	Airport/Aircraft Specific
RAS	GA	2017	2020	1.02438137	Aircraft Specific
RBD	AC	2017	2020	1	Airport/Aircraft Specific
RBD	AT	2017	2020	1	Airport/Aircraft Specific
RBD	GA	2017	2020	1.024523608	Airport/Aircraft Specific
RBD	MIL	2017	2020	1	Airport/Aircraft Specific
RBO	GA	2017	2020	1	Airport/Aircraft Specific
RCK	GA	2017	2020	1.02438137	Aircraft Specific
RFG	GA	2017	2020	1	Airport/Aircraft Specific
RFI	GA	2017	2020	1	Airport/Aircraft Specific
RFI	MIL	2017	2020	1	Airport/Aircraft Specific
RKP	GA	2017	2020	1	Airport/Aircraft Specific
RKP	MIL	2017	2020	1	Airport/Aircraft Specific
RND	GA	2017	2020	1.02438137	Aircraft Specific
RPH	GA	2017	2020	1	Airport/Aircraft Specific
RPH	MIL	2017	2020	1	Airport/Aircraft Specific
RWV	GA	2017	2020	1.02438137	Aircraft Specific
RYW	GA	2017	2020	1	Airport/Aircraft Specific
SAT	AC	2017	2020	1.086762246	Airport/Aircraft Specific
SAT	AT	2017	2020	1.011804131	Airport/Aircraft Specific
SAT	GA	2017	2020	0.954266855	Airport/Aircraft Specific
SAT	MIL	2017	2020	1	Airport/Aircraft Specific
SEP	AT	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
SEP	GA	2017	2020	1	Airport/Aircraft Specific
SEP	MIL	2017	2020	1	Airport/Aircraft Specific
SEQ	GA	2017	2020	1.02438137	Aircraft Specific
SGR	AT	2017	2020	1.030259134	Airport/Aircraft Specific
SGR	GA	2017	2020	0.990563128	Airport/Aircraft Specific
SGR	MIL	2017	2020	1	Airport/Aircraft Specific
SKF	GA	2017	2020	1	Airport/Aircraft Specific
SKF	MIL	2017	2020	1	Airport/Aircraft Specific
SLR	AT	2017	2020	1	Airport/Aircraft Specific
SLR	GA	2017	2020	1	Airport/Aircraft Specific
SLR	MIL	2017	2020	1	Airport/Aircraft Specific
SNK	GA	2017	2020	1	Airport/Aircraft Specific
SOA	GA	2017	2020	1.02438137	Aircraft Specific
SPS	GA	2017	2020	1	Airport/Aircraft Specific
SPS	MIL	2017	2020	1	Airport/Aircraft Specific
SSF	AC	2017	2020	1	Airport/Aircraft Specific
SSF	AT	2017	2020	1	Airport/Aircraft Specific
SSF	GA	2017	2020	1.013441863	Airport/Aircraft Specific
SSF	MIL	2017	2020	1	Airport/Aircraft Specific
SWI	GA	2017	2020	1.02438137	Aircraft Specific
SWW	GA	2017	2020	1	Airport/Aircraft Specific
T00	GA	2017	2020	1	Airport/Aircraft Specific
T05	GA	2017	2020	1.02438137	Aircraft Specific
T12	GA	2017	2020	1.02438137	Aircraft Specific
T13	GA	2017	2020	1.02438137	Aircraft Specific
T14	GA	2017	2020	1.02438137	Aircraft Specific
T15	GA	2017	2020	1.02438137	Aircraft Specific
T17	GA	2017	2020	1.02438137	Aircraft Specific
T19	GA	2017	2020	1.02438137	Aircraft Specific
T20	GA	2017	2020	1.02438137	Aircraft Specific
T22	GA	2017	2020	1.02438137	Aircraft Specific
T23	GA	2017	2020	1.02438137	Aircraft Specific
T24	GA	2017	2020	1.02438137	Aircraft Specific
T25	GA	2017	2020	1.02438137	Aircraft Specific
T26	GA	2017	2020	1.02438137	Aircraft Specific
T27	GA	2017	2020	1.02438137	Aircraft Specific
T28	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
T29	GA	2017	2020	1.02438137	Aircraft Specific
T30	GA	2017	2020	1.02438137	Aircraft Specific
T31	GA	2017	2020	1.02438137	Aircraft Specific
T32	GA	2017	2020	1.02438137	Aircraft Specific
T33	GA	2017	2020	1.02438137	Aircraft Specific
T34	GA	2017	2020	1.02438137	Aircraft Specific
T35	GA	2017	2020	1	Airport/Aircraft Specific
T37	GA	2017	2020	1.02438137	Aircraft Specific
T39	GA	2017	2020	1.02438137	Aircraft Specific
T41	GA	2017	2020	1.071584755	Airport/Aircraft Specific
T45	GA	2017	2020	1.02438137	Aircraft Specific
T48	GA	2017	2020	1.02438137	Aircraft Specific
T50	GA	2017	2020	1.02438137	Aircraft Specific
T51	GA	2017	2020	1.02438137	Aircraft Specific
T54	GA	2017	2020	1.02438137	Aircraft Specific
T55	GA	2017	2020	1	Airport/Aircraft Specific
T57	AT	2017	2020	1	Airport/Aircraft Specific
T57	GA	2017	2020	1	Airport/Aircraft Specific
T58	GA	2017	2020	1.02438137	Aircraft Specific
T59	GA	2017	2020	1.02438137	Aircraft Specific
T60	GA	2017	2020	1	Airport/Aircraft Specific
T65	AT	2017	2020	1	Airport/Aircraft Specific
T65	GA	2017	2020	1.057881471	Airport/Aircraft Specific
T65	MIL	2017	2020	1	Airport/Aircraft Specific
T67	GA	2017	2020	1.02438137	Aircraft Specific
T69	GA	2017	2020	1.02438137	Aircraft Specific
T70	GA	2017	2020	1.02438137	Aircraft Specific
T71	GA	2017	2020	1	Airport/Aircraft Specific
T74	GA	2017	2020	1	Airport/Aircraft Specific
T76	GA	2017	2020	1.02438137	Aircraft Specific
T77	GA	2017	2020	1.02438137	Aircraft Specific
T78	GA	2017	2020	1	Airport/Aircraft Specific
T78	MIL	2017	2020	1	Airport/Aircraft Specific
T79	GA	2017	2020	1.02438137	Aircraft Specific
T80	GA	2017	2020	1.02438137	Aircraft Specific
T82	AT	2017	2020	1	Airport/Aircraft Specific
T82	GA	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
T82	MIL	2017	2020	1	Airport/Aircraft Specific
T84	GA	2017	2020	1.02438137	Aircraft Specific
T85	GA	2017	2020	1.02438137	Aircraft Specific
T87	GA	2017	2020	1.02438137	Aircraft Specific
T88	GA	2017	2020	1.02438137	Aircraft Specific
T90	GA	2017	2020	1	Airport/Aircraft Specific
T91	GA	2017	2020	1.02438137	Aircraft Specific
T92	GA	2017	2020	1.02438137	Aircraft Specific
T93	GA	2017	2020	1.02438137	Aircraft Specific
T94	GA	2017	2020	1.02438137	Aircraft Specific
T95	GA	2017	2020	1.02438137	Aircraft Specific
TA00	GA	2017	2020	1.02438137	Aircraft Specific
TA01	GA	2017	2020	1.02438137	Aircraft Specific
TA02	GA	2017	2020	1.02438137	Aircraft Specific
TA03	GA	2017	2020	1.02438137	Aircraft Specific
TA04	GA	2017	2020	1.02438137	Aircraft Specific
TA05	GA	2017	2020	1.02438137	Aircraft Specific
TA06	GA	2017	2020	1.02438137	Aircraft Specific
TA07	GA	2017	2020	1.02438137	Aircraft Specific
TA08	GA	2017	2020	1.02438137	Aircraft Specific
TA09	GA	2017	2020	1.02438137	Aircraft Specific
TA10	GA	2017	2020	1.02438137	Aircraft Specific
TA11	GA	2017	2020	1.02438137	Aircraft Specific
TA12	GA	2017	2020	1.02438137	Aircraft Specific
TA13	GA	2017	2020	1.02438137	Aircraft Specific
TA14	GA	2017	2020	1.02438137	Aircraft Specific
TA15	GA	2017	2020	1.02438137	Aircraft Specific
TA16	GA	2017	2020	1.02438137	Aircraft Specific
TA17	GA	2017	2020	1.02438137	Aircraft Specific
TA18	GA	2017	2020	1.02438137	Aircraft Specific
TA19	GA	2017	2020	1.02438137	Aircraft Specific
TA20	GA	2017	2020	1.02438137	Aircraft Specific
TA21	GA	2017	2020	1.02438137	Aircraft Specific
TA22	GA	2017	2020	1.02438137	Aircraft Specific
TA23	GA	2017	2020	1.02438137	Aircraft Specific
TA24	GA	2017	2020	1.02438137	Aircraft Specific
TA25	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TA26	GA	2017	2020	1.02438137	Aircraft Specific
TA27	GA	2017	2020	1.02438137	Aircraft Specific
TA28	GA	2017	2020	1.02438137	Aircraft Specific
TA29	GA	2017	2020	1.02438137	Aircraft Specific
TA30	GA	2017	2020	1.02438137	Aircraft Specific
TA31	GA	2017	2020	1.02438137	Aircraft Specific
TA32	GA	2017	2020	1.02438137	Aircraft Specific
TA33	GA	2017	2020	1.02438137	Aircraft Specific
TA34	GA	2017	2020	1.02438137	Aircraft Specific
TA35	GA	2017	2020	1.02438137	Aircraft Specific
TA36	GA	2017	2020	1.02438137	Aircraft Specific
TA37	GA	2017	2020	1.02438137	Aircraft Specific
TA38	GA	2017	2020	1.02438137	Aircraft Specific
TA39	GA	2017	2020	1.02438137	Aircraft Specific
TA40	GA	2017	2020	1.02438137	Aircraft Specific
TA41	GA	2017	2020	1.02438137	Aircraft Specific
TA42	GA	2017	2020	1.02438137	Aircraft Specific
TA43	GA	2017	2020	1.02438137	Aircraft Specific
TA44	GA	2017	2020	1.02438137	Aircraft Specific
TA45	GA	2017	2020	1.02438137	Aircraft Specific
TA46	GA	2017	2020	1.02438137	Aircraft Specific
TA47	GA	2017	2020	1.02438137	Aircraft Specific
TA48	GA	2017	2020	1.02438137	Aircraft Specific
TA49	GA	2017	2020	1.02438137	Aircraft Specific
TA51	GA	2017	2020	1.02438137	Aircraft Specific
TA52	GA	2017	2020	1.02438137	Aircraft Specific
TA53	GA	2017	2020	1.02438137	Aircraft Specific
TA54	GA	2017	2020	1.02438137	Aircraft Specific
TA55	GA	2017	2020	1.02438137	Aircraft Specific
TA57	GA	2017	2020	1.02438137	Aircraft Specific
TA58	GA	2017	2020	1.02438137	Aircraft Specific
TA59	GA	2017	2020	1.02438137	Aircraft Specific
TA60	GA	2017	2020	1.02438137	Aircraft Specific
TA61	GA	2017	2020	1.02438137	Aircraft Specific
TA62	GA	2017	2020	1.02438137	Aircraft Specific
TA63	GA	2017	2020	1.02438137	Aircraft Specific
TA64	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TA65	GA	2017	2020	1.02438137	Aircraft Specific
TA66	GA	2017	2020	1.02438137	Aircraft Specific
TA67	GA	2017	2020	1.02438137	Aircraft Specific
TA68	GA	2017	2020	1.02438137	Aircraft Specific
TA69	GA	2017	2020	1.02438137	Aircraft Specific
TA70	GA	2017	2020	1.02438137	Aircraft Specific
TA71	GA	2017	2020	1.02438137	Aircraft Specific
TA72	GA	2017	2020	1.02438137	Aircraft Specific
TA73	GA	2017	2020	1.02438137	Aircraft Specific
TA74	GA	2017	2020	1.02438137	Aircraft Specific
TA75	GA	2017	2020	1.02438137	Aircraft Specific
TA77	GA	2017	2020	1.02438137	Aircraft Specific
TA78	GA	2017	2020	1.02438137	Aircraft Specific
TA79	GA	2017	2020	1.02438137	Aircraft Specific
TA80	GA	2017	2020	1.02438137	Aircraft Specific
TA81	GA	2017	2020	1.02438137	Aircraft Specific
TA83	GA	2017	2020	1.02438137	Aircraft Specific
TA84	GA	2017	2020	1.02438137	Aircraft Specific
TA86	GA	2017	2020	1.02438137	Aircraft Specific
TA87	GA	2017	2020	1.02438137	Aircraft Specific
TA88	GA	2017	2020	1.02438137	Aircraft Specific
TA89	GA	2017	2020	1.02438137	Aircraft Specific
TA90	GA	2017	2020	1.02438137	Aircraft Specific
TA91	GA	2017	2020	1.02438137	Aircraft Specific
TA93	GA	2017	2020	1.02438137	Aircraft Specific
TA94	GA	2017	2020	1.02438137	Aircraft Specific
TA95	GA	2017	2020	1.02438137	Aircraft Specific
TA96	GA	2017	2020	1.02438137	Aircraft Specific
TA97	GA	2017	2020	1.02438137	Aircraft Specific
TA98	GA	2017	2020	1.02438137	Aircraft Specific
TA99	GA	2017	2020	1.02438137	Aircraft Specific
TDW	GA	2017	2020	1.02438137	Aircraft Specific
TE00	GA	2017	2020	1.02438137	Aircraft Specific
TE01	GA	2017	2020	1.02438137	Aircraft Specific
TE02	GA	2017	2020	1.02438137	Aircraft Specific
TE03	GA	2017	2020	1.02438137	Aircraft Specific
TE04	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TE05	GA	2017	2020	1.02438137	Aircraft Specific
TE06	GA	2017	2020	1.02438137	Aircraft Specific
TE07	GA	2017	2020	1.02438137	Aircraft Specific
TE08	GA	2017	2020	1.02438137	Aircraft Specific
TE09	GA	2017	2020	1.02438137	Aircraft Specific
TE10	GA	2017	2020	1.02438137	Aircraft Specific
TE11	GA	2017	2020	1.02438137	Aircraft Specific
TE12	GA	2017	2020	1.02438137	Aircraft Specific
TE13	GA	2017	2020	1.02438137	Aircraft Specific
TE14	GA	2017	2020	1.02438137	Aircraft Specific
TE15	GA	2017	2020	1.02438137	Aircraft Specific
TE16	GA	2017	2020	1.02438137	Aircraft Specific
TE17	GA	2017	2020	1.02438137	Aircraft Specific
TE18	GA	2017	2020	1.02438137	Aircraft Specific
TE19	GA	2017	2020	1.02438137	Aircraft Specific
TE20	GA	2017	2020	1.02438137	Aircraft Specific
TE21	GA	2017	2020	1.02438137	Aircraft Specific
TE22	GA	2017	2020	1.02438137	Aircraft Specific
TE23	GA	2017	2020	1.02438137	Aircraft Specific
TE24	GA	2017	2020	1.02438137	Aircraft Specific
TE25	GA	2017	2020	1.02438137	Aircraft Specific
TE26	GA	2017	2020	1.02438137	Aircraft Specific
TE27	GA	2017	2020	1.02438137	Aircraft Specific
TE28	GA	2017	2020	1.02438137	Aircraft Specific
TE29	GA	2017	2020	1.02438137	Aircraft Specific
TE30	GA	2017	2020	1.02438137	Aircraft Specific
TE31	GA	2017	2020	1.02438137	Aircraft Specific
TE32	GA	2017	2020	1.02438137	Aircraft Specific
TE33	GA	2017	2020	1.02438137	Aircraft Specific
TE34	GA	2017	2020	1.02438137	Aircraft Specific
TE35	GA	2017	2020	1.02438137	Aircraft Specific
TE36	GA	2017	2020	1.02438137	Aircraft Specific
TE37	GA	2017	2020	1.02438137	Aircraft Specific
TE38	GA	2017	2020	1.02438137	Aircraft Specific
TE39	GA	2017	2020	1.02438137	Aircraft Specific
TE40	GA	2017	2020	1.02438137	Aircraft Specific
TE41	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TE42	GA	2017	2020	1.02438137	Aircraft Specific
TE43	GA	2017	2020	1.02438137	Aircraft Specific
TE44	GA	2017	2020	1.02438137	Aircraft Specific
TE45	GA	2017	2020	1.02438137	Aircraft Specific
TE46	GA	2017	2020	1.02438137	Aircraft Specific
TE47	GA	2017	2020	1.02438137	Aircraft Specific
TE48	GA	2017	2020	1.02438137	Aircraft Specific
TE49	GA	2017	2020	1.02438137	Aircraft Specific
TE50	GA	2017	2020	1.02438137	Aircraft Specific
TE51	GA	2017	2020	1.02438137	Aircraft Specific
TE52	GA	2017	2020	1.02438137	Aircraft Specific
TE53	GA	2017	2020	1.02438137	Aircraft Specific
TE54	GA	2017	2020	1.02438137	Aircraft Specific
TE55	GA	2017	2020	1.02438137	Aircraft Specific
TE56	GA	2017	2020	1.02438137	Aircraft Specific
TE57	GA	2017	2020	1.02438137	Aircraft Specific
TE59	GA	2017	2020	1.02438137	Aircraft Specific
TE60	GA	2017	2020	1.02438137	Aircraft Specific
TE61	GA	2017	2020	1.02438137	Aircraft Specific
TE62	GA	2017	2020	1.02438137	Aircraft Specific
TE63	GA	2017	2020	1.02438137	Aircraft Specific
TE64	GA	2017	2020	1.02438137	Aircraft Specific
TE65	GA	2017	2020	1.02438137	Aircraft Specific
TE66	GA	2017	2020	1.02438137	Aircraft Specific
TE67	GA	2017	2020	1.02438137	Aircraft Specific
TE68	GA	2017	2020	1.02438137	Aircraft Specific
TE69	GA	2017	2020	1.02438137	Aircraft Specific
TE70	GA	2017	2020	1.02438137	Aircraft Specific
TE71	GA	2017	2020	1.02438137	Aircraft Specific
TE72	GA	2017	2020	1.02438137	Aircraft Specific
TE73	GA	2017	2020	1.02438137	Aircraft Specific
TE74	GA	2017	2020	1.02438137	Aircraft Specific
TE75	GA	2017	2020	1.02438137	Aircraft Specific
TE76	GA	2017	2020	1.02438137	Aircraft Specific
TE77	GA	2017	2020	1.02438137	Aircraft Specific
TE78	GA	2017	2020	1.02438137	Aircraft Specific
TE79	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TE80	GA	2017	2020	1.02438137	Aircraft Specific
TE81	GA	2017	2020	1.02438137	Aircraft Specific
TE82	GA	2017	2020	1.02438137	Aircraft Specific
TE83	GA	2017	2020	1.02438137	Aircraft Specific
TE84	GA	2017	2020	1.02438137	Aircraft Specific
TE85	GA	2017	2020	1.02438137	Aircraft Specific
TE86	GA	2017	2020	1.02438137	Aircraft Specific
TE87	GA	2017	2020	1.02438137	Aircraft Specific
TE88	GA	2017	2020	1.02438137	Aircraft Specific
TE90	GA	2017	2020	1.02438137	Aircraft Specific
TE91	GA	2017	2020	1.02438137	Aircraft Specific
TE92	GA	2017	2020	1.02438137	Aircraft Specific
TE93	GA	2017	2020	1.02438137	Aircraft Specific
TE94	GA	2017	2020	1.02438137	Aircraft Specific
TE95	GA	2017	2020	1.02438137	Aircraft Specific
TE96	GA	2017	2020	1.02438137	Aircraft Specific
TE97	GA	2017	2020	1.02438137	Aircraft Specific
TE98	GA	2017	2020	1.02438137	Aircraft Specific
TE99	GA	2017	2020	1.02438137	Aircraft Specific
TFP	GA	2017	2020	1	Airport/Aircraft Specific
TKI	AC	2017	2020	1	Airport/Aircraft Specific
TKI	AT	2017	2020	1	Airport/Aircraft Specific
TKI	GA	2017	2020	1.069807661	Airport/Aircraft Specific
TKI	MIL	2017	2020	1	Airport/Aircraft Specific
TME	GA	2017	2020	1.02438137	Aircraft Specific
TPL	GA	2017	2020	1.086960299	Airport/Aircraft Specific
TPL	MIL	2017	2020	1	Airport/Aircraft Specific
TRL	AT	2017	2020	1	Airport/Aircraft Specific
TRL	GA	2017	2020	1	Airport/Aircraft Specific
TS00	GA	2017	2020	1.02438137	Aircraft Specific
TS01	GA	2017	2020	1.02438137	Aircraft Specific
TS02	GA	2017	2020	1.02438137	Aircraft Specific
TS03	GA	2017	2020	1.02438137	Aircraft Specific
TS04	GA	2017	2020	1.02438137	Aircraft Specific
TS05	GA	2017	2020	1.02438137	Aircraft Specific
TS06	GA	2017	2020	1.02438137	Aircraft Specific
TS07	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TS08	GA	2017	2020	1.02438137	Aircraft Specific
TS09	GA	2017	2020	1.02438137	Aircraft Specific
TS10	GA	2017	2020	1.02438137	Aircraft Specific
TS11	GA	2017	2020	1.02438137	Aircraft Specific
TS12	GA	2017	2020	1.02438137	Aircraft Specific
TS13	GA	2017	2020	1.02438137	Aircraft Specific
TS14	GA	2017	2020	1.02438137	Aircraft Specific
TS15	GA	2017	2020	1.02438137	Aircraft Specific
TS16	GA	2017	2020	1.02438137	Aircraft Specific
TS17	GA	2017	2020	1.02438137	Aircraft Specific
TS18	GA	2017	2020	1.02438137	Aircraft Specific
TS19	GA	2017	2020	1.02438137	Aircraft Specific
TS20	GA	2017	2020	1.02438137	Aircraft Specific
TS21	GA	2017	2020	1.02438137	Aircraft Specific
TS22	GA	2017	2020	1.02438137	Aircraft Specific
TS23	GA	2017	2020	1.02438137	Aircraft Specific
TS24	GA	2017	2020	1.02438137	Aircraft Specific
TS26	GA	2017	2020	1.02438137	Aircraft Specific
TS27	GA	2017	2020	1.02438137	Aircraft Specific
TS28	GA	2017	2020	1.02438137	Aircraft Specific
TS29	GA	2017	2020	1.02438137	Aircraft Specific
TS30	GA	2017	2020	1.02438137	Aircraft Specific
TS31	GA	2017	2020	1.02438137	Aircraft Specific
TS32	GA	2017	2020	1.02438137	Aircraft Specific
TS33	GA	2017	2020	1.02438137	Aircraft Specific
TS34	GA	2017	2020	1.02438137	Aircraft Specific
TS35	GA	2017	2020	1.02438137	Aircraft Specific
TS36	GA	2017	2020	1.02438137	Aircraft Specific
TS37	GA	2017	2020	1.02438137	Aircraft Specific
TS38	GA	2017	2020	1.02438137	Aircraft Specific
TS39	GA	2017	2020	1.02438137	Aircraft Specific
TS40	GA	2017	2020	1.02438137	Aircraft Specific
TS41	GA	2017	2020	1.02438137	Aircraft Specific
TS42	GA	2017	2020	1.02438137	Aircraft Specific
TS43	GA	2017	2020	1.02438137	Aircraft Specific
TS44	GA	2017	2020	1.02438137	Aircraft Specific
TS45	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TS47	GA	2017	2020	1.02438137	Aircraft Specific
TS48	GA	2017	2020	1.02438137	Aircraft Specific
TS49	GA	2017	2020	1.02438137	Aircraft Specific
TS50	GA	2017	2020	1.02438137	Aircraft Specific
TS51	GA	2017	2020	1.02438137	Aircraft Specific
TS52	GA	2017	2020	1.02438137	Aircraft Specific
TS54	GA	2017	2020	1.02438137	Aircraft Specific
TS55	GA	2017	2020	1.02438137	Aircraft Specific
TS56	GA	2017	2020	1.02438137	Aircraft Specific
TS57	GA	2017	2020	1.02438137	Aircraft Specific
TS58	GA	2017	2020	1.02438137	Aircraft Specific
TS59	GA	2017	2020	1.02438137	Aircraft Specific
TS60	GA	2017	2020	1.02438137	Aircraft Specific
TS61	GA	2017	2020	1.02438137	Aircraft Specific
TS62	GA	2017	2020	1.02438137	Aircraft Specific
TS63	GA	2017	2020	1.02438137	Aircraft Specific
TS64	GA	2017	2020	1.02438137	Aircraft Specific
TS65	GA	2017	2020	1.02438137	Aircraft Specific
TS66	GA	2017	2020	1.02438137	Aircraft Specific
TS67	GA	2017	2020	1.02438137	Aircraft Specific
TS68	GA	2017	2020	1.02438137	Aircraft Specific
TS69	GA	2017	2020	1.02438137	Aircraft Specific
TS70	GA	2017	2020	1.02438137	Aircraft Specific
TS71	GA	2017	2020	1.02438137	Aircraft Specific
TS72	GA	2017	2020	1.02438137	Aircraft Specific
TS73	GA	2017	2020	1.02438137	Aircraft Specific
TS74	GA	2017	2020	1.02438137	Aircraft Specific
TS75	GA	2017	2020	1.02438137	Aircraft Specific
TS76	GA	2017	2020	1.02438137	Aircraft Specific
TS77	GA	2017	2020	1.02438137	Aircraft Specific
TS78	GA	2017	2020	1.02438137	Aircraft Specific
TS79	GA	2017	2020	1.02438137	Aircraft Specific
TS80	GA	2017	2020	1.02438137	Aircraft Specific
TS81	GA	2017	2020	1.02438137	Aircraft Specific
TS82	GA	2017	2020	1.02438137	Aircraft Specific
TS83	GA	2017	2020	1.02438137	Aircraft Specific
TS85	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TS86	GA	2017	2020	1.02438137	Aircraft Specific
TS87	GA	2017	2020	1.02438137	Aircraft Specific
TS88	GA	2017	2020	1.02438137	Aircraft Specific
TS89	GA	2017	2020	1.02438137	Aircraft Specific
TS90	GA	2017	2020	1.02438137	Aircraft Specific
TS91	GA	2017	2020	1.02438137	Aircraft Specific
TS92	GA	2017	2020	1.02438137	Aircraft Specific
TS93	GA	2017	2020	1.02438137	Aircraft Specific
TS94	GA	2017	2020	1.02438137	Aircraft Specific
TS96	GA	2017	2020	1.02438137	Aircraft Specific
TS97	GA	2017	2020	1.02438137	Aircraft Specific
TS98	GA	2017	2020	1.02438137	Aircraft Specific
TS99	GA	2017	2020	1.02438137	Aircraft Specific
TX00	GA	2017	2020	1.02438137	Aircraft Specific
TX02	GA	2017	2020	1.02438137	Aircraft Specific
TX03	GA	2017	2020	1.02438137	Aircraft Specific
TX05	GA	2017	2020	1.02438137	Aircraft Specific
TX06	GA	2017	2020	1.02438137	Aircraft Specific
TX07	GA	2017	2020	1.02438137	Aircraft Specific
TX08	GA	2017	2020	1.02438137	Aircraft Specific
TX09	GA	2017	2020	1.02438137	Aircraft Specific
TX10	GA	2017	2020	1.02438137	Aircraft Specific
TX11	GA	2017	2020	1.02438137	Aircraft Specific
TX12	GA	2017	2020	1.02438137	Aircraft Specific
TX13	GA	2017	2020	1.02438137	Aircraft Specific
TX14	GA	2017	2020	1.02438137	Aircraft Specific
TX15	GA	2017	2020	1.02438137	Aircraft Specific
TX16	GA	2017	2020	1.02438137	Aircraft Specific
TX17	GA	2017	2020	1.02438137	Aircraft Specific
TX18	GA	2017	2020	1.02438137	Aircraft Specific
TX19	GA	2017	2020	1.02438137	Aircraft Specific
TX20	GA	2017	2020	1.02438137	Aircraft Specific
TX21	GA	2017	2020	1.02438137	Aircraft Specific
TX22	GA	2017	2020	1.02438137	Aircraft Specific
TX23	GA	2017	2020	1.02438137	Aircraft Specific
TX24	GA	2017	2020	1.02438137	Aircraft Specific
TX25	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TX26	GA	2017	2020	1.02438137	Aircraft Specific
TX28	GA	2017	2020	1.02438137	Aircraft Specific
TX29	GA	2017	2020	1.02438137	Aircraft Specific
TX30	GA	2017	2020	1.02438137	Aircraft Specific
TX31	GA	2017	2020	1.02438137	Aircraft Specific
TX32	GA	2017	2020	1.02438137	Aircraft Specific
TX33	GA	2017	2020	1.02438137	Aircraft Specific
TX34	GA	2017	2020	1.02438137	Aircraft Specific
TX35	GA	2017	2020	1.02438137	Aircraft Specific
TX36	GA	2017	2020	1.02438137	Aircraft Specific
TX37	GA	2017	2020	1.02438137	Aircraft Specific
TX38	GA	2017	2020	1.02438137	Aircraft Specific
TX39	GA	2017	2020	1.02438137	Aircraft Specific
TX40	GA	2017	2020	1.02438137	Aircraft Specific
TX41	GA	2017	2020	1.02438137	Aircraft Specific
TX42	GA	2017	2020	1.02438137	Aircraft Specific
TX43	GA	2017	2020	1.02438137	Aircraft Specific
TX44	GA	2017	2020	1.02438137	Aircraft Specific
TX45	GA	2017	2020	1.02438137	Aircraft Specific
TX46	GA	2017	2020	1.02438137	Aircraft Specific
TX47	GA	2017	2020	1.02438137	Aircraft Specific
TX48	GA	2017	2020	1.02438137	Aircraft Specific
TX50	GA	2017	2020	1.02438137	Aircraft Specific
TX51	GA	2017	2020	1.02438137	Aircraft Specific
TX52	GA	2017	2020	1.02438137	Aircraft Specific
TX53	GA	2017	2020	1.02438137	Aircraft Specific
TX54	GA	2017	2020	1.02438137	Aircraft Specific
TX55	GA	2017	2020	1.02438137	Aircraft Specific
TX56	GA	2017	2020	1.02438137	Aircraft Specific
TX57	GA	2017	2020	1.02438137	Aircraft Specific
TX58	GA	2017	2020	1.02438137	Aircraft Specific
TX59	GA	2017	2020	1.02438137	Aircraft Specific
TX60	GA	2017	2020	1.02438137	Aircraft Specific
TX61	GA	2017	2020	1.02438137	Aircraft Specific
TX62	GA	2017	2020	1.02438137	Aircraft Specific
TX63	GA	2017	2020	1.02438137	Aircraft Specific
TX64	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
TX65	GA	2017	2020	1.02438137	Aircraft Specific
TX66	GA	2017	2020	1.02438137	Aircraft Specific
TX67	GA	2017	2020	1.02438137	Aircraft Specific
TX68	GA	2017	2020	1.02438137	Aircraft Specific
TX69	GA	2017	2020	1.02438137	Aircraft Specific
TX70	GA	2017	2020	1.02438137	Aircraft Specific
TX71	GA	2017	2020	1.02438137	Aircraft Specific
TX72	GA	2017	2020	1.02438137	Aircraft Specific
TX73	GA	2017	2020	1.02438137	Aircraft Specific
TX74	GA	2017	2020	1.02438137	Aircraft Specific
TX75	GA	2017	2020	1.02438137	Aircraft Specific
TX76	GA	2017	2020	1.02438137	Aircraft Specific
TX77	GA	2017	2020	1.02438137	Aircraft Specific
TX78	GA	2017	2020	1.02438137	Aircraft Specific
TX79	GA	2017	2020	1.02438137	Aircraft Specific
TX80	GA	2017	2020	1.02438137	Aircraft Specific
TX81	GA	2017	2020	1.02438137	Aircraft Specific
TX82	GA	2017	2020	1.02438137	Aircraft Specific
TX83	GA	2017	2020	1.02438137	Aircraft Specific
TX84	GA	2017	2020	1.02438137	Aircraft Specific
TX85	GA	2017	2020	1.02438137	Aircraft Specific
TX86	GA	2017	2020	1.02438137	Aircraft Specific
TX87	GA	2017	2020	1.02438137	Aircraft Specific
TX89	GA	2017	2020	1.02438137	Aircraft Specific
TX90	GA	2017	2020	1.02438137	Aircraft Specific
TX91	GA	2017	2020	1.02438137	Aircraft Specific
TX92	GA	2017	2020	1.02438137	Aircraft Specific
TX93	GA	2017	2020	1.02438137	Aircraft Specific
TX94	GA	2017	2020	1.02438137	Aircraft Specific
TX95	GA	2017	2020	1.02438137	Aircraft Specific
TX96	GA	2017	2020	1.02438137	Aircraft Specific
TX97	GA	2017	2020	1.02438137	Aircraft Specific
TX98	GA	2017	2020	1.02438137	Aircraft Specific
TX99	GA	2017	2020	1.02438137	Aircraft Specific
TYR	AT	2017	2020	1.039340469	Airport/Aircraft Specific
TYR	GA	2017	2020	0.96486332	Airport/Aircraft Specific
TYR	MIL	2017	2020	1	Airport/Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
UTS	AT	2017	2020	1	Airport/Aircraft Specific
UTS	GA	2017	2020	1	Airport/Aircraft Specific
UTS	MIL	2017	2020	1	Airport/Aircraft Specific
UVA	AT	2017	2020	1	Airport/Aircraft Specific
UVA	GA	2017	2020	1	Airport/Aircraft Specific
UVA	MIL	2017	2020	1	Airport/Aircraft Specific
VCT	AT	2017	2020	1.011245314	Airport/Aircraft Specific
VCT	GA	2017	2020	0.971835581	Airport/Aircraft Specific
VCT	MIL	2017	2020	1	Airport/Aircraft Specific
VHN	GA	2017	2020	1	Airport/Aircraft Specific
VHN	MIL	2017	2020	1	Airport/Aircraft Specific
WEA	GA	2017	2020	1.02438137	Aircraft Specific
X09	GA	2017	2020	1.02438137	Aircraft Specific
X43	GA	2017	2020	1.02438137	Aircraft Specific
X54	GA	2017	2020	1.02438137	Aircraft Specific
X65	GA	2017	2020	1.02438137	Aircraft Specific
XA0	GA	2017	2020	1.02438137	Aircraft Specific
XA01	GA	2017	2020	1.02438137	Aircraft Specific
XA02	GA	2017	2020	1.02438137	Aircraft Specific
XA03	GA	2017	2020	1.02438137	Aircraft Specific
XA04	GA	2017	2020	1.02438137	Aircraft Specific
XA05	GA	2017	2020	1.02438137	Aircraft Specific
XA06	GA	2017	2020	1.02438137	Aircraft Specific
XA07	GA	2017	2020	1.02438137	Aircraft Specific
XA08	GA	2017	2020	1.02438137	Aircraft Specific
XA09	GA	2017	2020	1.02438137	Aircraft Specific
XA10	GA	2017	2020	1.02438137	Aircraft Specific
XA11	GA	2017	2020	1.02438137	Aircraft Specific
XA12	GA	2017	2020	1.02438137	Aircraft Specific
XA13	GA	2017	2020	1.02438137	Aircraft Specific
XA14	GA	2017	2020	1.02438137	Aircraft Specific
XA15	GA	2017	2020	1.02438137	Aircraft Specific
XA16	GA	2017	2020	1.02438137	Aircraft Specific
XA17	GA	2017	2020	1.02438137	Aircraft Specific
XA18	GA	2017	2020	1.02438137	Aircraft Specific
XA19	GA	2017	2020	1.02438137	Aircraft Specific
XA20	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
XA21	GA	2017	2020	1.02438137	Aircraft Specific
XA22	GA	2017	2020	1.02438137	Aircraft Specific
XA23	GA	2017	2020	1.02438137	Aircraft Specific
XA24	GA	2017	2020	1.02438137	Aircraft Specific
XA25	GA	2017	2020	1.02438137	Aircraft Specific
XA26	GA	2017	2020	1.02438137	Aircraft Specific
XA27	GA	2017	2020	1.02438137	Aircraft Specific
XA28	GA	2017	2020	1.02438137	Aircraft Specific
XA29	GA	2017	2020	1.02438137	Aircraft Specific
XA30	GA	2017	2020	1.02438137	Aircraft Specific
XA31	GA	2017	2020	1.02438137	Aircraft Specific
XA32	GA	2017	2020	1.02438137	Aircraft Specific
XA33	GA	2017	2020	1.02438137	Aircraft Specific
XA34	GA	2017	2020	1.02438137	Aircraft Specific
XA35	GA	2017	2020	1.02438137	Aircraft Specific
XA36	GA	2017	2020	1.02438137	Aircraft Specific
XA37	GA	2017	2020	1.02438137	Aircraft Specific
XA38	GA	2017	2020	1.02438137	Aircraft Specific
XA39	GA	2017	2020	1.02438137	Aircraft Specific
XA40	GA	2017	2020	1.02438137	Aircraft Specific
XA41	GA	2017	2020	1.02438137	Aircraft Specific
XA42	GA	2017	2020	1.02438137	Aircraft Specific
XA43	GA	2017	2020	1.02438137	Aircraft Specific
XA44	GA	2017	2020	1.02438137	Aircraft Specific
XA45	GA	2017	2020	1.02438137	Aircraft Specific
XA46	GA	2017	2020	1.02438137	Aircraft Specific
XA47	GA	2017	2020	1.02438137	Aircraft Specific
XA48	GA	2017	2020	1.02438137	Aircraft Specific
XA49	GA	2017	2020	1.02438137	Aircraft Specific
XA50	GA	2017	2020	1.02438137	Aircraft Specific
XA51	GA	2017	2020	1.02438137	Aircraft Specific
XA52	GA	2017	2020	1.02438137	Aircraft Specific
XA53	GA	2017	2020	1.02438137	Aircraft Specific
XA54	GA	2017	2020	1.02438137	Aircraft Specific
XA56	GA	2017	2020	1.02438137	Aircraft Specific
XA57	GA	2017	2020	1.02438137	Aircraft Specific
XA59	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
XA60	GA	2017	2020	1.02438137	Aircraft Specific
XA61	GA	2017	2020	1.02438137	Aircraft Specific
XA62	GA	2017	2020	1.02438137	Aircraft Specific
XA63	GA	2017	2020	1.02438137	Aircraft Specific
XA64	GA	2017	2020	1.02438137	Aircraft Specific
XA66	GA	2017	2020	1.02438137	Aircraft Specific
XA67	GA	2017	2020	1.02438137	Aircraft Specific
XA68	GA	2017	2020	1.02438137	Aircraft Specific
XA69	GA	2017	2020	1.02438137	Aircraft Specific
XA70	GA	2017	2020	1.02438137	Aircraft Specific
XA71	GA	2017	2020	1.02438137	Aircraft Specific
XA72	GA	2017	2020	1.02438137	Aircraft Specific
XA73	GA	2017	2020	1.02438137	Aircraft Specific
XA74	GA	2017	2020	1.02438137	Aircraft Specific
XA75	GA	2017	2020	1.02438137	Aircraft Specific
XA76	GA	2017	2020	1.02438137	Aircraft Specific
XA77	GA	2017	2020	1.02438137	Aircraft Specific
XA78	GA	2017	2020	1.02438137	Aircraft Specific
XA79	GA	2017	2020	1.02438137	Aircraft Specific
XA80	GA	2017	2020	1.02438137	Aircraft Specific
XA81	GA	2017	2020	1.02438137	Aircraft Specific
XA82	GA	2017	2020	1.02438137	Aircraft Specific
XA83	GA	2017	2020	1.02438137	Aircraft Specific
XA84	GA	2017	2020	1.02438137	Aircraft Specific
XA85	GA	2017	2020	1.02438137	Aircraft Specific
XA86	GA	2017	2020	1.02438137	Aircraft Specific
XA87	GA	2017	2020	1.02438137	Aircraft Specific
XA88	GA	2017	2020	1.02438137	Aircraft Specific
XA89	GA	2017	2020	1.02438137	Aircraft Specific
XA90	GA	2017	2020	1.02438137	Aircraft Specific
XA91	GA	2017	2020	1.02438137	Aircraft Specific
XA92	GA	2017	2020	1.02438137	Aircraft Specific
XA93	GA	2017	2020	1.02438137	Aircraft Specific
XA94	GA	2017	2020	1.02438137	Aircraft Specific
XA95	GA	2017	2020	1.02438137	Aircraft Specific
XA96	GA	2017	2020	1.02438137	Aircraft Specific
XA98	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
XA99	GA	2017	2020	1.02438137	Aircraft Specific
XBP	GA	2017	2020	1	Airport/Aircraft Specific
XS00	GA	2017	2020	1.02438137	Aircraft Specific
XS01	GA	2017	2020	1.02438137	Aircraft Specific
XS02	GA	2017	2020	1.02438137	Aircraft Specific
XS03	GA	2017	2020	1.02438137	Aircraft Specific
XS04	GA	2017	2020	1.02438137	Aircraft Specific
XS05	GA	2017	2020	1.02438137	Aircraft Specific
XS06	GA	2017	2020	1.02438137	Aircraft Specific
XS07	GA	2017	2020	1.02438137	Aircraft Specific
XS08	GA	2017	2020	1.02438137	Aircraft Specific
XS09	GA	2017	2020	1.02438137	Aircraft Specific
XS10	GA	2017	2020	1.02438137	Aircraft Specific
XS11	GA	2017	2020	1.02438137	Aircraft Specific
XS12	GA	2017	2020	1.02438137	Aircraft Specific
XS13	GA	2017	2020	1.02438137	Aircraft Specific
XS14	GA	2017	2020	1.02438137	Aircraft Specific
XS15	GA	2017	2020	1.02438137	Aircraft Specific
XS16	GA	2017	2020	1.02438137	Aircraft Specific
XS17	GA	2017	2020	1.02438137	Aircraft Specific
XS18	GA	2017	2020	1.02438137	Aircraft Specific
XS19	GA	2017	2020	1.02438137	Aircraft Specific
XS20	GA	2017	2020	1.02438137	Aircraft Specific
XS21	GA	2017	2020	1.02438137	Aircraft Specific
XS22	GA	2017	2020	1.02438137	Aircraft Specific
XS23	GA	2017	2020	1.02438137	Aircraft Specific
XS24	GA	2017	2020	1.02438137	Aircraft Specific
XS25	GA	2017	2020	1.02438137	Aircraft Specific
XS26	GA	2017	2020	1.02438137	Aircraft Specific
XS27	GA	2017	2020	1.02438137	Aircraft Specific
XS28	GA	2017	2020	1.02438137	Aircraft Specific
XS29	GA	2017	2020	1.02438137	Aircraft Specific
XS30	GA	2017	2020	1.02438137	Aircraft Specific
XS31	GA	2017	2020	1.02438137	Aircraft Specific
XS32	GA	2017	2020	1.02438137	Aircraft Specific
XS33	GA	2017	2020	1.02438137	Aircraft Specific
XS34	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
XS35	GA	2017	2020	1.02438137	Aircraft Specific
XS36	GA	2017	2020	1.02438137	Aircraft Specific
XS37	GA	2017	2020	1.02438137	Aircraft Specific
XS38	GA	2017	2020	1.02438137	Aircraft Specific
XS39	GA	2017	2020	1.02438137	Aircraft Specific
XS40	GA	2017	2020	1.02438137	Aircraft Specific
XS41	GA	2017	2020	1.02438137	Aircraft Specific
XS42	GA	2017	2020	1.02438137	Aircraft Specific
XS43	GA	2017	2020	1.02438137	Aircraft Specific
XS44	GA	2017	2020	1.02438137	Aircraft Specific
XS45	GA	2017	2020	1.02438137	Aircraft Specific
XS46	GA	2017	2020	1.02438137	Aircraft Specific
XS47	GA	2017	2020	1.02438137	Aircraft Specific
XS48	GA	2017	2020	1.02438137	Aircraft Specific
XS49	GA	2017	2020	1.02438137	Aircraft Specific
XS50	GA	2017	2020	1.02438137	Aircraft Specific
XS51	GA	2017	2020	1.02438137	Aircraft Specific
XS52	GA	2017	2020	1.02438137	Aircraft Specific
XS53	GA	2017	2020	1.02438137	Aircraft Specific
XS54	GA	2017	2020	1.02438137	Aircraft Specific
XS55	GA	2017	2020	1.02438137	Aircraft Specific
XS56	GA	2017	2020	1.02438137	Aircraft Specific
XS57	GA	2017	2020	1.02438137	Aircraft Specific
XS58	GA	2017	2020	1.02438137	Aircraft Specific
XS59	GA	2017	2020	1.02438137	Aircraft Specific
XS60	GA	2017	2020	1.02438137	Aircraft Specific
XS61	GA	2017	2020	1.02438137	Aircraft Specific
XS62	GA	2017	2020	1.02438137	Aircraft Specific
XS63	GA	2017	2020	1.02438137	Aircraft Specific
XS64	GA	2017	2020	1.02438137	Aircraft Specific
XS65	GA	2017	2020	1.02438137	Aircraft Specific
XS66	GA	2017	2020	1.02438137	Aircraft Specific
XS67	GA	2017	2020	1.02438137	Aircraft Specific
XS68	GA	2017	2020	1.02438137	Aircraft Specific
XS69	GA	2017	2020	1.02438137	Aircraft Specific
XS70	GA	2017	2020	1.02438137	Aircraft Specific
XS71	GA	2017	2020	1.02438137	Aircraft Specific

Table A-1. Projection Factors

State Facility Identifier	Category	Base Year	Projecting Year	Growth Factor	Note
XS72	GA	2017	2020	1.02438137	Aircraft Specific
XS74	GA	2017	2020	1.02438137	Aircraft Specific
XS77	GA	2017	2020	1.02438137	Aircraft Specific
XS78	GA	2017	2020	1.02438137	Aircraft Specific
XS80	GA	2017	2020	1.02438137	Aircraft Specific
XS81	GA	2017	2020	1.02438137	Aircraft Specific
XS82	GA	2017	2020	1.02438137	Aircraft Specific
XS83	GA	2017	2020	1.02438137	Aircraft Specific
XS84	GA	2017	2020	1.02438137	Aircraft Specific
XS85	GA	2017	2020	1.02438137	Aircraft Specific
XS86	GA	2017	2020	1.02438137	Aircraft Specific
XS87	GA	2017	2020	1.02438137	Aircraft Specific
XS88	GA	2017	2020	1.02438137	Aircraft Specific
XS89	GA	2017	2020	1.02438137	Aircraft Specific
XS90	GA	2017	2020	1.02438137	Aircraft Specific
XS91	GA	2017	2020	1.02438137	Aircraft Specific
XS92	GA	2017	2020	1.02438137	Aircraft Specific
XS93	GA	2017	2020	1.02438137	Aircraft Specific
XS94	GA	2017	2020	1.02438137	Aircraft Specific
XS95	GA	2017	2020	1.02438137	Aircraft Specific
XS96	GA	2017	2020	1.02438137	Aircraft Specific
XS97	GA	2017	2020	1.02438137	Aircraft Specific
XS98	GA	2017	2020	1.02438137	Aircraft Specific
XS99	GA	2017	2020	1.02438137	Aircraft Specific
00R	GA	2017	2020	1	Airport/Aircraft Specific
00TA	GA	2017	2020	1.02438137	Aircraft Specific
00TE	GA	2017	2020	1.02438137	Aircraft Specific
00TS	GA	2017	2020	1.02438137	Aircraft Specific
00TX	AT	2017	2020	0.803340056	Aircraft Specific

Appendix B
Quality Assurance

Appendix B
Quality Assurance

QUALITY ASSURANCE

All resulting emission inventories were subjected to internal review and QA/QC procedures outlined in the Quality Assurance Project Plan (QAPP) for Development of 2017 Statewide Emissions Inventories for Air Emissions Reporting Requirements and Reasonable Further Progress for Airport Sources Work Order No. 582-18-82508-19, as per the requirements of a Category III QAPP for Data Evaluation or Use for a Secondary Purpose.

The Category III QAPP establishes requirements for projects involving data use for secondary purposes. The internal review and QA/QC procedures were consistent with the NRML QAPP requirements. These procedures are outlined below.

A. Project Management

Project Staff: The project included a team of technical specialists who are well trained to address each project objective. These staff and their primary responsibility area are delineated as follows.

Rick Baker: Mr. Baker is the overall ERG contract manager for this TCEQ contract. He ensures the project implementation follows all contract requirements and that project quality standards are met on all deliverables. He assists in interactions with the TCEQ as required.

Donna Tedder: Ms. Tedder provided peer review for the QAPP and oversaw the QA/QC procedures, ensuring Mr. Billings reviews were all in line with the QAPP and ERG's corporate QA guidelines.

Roger Chang: Project manager for this study, Mr. Chang was recommended to the FAA by the US EPA to be a beta tester for the FAA's Aviation Environmental Design Tool (AEDT) used for this project. Additionally, he has been involved with the development of airport inventories for the US EPA and other federal agencies as well as the TCEQ for over a decade.

Richard Billings: Mr. Billings has extensive knowledge and expertise on aircraft and worked as peer reviewer for the project, ensuring that following checks were made:

- Reviewed at least ten percent of project data files to check for data transfer issues and to ensure that database queries were implemented correctly.
- Project staff used appropriate methodologies and documented data quality activities and the deliverable review process.
- The preliminary data and draft/final reports were reviewed by technical staff to ensure that the project objectives and data quality objectives (DQOs) expressed for this study.
- The report was reviewed by the project's editing staff prior to delivery of the draft version to the TCEQ.

Jennifer Sellers: Ms. Sellers is an experienced environmental scientist who served as the Task Lead for 4 and 5 and Task support for 2, 3, and 6. She is experienced in aircraft emission inventories.

Heather Perez: Ms. Perez is an experienced environmental scientist and database manager who served as technical support and QA reviewer for Tasks 3, 4, 5 and 6. She is experienced in aircraft emission inventories.

Marty Wolf: Mr. Wolf is an experienced environmental engineer who served as technical support for Task 3, 4, and 5. He is experienced in data collection and formatting.

Steve Mendenhall: Mr. Mendenhall is an experienced programmer who served as technical support for tasks 2, 3, 4, and 5. He is experienced with SQL, Access, XML, and various programming languages.

Lindsay Dayton: Ms. Dayton is an experienced environmental scientist who served as the Task support for 3, 4 and 5. She is experienced in aircraft emission inventories.

Jody Tisano: Ms. Tisano is an administrative assistant who provided administrative and clerical support, mainly on Tasks 5 and 6. She has performed similar work on previous TCEQ projects.

Background: The purpose of this project was to develop a set of Statewide and Area-specific emissions inventories (EI) and activity data for all airport sources including aircraft, Auxiliary Power Units (APU), and Ground Support Equipment (GSE). These Els are needed to fulfill the Federal Air Emissions Reporting Requirements (AERR) and support State Implementation Plan (SIP) development. For this project, ERG developed the annual (tons per year) and average summer weekday (tons per day) emissions inventory estimates of Criteria Air Pollutants (CAP), CAP precursors, and Hazardous Air Pollutants (HAP) using the Federal Aviation Agency (FAA) Aviation Environmental Design Tool (AEDT) model.

The overall objective of this project was to provide the aircraft mobile sources 2017 evaluation year activity and annual emissions inventory estimates required for the State of Texas for inclusion in the EPA's 2017 NEI and emissions inventories for SIP development. The previous trend inventory for 2017 was used for every Texas county including estimates for controlled and uncontrolled emissions in both annual (tons per year) and average weekday (tons per day) emissions.

The secondary purpose of this project was to develop area-specific emissions inventories necessary to support both an attainment demonstration and a rate of further progress (RFP) analysis for the Houston-Galveston-Brazoria (HGB) eight-county and the Dallas-Fort Worth (DFW) ten-county non-attainment areas to develop the SIP revision(s) for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS). These inventories were based off previously collected data for 2011 and the 2020 inventory was developed by projecting data from the 2017 activity data.

Project/Task Description:

To meet the project objectives, the following tasks were completed:

- Provided an emissions inventory development plan
- Recompiled the 2011 calendar year data from Work Order 582-11-99776-FY12- 09
- Developed Summer weekday emissions for 2017, 2018, 2020, and 2021 for the HGB Eight-County and the DFW Ten-County areas using the previous 2011 data
- Developed a revised statewide 2011 EI and provided the AEDT files
- Collected new 2017 national data and local data
- Developed 2017 statewide inventory and formatted the data into XML for TexAER and EPA EIS
- Projected the 2017 statewide inventory to 2020 and provided the 2017 AEDT files
- Provided the final report

The project included producing XML files and Excel summary files which were shared with the TCEQ Work Assignment Manager and used in our quality checks.

Quality Objectives and Criteria: ERG provided the TCEQ with comprehensive and accurate emission inventories based on the FAA's latest emission estimating model. Typically, the quality of such inventories was measured by the degree to which local rather than default data were used in their development. ERG documented all the airports from which we solicited data including documentation of repeated calls and emails. Only when there were data gaps in the local data did ERG use national FAA data to gap fill. The FAA data used was obtained from the T-100 dataset that provides aircraft make and model specific data for the 49 airports in Texas that provide commercial air services from a regulated airline. These T-100 data were supplemented with FAA Terminal Area Facility (TAF) data and the FAA's airport Master Plan data (5010) to quantify aircraft activities in the remaining Texas airports. Note that the 5010 and TAF datasets provide activity data in terms of generic aircraft types. Adjustments were made to the generic LTO counts to avoid double counting with the local data and the T-100 aircraft specific data. The resulting TCEQ airport inventory includes locally provided data, T-100 aircraft specific data, and TAF/5010 generic data to ensure that all Texas airports have representative activity data.

The 2011, 2017, and 2020 inventories developed for this project were compared to previous inventory efforts. The 2011 inventory was compared to the 2011 inventory created for the TCEQ's 2011 NEI submittal (Work Order 582-11-99776-FY12- 09). The 2017 and 2020 inventories were compared to the applicable trend inventories developed from the 2014 inventory submitted to the EPA for the NEI. These comparisons were implemented at the state level to evaluate whether the overall state trend was reasonable; at the county level to see if there were any counties that indicated an unexpected increase or decrease in emissions; and at the airport and aircraft level to identify outliers.

When outliers were identified, ERG investigated further to ensure that the data were correct and there were no errors in data handling, in creating the input files for AEDT or for generic aircraft data, and the emission queries were evaluated to ensure they were linking the data correctly. Under Task 4, the final emissions inventory and activity data were formatted to meet the TCEQ's TexAER and EPA's CERS XML requirements.

Special Training/Certification: No special training or certification is required.

Documents and Records: The process used to collect data and develop the inventories was documented from start to finish. All procedures and data sources used to create the inventories were presented such that the TCEQ or any third party have sufficient information to independently replicate any part of the process if needed.

The process of providing interim products for each work task and obtaining TCEQ review comments enhanced the completeness and quality of the documentation in the final project report. The final report includes this document in the QA section, discussion of any problems encountered, corrective actions taken, and limitation of the data identified in the process of developing the emission inventories.

B. Data Generation and Acquisition

ERG recompiled the 2011 data originally obtained from Work Order 582-11-99776-FY12- 09. ERG conducted no additional data acquisition for 2011.

ERG obtained various aircraft activity data for 2017. There are two general sources of airport data. The preferred sources are from the local airports. The other data are from the publicly available national information from the FAA.

ERG contacted 213 local Texas airports by telephone and email to request 2017 activity data and to identify and characterize control strategies used or planned at each airport. Of the 213 airports contacted, 26 provided data that could be used in the 2017 inventory.

To develop the most accurate aircraft emission inventory possible, ERG took two approaches. First, if aircraft-specific make and model data were available, ERG used the FAA's AEDT model in conjunction with the detailed aircraft activity data either provided by the airport or obtained from T-100. If such detailed data were not available, then ERG applied a more general approach for different aircraft types (i.e., air taxis, general aviation, and military aircraft) using available generic activity data from the local airports, or from the FAA's TAF dataset and FAA's 5010 dataset in conjunction with EPA emission estimating methods noted in the National Emission Inventory documentation.

a. Data Management

No hard copy data were received during the project. For this project all data obtained were electronic. Working copies of the original data files were shared with the team, such that the integrity of the original files was maintained. The original files were never checked out, and only viewed a couple of times to confirm that the data in the working files were correctly transferred.

The electronic working files were stored in a specific project directory on ERG's network drive in Morrisville, North Carolina. The original data files were kept in a separate folder on the same network. All files on the Morrisville server are backed up daily.

Only project team members were granted access to the directories where the working files were stored, such that all members of the team had access to all project data and could perform their work using these files. Once the project was completed, all project electronic files were moved into an archive directory on the network for permanent storage.

C. Assessment and Oversight

Data collection efforts were coordinated so that all ERG team members understood the project goals. Following the kickoff discussions with TCEQ staff and submittal of the work plan, the ERG Project Manager and task leads had internal team meetings to discuss and verify data collection efforts for each project task. Each team member had a clear understanding of all project objectives and deliverables and the data that will be needed to support those deliverables. This coordinated process is seen as essential to efficient and productive data collection.

When data were received from airports, federal agencies or the TCEQ, the staff receiving the data put the original data files directly on the Morrisville server and sent a working copy to the appropriate staff responsible for that task. These staff members reviewed and briefly summarized the findings in the data submittal and informed the ERG project manager. The ERG project manager informed the TCEQ project manager of the data submittal noting any issues with the data based on the initial summary. Once the TCEQ project manager approved the data, ERG team members started working with the submitted data. The TCEQ project manager did not direct ERG to exclude any of the compiled data.

After the aviation data had been compiled and adjustments were made to avoid double counting, the data were stored in a file format appropriate for inclusion into the AEDT. Peer reviewers knowledgeable about the source category but not directly involved in conducting day to day activities of the project reviewed all data handling methods and results of the work. ERG's peer reviewers were included in the initial planning stages of this project to ensure the planned approaches were technically sound and that quality checks were planned for critical points in the process. This included review of AEDT input files and output files as well as the generic aircraft type calculations.

ERG peer reviewers did not find any issues with data handling for the AEDT input files nor did they have any problem reproducing the generic emission estimates using the project access database and associated queries.

All final products were reviewed by senior team members prior to submittal to the TCEQ to ensure the project procedures were properly implemented. The ERG Project Manager and task leads signed off on all deliverables to the TCEQ documenting that all quality checks were implemented and where problems were identified corrections were made in the preliminary or final dataset, and the draft or final report.

> **The ERG editor worked directly with task leads, making changes to the draft report to make the document clear and easy to follow. The ERG Project Manager also ensured that the final report included all recommended changes suggested by the TCEQ Project Manager.**

Reports to Management: The ERG project manager reported to the TCEQ project manager on a biweekly schedule or sooner if something urgent was raised.

D. Data Validation and Usability and Verification and Validation Methods

All information used to develop the emission inventories were checked and reviewed for reasonableness to the extent possible. This included checking activity data and emission factors against the reference source, such as the FAA T-100 and TAF datasets and the EPA's Documentation for the National Emission Inventory to ensure that the values used were correct (e.g., decimal location is correct, units are converted correctly). A minimum of 10% of the data were audited by an independent reviewer not involved with the inventory development. 100 percent of all calculation queries were checked by having a second staff member replicate the result by independently applying the input data and assumptions to see if the same data were produced.

> **The ERG data review did not find any formatting issues with the data used for the AEDT model input file or issues with the generic emission calculations.**

Activity and emissions data were reviewed by the Project Manager to ensure they were reasonable and consistent (i.e., extremely low or high values that are usually indicative of errors were flagged for further investigation). ERG highlighted NO_x emissions as it is a critical pollutant for the nonattainment areas. Any data that were found to be questionable were examined in greater detail to determine what was causing the issue and what adjustments, if any, were required. If data were revised, the procedures and assumptions used were documented. The Project Manager and task leads reviewed and approve all data adjustments, as documented in this QA summary.

2011 to Previous 2011 Inventory Comparison

The 2011 inventory including the DFW and HGB SIP areas was initially analyzed at the county level to see if there were any outliers. Table B-1 summarizes the counties with an absolute difference of 1000% percent or greater from the original 2011 inventory. Because the LTO data matched between the original 2011 data from Work Order 582-11-99776-FY12- 09, and the new inventory using AEDT and new EPA generic emission factors, ERG then looked at the data at the airport level within those counties to see where the underlying sources of the differences were. These airports are summarized in Table B-2.

Table B-1. Counties with the Highest Absolute Percent Changes in Emissions

County	2011 NO_X Emissions w/AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)*	Current 2011 w/ AEDT + Revised Emission Factors LTO	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Wichita	1,759.76	20.59	8,448.63	183,745	183,745	0
Victoria	212.05	2.75	7,619.11	28,709	28,709	0
Aransas	183.19	3.02	5,967.93	41,181	41,181	0
Culberson	1.13	0.02	5,296.46	334	334	0
Reeves	33.15	0.72	4,500.71	10,101	10,101	0
McCulloch	34.10	0.84	3,967.95	11,771	11,771	0
Jim Wells	11.41	0.32	3,420.48	4,474	4,474	0
La Salle	11.43	0.34	3,276.16	4,157	4,157	0
Walker	14.35	0.49	2,822.20	6,633	6,633	0
Kleberg	7.50	0.29	2,487.25	3,851	3,851	0
Calhoun	8.74	0.43	1,951.45	5,449	5,449	0
Howard	6.63	0.42	1,464.47	6,096	6,096	0
Tom Green	301.37	19.46	1,448.91	54,373	54,373	0
Matagorda	9.02	0.65	1,294.69	8,846	8,846	0

* Percent change greater than 1,000%

a. Previous Inventory was based on the same LTO data but used EDMS and previous EPA generic emission factors.

Table B-2. Airports with the Highest Absolute Percent Changes in Emissions Within the Previously Identified Counties

County	Airport	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)*	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Wichita	Sheppard AFB/Wichita Falls Muni	1,758.23	19.06	9,126.00	161,654	161,654	0
Victoria	Victoria Rgnl	211.83	2.52	8,294.44	26,070	26,070	0
Matagorda	Palacios Muni	8.20	0.11	7,417.74	1,480	1,480	0
Culberson	Culberson County	1.13	0.02	6,095.70	250	250	0
Aransas	Aransas Co	183.19	3.02	5,972.51	41,110	41,110	0
Reeves	Pecos Muni	33.15	0.72	4,516.27	10,025	10,025	0
McCulloch	Curtis Field	34.10	0.84	3,969.34	11,762	11,762	0
Calhoun	Calhoun County	8.53	0.21	3,893.33	3,000	3,000	0
Jim Wells	Alice Intl	11.39	0.31	3,612.01	4,305	4,305	0
La Salle	Cotulla-La Salle County	11.42	0.33	3,342.53	3,950	3,950	0
Walker	Huntsville Muni	14.33	0.47	2,932.53	6,425	6,425	0
Kleberg	Kleberg County	7.48	0.27	2,638.42	3,700	3,700	0
Howard	Big Spring Mc Mahon-Wrinkle	6.63	0.42	1,464.47	6,096	6,096	0
Tom Green	San Angelo Rgnl/Mathis Field	301.27	19.36	1,456.45	52,983	52,983	0

* Percent change greater than 1,000%

a. Previous Inventory was based on the same LTO data but used EDMS and older EPA generic emission factors.

The data from Table B-2 showed that the LTO data matched, whereas the emissions were higher in the new 2011 inventory developed using AEDT. Table B-2 also compares the new generic emission factors from the EPA to the emissions factors used in the prior inventory that was developed using the FAA's older EDMS software and the EPA's older generic emission factors. It is recognized by the FAA that AEDT emissions differ from EDMS emissions. Factors that contribute to these differences include the use of different fuel consumption methods (AEDT data are considered more accurate as they are based on aircraft flight recorder data). Also, AEDT uses different methods to determine aircraft weight, flap and power settings. EDMS uses more generic default values for these aircraft operating perimeters (see https://aedt.faa.gov/Documents/Comparison_AEDT_Legacy_Summary.pdf).

Overall, AEDT is believed to provide more accurate emissions estimates than EDMS. Based on ERG's analysis, the AEDT model generated results consistent with the FAA's findings that overall emissions from the resulting model outputs are typically higher than corresponding results from EDMS when analyzing aggregate emissions estimates.

Comparing the two models can be very complicated, as the two models use different methodologies to account for airport factors (e.g., runway length, relative elevation, time in mode and local meteorology) and aircraft factors (e.g., aircraft rate of climbout/descent, engine specific fuel consumption, aircraft weight, engine mode operations). Table B-3 provides a simple comparison where the emissions for a BOEING 737 200 series equipped with Pratt and Whitney 1PW011 engines are normalized on a per LTO basis.[1] As Table B-3 indicates, EDMS and AEDT emission estimates can differ for different airports and pollutants.

Variance in the AEDT output appears reasonable when considering the variance typically associated with the EDMS output, based on ERG's experience working with EDMS outputs.

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[1] This is just one example for the 737 200 series, most aircraft models have multiple engine options, and this series has five different low-bypass turbonfan variants as part of their JT8D product line.

Table B-3. Example Comparison for 2011 Inventory between AEDT and EDMS at the Airport, Aircraft, Engine, and Pollutant Level

Airport	Airframe	Engine	Pollutant Code	AEDT Emissions (Ton per LTO)	EDMS Emissions (Tons per LTO)	Percent Change
Dallas Love Field	Boeing 737-200 Series	1PW011	CO	1.93E-02	8.32E-03	132
San Antonio Intl	Boeing 737-200 Series	1PW011	CO	2.53E-02	1.50E-02	68
William P Hobby	Boeing 737-200 Series	1PW011	CO	2.87E-02	1.75E-02	64
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	CO	1.41E-02	9.21E-03	53
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	CO	1.07E-02	7.23E-03	49
Dallas Love Field	Boeing 737-200 Series	1PW011	NO_X	2.14E-02	1.93E-02	11
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	NO_X	2.24E-02	2.03E-02	10
San Antonio Intl	Boeing 737-200 Series	1PW011	NO_X	2.01E-02	2.05E-02	-2
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	NO_X	2.02E-02	2.10E-02	-4
William P Hobby	Boeing 737-200 Series	1PW011	NO_X	2.15E-02	2.24E-02	-4
Dallas Love Field	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.56E-04	2.82E-04	-45
San Antonio Intl	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.86E-04	3.56E-04	-48
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.74E-04	4.01E-04	-57
William P Hobby	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.39E-04	3.30E-04	-58
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	PM_{10}-PRI	1.28E-04	3.04E-04	-58
Dallas Love Field	Boeing 737-200 Series	1PW011	SO_2	1.71E-03	1.38E-03	24
San Antonio Intl	Boeing 737-200 Series	1PW011	SO_2	2.08E-03	1.78E-03	17
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	SO_2	1.93E-03	2.00E-03	-4
William P Hobby	Boeing 737-200 Series	1PW011	SO_2	1.51E-03	1.63E-03	-7
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	SO_2	1.37E-03	1.49E-03	-8
Dallas Love Field	Boeing 737-200 Series	1PW011	VOC	5.38E-03	2.57E-03	109
San Antonio Intl	Boeing 737-200 Series	1PW011	VOC	6.92E-03	4.26E-03	62
William P Hobby	Boeing 737-200 Series	1PW011	VOC	7.80E-03	4.92E-03	58
George Bush Intercontinental/Houston	Boeing 737-200 Series	1PW011	VOC	4.05E-03	2.77E-03	46
Austin-Bergstrom Intl	Boeing 737-200 Series	1PW011	VOC	3.19E-03	2.27E-03	41

Additionally, ERG looked at the data at the airport and SCC level, summarized in Table B-4. This table clearly showed that the large difference (14,035% increase) in emissions were from military activity. ERG concluded the change in emissions were due to the revised generic military emission factors. ERG confirmed that in all the cases the military data with high emission differences were from generic activity. The percent difference between the older emission factor and the revised emission factor for NO_x is 14,035%. The smaller absolute percent changes, such as the -36% change at Austin Bergstrom International Airport, are due to the use of AEDT vs EDMS. Additional details can be found in Table B-5.

Additional checks were conducted by looking at the top 25 airports in Texas to see if there were any additional outliers of concern. The TCEQ noticed that Hondo Municipal Airport seemed to have an unusually high level of activity. The original 2011 data were based on data the airport provided in 2008 and were grown using the growth factors in the FAA's TAF dataset. Upon further investigation it was noted that Hondo Municipal Airport had unusually high LTO values in 2011 resulting in an unusually high calculated annual growth rate that, when applied to the airport-provided 2008 data, generated unrealistic 2011 values.

> **ERG replaced the elevated projected 2011 data with TAF data which was more consistent with the 2008 value. The correction was made to the data file and summary tables in the final report and included in this document as well.**

Table B-5 provides a revised list of the top 25 airports where the Hondo Municipal Airport data has been corrected. In this table, there are some emission differences, but these are attributed to the following:

- In comparing emission trends by airport with earlier inventory years, differences were noted that were attributed to the fact that the older 2011 emissions were based on the EDMS model, while other years were based on the FAA's new AEDT model.

  No changes were made since the FAA acknowledges the AEDT model provides notably different results than the EDMS model.

Table B-4. SCCs With the Highest Absolute Percent Change in Emissions Within the Previously Identified Airport/County Combinations

Airport	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)*	Current 2011 LTO w/ AEDT + Revised Emission Factors **	Previous 2011 LTO w/ EDMS + Previous Emission Factors[a]	LTO Percent Change (%)
Culberson County	2275001000	1.12	0.01	14,034.95	100	100	0
Alice Intl	2275001000	11.17	0.08	14,034.95	1,000	1,000	0
Cotulla-La Salle County	2275001000	11.17	0.08	14,034.95	1,000	1,000	0
Huntsville Muni	2275001000	13.96	0.10	14,034.95	1,250	1,250	0
Curtis Field	2275001000	33.50	0.24	14,034.95	3,000	3,000	0
Big Spring Mc Mahon-Wrinkle	2275001000	6.25	0.04	14,034.95	560	560	0
Calhoun County	2275001000	8.37	0.06	14,034.95	750	750	0
San Angelo Rgnl/Mathis Field	2275001000	283.67	2.01	14,034.95	25,404	25,404	0
Palacios Muni	2275001000	8.15	0.06	14,034.95	730	730	0
Kleberg County	2275001000	7.26	0.05	14,034.95	650	650	0
Victoria Rgnl	2275001000	210.76	1.49	14,034.95	18,875	18,875	0
Pecos Muni	2275001000	32.66	0.23	14,034.95	2,925	2,925	0
Sheppard AFB/Wichita Falls Muni	2275001000	1,751.34	12.39	14,034.95	156,837	156,837	0
Aransas Co	2275001000	181.46	1.28	14,034.95	16,250	16,250	0

*High percent change due to updates to Military EF update

**Military LTOs were all generic

a. Previous Inventory was based on the same LTO data but used EDMS and older EPA generic emission factors.

Table B-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Tarrant	Dallas/Fort Worth Intl	2275060012	38.74	26.76	45	21,405	21,405	0
Tarrant	Dallas/Fort Worth Intl	2275020000	3,638.95	2,898.22	26	296,412	296,412	0
Tarrant	Dallas/Fort Worth Intl	2275050012	12.18	6.17	97	5,427	5,427	0
Tarrant	Dallas/Fort Worth Intl	2275060011	0.01	0.01	14	157	157	0
Harris	George Bush Intercontinental/Houston	2275050011	0.05	0.03	43	110	110	0
Harris	George Bush Intercontinental/Houston	2275001000	0.16	0.23	-30	199	199	0
Harris	George Bush Intercontinental/Houston	2275020000	1,751.10	1,697.93	3	174,556	174,556	0
Harris	George Bush Intercontinental/Houston	2275060012	310.77	231.41	34	81,863	81,863	0
Harris	George Bush Intercontinental/Houston	2275050012	3.52	3.81	-7	2,435	2,435	0
Harris	George Bush Intercontinental/Houston	2275060011	0.00	0.00	-56	71	71	0
Harris	William P Hobby	2275060012	24.48	21.15	16	13,669	13,669	0
Harris	William P Hobby	2275060011	0.01	0.03	-59	774	774	0
Harris	William P Hobby	2275050012	15.55	17.48	-11	13,148	13,148	0
Harris	William P Hobby	2275050011	0.09	0.08	18	595	595	0
Harris	William P Hobby	2275020000	548.73	637.71	-14	80,192	80,192	0
Harris	William P Hobby	2275001000	1.16	0.68	71	2,256	2,256	0
Travis	Austin-Bergstrom Intl	2275001000	0.22	0.34	-36	220	220	0
Travis	Austin-Bergstrom Intl	2275020000	397.47	415.95	-4	52,481	52,481	0

Table B-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Travis	Austin-Bergstrom Intl	2275050011	0.55	0.67	-18	9,912	9,912	0
Travis	Austin-Bergstrom Intl	2275050012	17.31	18.66	-7	19,471	19,471	0
Travis	Austin-Bergstrom Intl	2275060011	0.20	1.06	-81	14,122	14,122	0
Travis	Austin-Bergstrom Intl	2275060012	18.78	18.71	0	20,201	20,201	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275060012	2.45	2.38	3	1,129	1,129	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275050011	0.07	0.07	0	2,277	2,277	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	1,751.34	12.39	14,035	156,837	156,837	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275020000	4.22	4.07	4	530	530	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275050012	0.14	0.14	0	881	881	0
Dallas	Dallas Love Field	2275060012	21.10	11.82	78	14,252	14,252	0
Dallas	Dallas Love Field	2275060011	0.14	0.09	65	7,821	7,821	0
Dallas	Dallas Love Field	2275050012	18.32	13.82	33	14,431	14,431	0
Dallas	Dallas Love Field	2275050011	0.15	0.06	130	1,333	1,333	0
Dallas	Dallas Love Field	2275020000	405.68	322.45	26	51,171	51,171	0
Dallas	Dallas Love Field	2275001000	1.32	1.16	14	589	589	0
Harris	Ellington Field	2275060011	0.22	0.58	-62	13,668	13,668	0
Harris	Ellington Field	2275050011	0.20	0.33	-38	4,903	4,903	0
Harris	Ellington Field	2275060012	22.45	18.47	22	31,284	31,284	0
Harris	Ellington Field	2275020000	60.86	70.04	-13	14,930	14,930	0

Table B-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Harris	Ellington Field	2275001000	29.77	58.00	-49	30,778	30,778	0
Harris	Ellington Field	2275050012	13.19	16.39	-20	14,017	14,017	0
Bexar	San Antonio Intl	2275020000	339.28	379.15	-11	39,181	39,181	0
Bexar	San Antonio Intl	2275050011	0.14	0.14	2	1,264	1,264	0
Bexar	San Antonio Intl	2275050012	4.26	4.58	-7	3,941	3,941	0
Bexar	San Antonio Intl	2275060011	0.06	0.12	-48	4,125	4,125	0
Bexar	San Antonio Intl	2275060012	9.56	8.98	6	10,712	10,712	0
Bexar	San Antonio Intl	2275001000	11.78	29.59	-60	1,391	1,391	0
Harris	David Wayne Hooks Memorial	2275020000	0.02	0.02	0	2	2	0
Harris	David Wayne Hooks Memorial	2275060012	0.70	0.70	0	1,803	1,803	0
Harris	David Wayne Hooks Memorial	2275060011	0.04	0.04	0	502	502	0
Harris	David Wayne Hooks Memorial	2275050011	2.12	2.12	0	65,380	65,380	0
Harris	David Wayne Hooks Memorial	2275001000	18.36	0.13	14,035	1,644	1,644	0
Harris	David Wayne Hooks Memorial	2275050012	4.10	4.10	0	25,299	25,299	0
Tarrant	Fort Worth Alliance	2275060011	0.26	0.34	-25	17,174	17,174	0
Tarrant	Fort Worth Alliance	2275020000	243.93	211.83	15	5,725	5,725	0
Tarrant	Fort Worth Alliance	2275060012	4.23	2.26	87	5,724	5,724	0
Tarrant	Fort Worth Alliance	2275050012	88.00	49.73	77	28,625	28,625	0

Table B-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Denton	Northwest Rgnl	2275060011	1.09	1.47	-26	82,170	82,170	0
Denton	Northwest Rgnl	2275060012	0.55	0.10	441	830	830	0
Bexar	Stinson Muni	2275020000	0.31	0.26	18	168	168	0
Bexar	Stinson Muni	2275050011	0.33	1.29	-75	14,397	14,397	0
Bexar	Stinson Muni	2275050012	2.34	2.76	-15	2,098	2,098	0
Bexar	Stinson Muni	2275060011	1.75	1.02	72	58,245	58,245	0
Bexar	Stinson Muni	2275060012	3.55	6.89	-49	7,021	7,021	0
Denton	Denton Muni	2275060012	12.14	4.12	195	19,983	19,983	0
Denton	Denton Muni	2275050012	9.99	3.99	150	4,440	4,440	0
Denton	Denton Muni	2275060011	1.29	0.89	44	49,586	49,586	0
El Paso	El Paso Intl	2275020000	224.69	227.58	-1	24,283	24,283	0
El Paso	El Paso Intl	2275050011	0.33	0.33	0	10,093	10,093	0
El Paso	El Paso Intl	2275060012	1.05	1.18	-11	1,831	1,831	0
El Paso	El Paso Intl	2275060011	0.32	0.32	0	3,994	3,994	0
El Paso	El Paso Intl	2275050012	0.72	0.71	1	3,979	3,979	0
El Paso	El Paso Intl***	2275001000	34.00	0.25	13,776	3,046	3,046	0
Dallas	Addison	2275060012	10.20	4.95	106	16,256	16,256	0
Dallas	Addison	2275050012	35.17	18.86	86	13,716	13,716	0
Dallas	Addison	2275060011	0.48	0.38	25	20,828	20,828	0
Brazoria	Pearland Rgnl	2275060012	0.03	0.03	0	85	85	0
Brazoria	Pearland Rgnl	2275060011	0.02	0.02	0	218	218	0
Brazoria	Pearland Rgnl	2275050012	2.71	2.71	0	16,715	16,715	0

Table B-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Brazoria	Pearland Rgnl	2275050011	1.40	1.40	0	42,982	42,982	0
Nueces	Corpus Christi Intl	2275050012	0.47	0.47	0	2,927	2,927	0
Nueces	Corpus Christi Intl	2275050011	0.24	0.24	0	7,526	7,526	0
Nueces	Corpus Christi Intl	2275060011	0.14	0.14	0	1,785	1,785	0
Nueces	Corpus Christi Intl	2275060012	0.38	0.37	3	723	723	0
Nueces	Corpus Christi Intl	2275001000	336.94	2.38	14,035	30,174	30,174	0
Nueces	Corpus Christi Intl	2275020000	27.80	35.16	-21	6,725	6,725	0
Tom Green	San Angelo Rgnl/Mathis Field	2275050012	1.02	1.02	0	6,253	6,253	0
Tom Green	San Angelo Rgnl/Mathis Field	2275060011	0.04	0.04	0	492	492	0
Tom Green	San Angelo Rgnl/Mathis Field	2275060012	3.18	3.01	6	3,241	3,241	0
Tom Green	San Angelo Rgnl/Mathis Field	2275001000	283.67	2.01	14,035	25,404	25,404	0
Tom Green	San Angelo Rgnl/Mathis Field	2275020000	12.84	12.76	1	1,436	1,436	0
Tom Green	San Angelo Rgnl/Mathis Field	2275050011	0.53	0.53	0	16,157	16,157	0
Brazoria	Brazoria County	2275050012	5.55	5.55	0	34,263	34,263	0
Brazoria	Brazoria County	2275060011	0.06	0.06	0	780	780	0
Brazoria	Brazoria County	2275050011	0.43	0.43	0	13,324	13,324	0
Brazoria	Brazoria County	2275020000	6.43	7.05	-9	639	639	0
Brazoria	Brazoria County	2275001000	18.61	0.13	14,035	1,667	1,667	0
Brazoria	Brazoria County	2275060012	0.78	0.78	0	2,004	2,004	0
Harris	West Houston	2275060012	0.15	0.15	0	391	391	0
Harris	West Houston	2275050012	2.34	2.34	0	14,434	14,434	0
Harris	West Houston	2275050011	1.21	1.21	0	37,300	37,300	0

Table B-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Harris	West Houston	2275060011	0.01	0.01	0	109	109	0
Dallas	Mesquite Metro	2275050012	2.33	0.64	268	1,015	1,015	0
Dallas	Mesquite Metro	2275060011	0.67	0.73	-8	41,596	41,596	0
Dallas	Mesquite Metro	2275060012	5.83	1.95	198	8,117	8,117	0
Tarrant	Fort Worth Meacham Intl	2275050012	32.94	15.41	114	12,131	12,131	0
Tarrant	Fort Worth Meacham Intl	2275060011	0.42	0.31	36	16,869	16,869	0
Tarrant	Fort Worth Meacham Intl	2275060012	5.45	2.20	148	8,909	8,909	0
Medina	Hondo Muni	2275050012	2.15	73.91	-97	13,253	455,851	-97
Medina	Hondo Muni	2275050011	1.11	0	100	34,248	0	100
Lubbock	Lubbock Preston Smith Intl	2275020000	62.59	62.09	1	9,041	9,041	0
Lubbock	Lubbock Preston Smith Intl	2275060012	3.48	3.54	-2	6,138	6,138	0
Lubbock	Lubbock Preston Smith Intl	2275060011	0.07	0.07	0	948	948	0
Lubbock	Lubbock Preston Smith Intl	2275050012	0.75	0.75	0	4,663	4,663	0
Lubbock	Lubbock Preston Smith Intl	2275050011	0.39	0.39	0	12,050	12,050	0
Lubbock	Lubbock Preston Smith Intl	2275001000	50.50	0.36	14,035	4,523	4,523	0
Fort Bend	Sugar Land Rgnl	2275001000	4.31	0.03	14,035	386	386	0
Fort Bend	Sugar Land Rgnl	2275060012	0.33	0.33	0	860	860	0
Fort Bend	Sugar Land Rgnl	2275060011	0.17	0.17	0	2,211	2,211	0

Table B-5. Airport/SCC Combinations Within the Top 25 Airports with the Highest Activity

County	Airport*	SCC	2011 NO_X Emissions w/ AEDT + Revised Emission Factors (tons)	Previous 2011 NO_X Emissions w/ EDMS + Previous Emission Factors (tons)[a]	Percent Change (%)**	Current 2011 LTO w/ AEDT + Revised Emission Factors	Previous 2011 LTO w/ EDMS + Previous Emission Factors [a]	LTO Percent Change (%)
Fort Bend	Sugar Land Rgnl	2275050012	1.88	1.88	0	11,632	11,632	0
Fort Bend	Sugar Land Rgnl	2275050011	0.97	0.97	0	29,911	29,911	0

*Airports with total aircraft LTO's greater than 45,000

a. Previous Inventory was based on the same LTO data but used EDMS and older EPA generic emission factors.

**Percent Increase greater than 1,000%, high change due to updates to Military EF update.

*** There were some specific military LTOs, that's why the percent difference was a little different.

The new EPA generic military emission factors replaced the earlier factors provided in the SIP 1992 Guidance, which were based on engine test data from 1987 to 1991. The EPA's new emission factors were derived from the International Civil Aviation Organization (ICAO) engine databank factors that were matched to U.S. military aircraft and weighted based on the current fleet composition. A comparison of the revised and previous generic military emission factors is summarized in Table B-6. (Eastern Research Group to United States Environmental Protection Agency Memorandum - Updating the Generic Military Emission Factors for the 2014 National Emission Inventory, December 15, 2015)

Table B-6. Comparison of Revised Military Criteria Emission Factors[1] to the Previous Generic Military Emission Factors[2] (tons/LTO)*

Pollutant	2014 NEI (1992 SIP EF)	Revised Emission Factors (2015 EDMS)	Percent Difference
THC	6.17E-04	4.72E-03	665
VOC	7.10E-04	5.43E-03	666
TOG	7.16E-04	5.46E-03	663
NO_x	7.90E-05	1.12E-02	14035
CO	1.41E-02	1.30E-02	-8
SO_x	7.50E-06	1.06E-03	13967
$PM_{10\text{-PRI}}$	3.02E-04	6.97E-04	131

*There may be rounding errors in the 1992 SIP EF and Percent Change numbers

[1] Memorandum to Laurel Driver from Roger Chang and Richard Billings (ERG) Updating the Generic Military Emission Factors for the 2014 National Emission Inventory, December 18, 2015.

[2] U.S. EPA, Procedures for Emission Inventory Preparation Volume IV: Mobile Sources, EPA420-R-92-009, December 1992.

> **The use of the latest EPA emission factors is consistent with developing inventories based on the latest data and methods currently available, and therefore no changes were made to these factors.**

An additional concern was that Sheppard Airforce Base also seemed to have an unusually high level of activity. ERG first confirmed the data was correctly compiled.

> **However, since Sheppard is the busiest dual-use Air Force base in the U.S. it is to be expected that the base has a large number of LTOs compared to other airports in Texas (see https://www.sheppard.af.mil/News/Article-Display/Article/1412802/sheppard-has-busiest-joint-use-airfield-in-af/).**

Differences of multiple orders of magnitude were noted for NO_x emissions for generic military aircraft operations (including Sheppard AFB) between the 2011 and 2017 inventories, which matched the difference in the new EPA generic emission factors for military aircraft.

> **No change was required as the newer EPA emission factors replaced older emission factors developed in 1987.**

In cases where quantitative data were developed, checks were made to ensure their accuracy. To this end ERG spot checked data and compared the calculated values to the previous 2014 trend inventories. The inventory data were also summarized for the TCEQ to evaluate independently. Data found to be questionable were examined in greater detail to determine if errors might be present and what adjustments might be needed. Where data were revised, the procedures and assumptions used were documented. The ERG Project Manager and task leads reviewed and approved all data adjustments.

ERG also confirmed that all aircraft in the previous inventory were included in the input/output files used to develop the new 2011 inventory (see Table B-7). Note that the small difference in the first 8 rows of Table B-7 are due to the change in the Hondo Municipal Airport data. Hondo Municipal Airport data originally included some aircraft-specific local data. These were removed and replaced with generic data from TAF.

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Dassault Falcon 2000	5	6	-17
Bombardier Learjet 24	7	8	-13
Bombardier Learjet 35	12	13	-8
Bombardier Learjet 45	13	14	-7
Cessna 560 Citation V	13	14	-7
Cessna 750 Citation X	13	14	-7
Raytheon Beechjet 400	13	14	-7
Bombardier Challenger 600	23	24	-4
Aerostar PA-60	7	7	0
Agusta A-109	2	2	0
Airbus A300B2-100 Series	2	2	0
Airbus A300B4-600 Series	4	4	0
Airbus A300C4-600 Series	1	1	0
Airbus A300F4-600 Series	4	4	0
Airbus A310-200 Series	9	9	0
Airbus A310-300 Series	1	1	0
Airbus A318-100 Series	4	4	0

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Airbus A319-100 Series	15	15	0
Airbus A320-100 Series	6	6	0
Airbus A320-200 Series	7	7	0
Airbus A321-100 Series	1	1	0
Airbus A321-200 Series	1	1	0
Airbus A330-200 Series	2	2	0
Airbus A330-300 Series	2	2	0
Airbus A340-300 Series	3	3	0
Antonov 12 Cub	2	2	0
Antonov 124 Ruslan	3	3	0
ATR 42-200	3	3	0
ATR 42-300	1	1	0
ATR 72-200	13	13	0
Aviat Husky A1B	7	7	0
Ayres Turbo Thrush T-65	1	1	0
BAC 1-11 200	1	1	0
BAE 146-100	3	3	0
BAE Jetstream 31	2	2	0
Bell 206 JetRanger	9	9	0
Bell AH-1S Cobra	3	3	0
Bell UH-1 Iroquois	1	1	0
Boeing 707-300 Series	1	1	0
Boeing 717-200 Series	5	5	0
Boeing 727-100 Series	8	8	0
Boeing 727-200 Series	19	19	0
Boeing 737-100 Series	12	12	0
Boeing 737-200 Series	9	9	0
Boeing 737-300 Series	24	24	0
Boeing 737-400 Series	21	21	0
Boeing 737-500 Series	16	16	0
Boeing 737-600 Series	2	2	0
Boeing 737-700 Series	24	24	0
Boeing 737-800 Series	28	28	0
Boeing 737-900 Series	13	13	0
Boeing 737-900-ER	1	1	0
Boeing 747-100 Series	2	2	0

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Boeing 747-200 Series	7	7	0
Boeing 747-400 Series	5	5	0
Boeing 757-200 Series	22	22	0
Boeing 757-300 Series	6	6	0
Boeing 767-200 ER	3	3	0
Boeing 767-200 Series	7	7	0
Boeing 767-300 ER	3	3	0
Boeing 767-300 Series	4	4	0
Boeing 767-400 ER	2	2	0
Boeing 777-200 Series	9	9	0
Boeing 777-300 Series	5	5	0
Boeing C-17A	2	2	0
Boeing DC-10-10 Series	5	5	0
Boeing DC-10-30 Series	2	2	0
Boeing DC-10-30ER	1	1	0
Boeing DC-3	2	2	0
Boeing DC-8 Series 50	1	1	0
Boeing DC-8 Series 60	2	2	0
Boeing DC-8 Series 70	7	7	0
Boeing DC-9-10 Series	5	5	0
Boeing DC-9-20 Series	9	9	0
Boeing DC-9-30 Series	17	17	0
Boeing DC-9-40 Series	1	1	0
Boeing DC-9-50 Series	4	4	0
Boeing F/A-18 Hornet	2	2	0
Boeing KC-135 Stratotanker	1	1	0
Boeing MD-10-1	2	2	0
Boeing MD-11	8	8	0
Boeing MD-11-ER	1	1	0
Boeing MD-81	2	2	0
Boeing MD-82	22	22	0
Boeing MD-83	6	6	0
Boeing MD-87	15	15	0
Boeing MD-88	2	2	0
Boeing MD-90	2	2	0
Boeing Stearman PT-17 / A75N1	1	1	0

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Bombardier Challenger 300	8	8	0
Bombardier Challenger 601	2	2	0
Bombardier Challenger 604	2	2	0
Bombardier CL-415	1	1	0
Bombardier CRJ-100	4	4	0
Bombardier CRJ-200	16	16	0
Bombardier CRJ-700	18	18	0
Bombardier CRJ-900	7	7	0
Bombardier CRJ-900-ER	1	1	0
Bombardier de Havilland Dash 8 Q400	7	7	0
Bombardier Global Express	5	5	0
Bombardier Learjet 25	12	12	0
Bombardier Learjet 31	11	11	0
Bombardier Learjet 35A/36A (C-21A)	2	2	0
Bombardier Learjet 36	1	1	0
Bombardier Learjet 40	10	10	0
Bombardier Learjet 55	11	11	0
Bombardier Learjet 60	11	11	0
CASA 212-100 Series	2	2	0
CASA C-101 Aviojet	1	1	0
Cessna 150 Series	13	13	0
Cessna 172 Skyhawk	80	80	0
Cessna 182	18	18	0
Cessna 206	14	14	0
Cessna 208 Caravan	20	20	0
Cessna 210 Centurion	14	14	0
Cessna 310	14	14	0
Cessna 337 Skymaster	4	4	0
Cessna 340	11	11	0
Cessna 402	8	8	0
Cessna 414	12	12	0
Cessna 421 Golden Eagle	15	15	0
Cessna 425 Conquest I	12	12	0
Cessna 441 Conquest II	12	12	0
Cessna 500 Citation I	31	31	0
Cessna 501 Citation ISP	14	14	0

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Cessna 525 CitationJet	13	13	0
Cessna 550 Citation II	12	12	0
Cessna 551 Citation IISP	3	3	0
Cessna 552 T-47A	1	1	0
Cessna 560 Citation Excel	9	9	0
Cessna 560 Citation XLS	4	4	0
Cessna 650 Citation III	10	10	0
Cessna 680 Citation Sovereign	11	11	0
Cessna S550 Citation S/II	1	1	0
Cessna T-37 Tweet	1	1	0
Cirrus SR20	9	9	0
Cirrus SR22	14	14	0
Convair CV-580	9	9	0
Dassault Falcon 10	17	17	0
Dassault Falcon 100	1	1	0
Dassault Falcon 200	1	1	0
Dassault Falcon 2000-EX	5	5	0
Dassault Falcon 20-C	9	9	0
Dassault Falcon 20-F	1	1	0
Dassault Falcon 50	10	10	0
Dassault Falcon 900	8	8	0
Dassault Falcon 900-EX	1	1	0
DeHavilland DHC-2 Mk III Beaver	1	1	0
DeHavilland DHC-6-100 Twin Otter	3	3	0
DeHavilland DHC-6-200 Twin Otter	1	1	0
DeHavilland DHC-6-300 Twin Otter	1	1	0
DeHavilland DHC-8-100	3	3	0
DeHavilland DHC-8-200	2	2	0
DeHavilland DHC-8-300	1	1	0
Dornier 328 Jet	3	3	0
Dornier 328-100 Series	4	4	0
EADS Socata TB-20 Trinidad	4	4	0
EADS Socata TB-9 Tampico	1	1	0
EADS Socata TBM-700	11	11	0
Embraer 312 Tucano	1	1	0
Embraer EMB110 Bandeirante	4	4	0

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Embraer EMB120 Brasilia	4	4	0
Embraer ERJ135	19	19	0
Embraer ERJ135-LR	1	1	0
Embraer ERJ140	21	21	0
Embraer ERJ145	27	27	0
Embraer ERJ145-EU	1	1	0
Embraer ERJ145-LR	1	1	0
Embraer ERJ145-XR	3	3	0
Embraer ERJ170	5	5	0
Embraer ERJ175	3	3	0
Embraer ERJ190	4	4	0
Fairchild Metro IVC	1	1	0
Fairchild SA-226-T Merlin III	8	8	0
Fairchild SA-226-TC Metro II	3	3	0
Fairchild SA-227-AC Metro III	7	7	0
Fairchild SA-227-AT Expeditor	5	5	0
Fairchild SA-26-T Merlin II	4	4	0
Falcon 7X	3	3	0
Fokker F27 Friendship	1	1	0
Fokker F27-100 Series	1	1	0
Gulfstream G100	3	3	0
Gulfstream G150	8	8	0
Gulfstream G200	7	7	0
Gulfstream G300	5	5	0
Gulfstream G400	6	6	0
Gulfstream G500	5	5	0
Gulfstream G550	2	2	0
Gulfstream I	6	6	0
Gulfstream II	7	7	0
Gulfstream II-B	1	1	0
Gulfstream IV-SP	3	3	0
Gulfstream V-SP	7	7	0
Hawker HS-125 Series 1	2	2	0
Hawker HS-125 Series 400	3	3	0
Hawker HS-125 Series 600	3	3	0
Hawker HS-125 Series 700	7	7	0

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Hughes 500D	1	1	0
Israel IAI-1124 Westwind I	9	9	0
Israel IAI-1124-A Westwind II	2	2	0
Israel IAI-1125 Astra	6	6	0
Israel IAI-1126 Galaxy	6	6	0
Lancair 360	5	5	0
Lockheed C-130 Hercules	7	7	0
Lockheed C-5 Galaxy	2	2	0
Lockheed L-1329 Jetstar I	1	1	0
Lockheed L-1329 Jetstar II	5	5	0
Lockheed Martin F-16 Fighting Falcon	4	4	0
Lockheed P-3 Orion ANP:P3A	1	1	0
Lockheed S-3 Viking	1	1	0
Maule MT-7-235	7	7	0
Mitsubishi MU-2	12	12	0
Mitsubishi MU-300 Diamond	6	6	0
Mooney M20-K	16	16	0
NAMC YS-11-100 Series	1	1	0
Partenavia P.68 Victor	1	1	0
Piaggio P.180 Avanti	10	10	0
Pilatus PC-12	13	13	0
Pilatus PC-6 Porter	1	1	0
Piper PA-23 Apache/Aztec	13	13	0
Piper PA-24 Comanche	10	10	0
Piper PA-27 Aztec	3	3	0
Piper PA-28 Cherokee Series	33	33	0
Piper PA-30 Twin Comanche	14	14	0
Piper PA-31 Navajo	12	12	0
Piper PA-31T Cheyenne	15	15	0
Piper PA-32 Cherokee Six	13	13	0
Piper PA-34 Seneca	13	13	0
Piper PA-42 Cheyenne Series	10	10	0
Piper PA46-TP Meridian	12	12	0
Rans S7S	1	1	0
Raytheon Beech 18	8	8	0
Raytheon Beech 1900-C	4	4	0

Table B-7. Comparison to Confirm All Aircraft Were Included in the New Inventory

Aircraft	2011 Aircraft w/ AEDT + Revised Emission Factors Count	Previous 2011 Aircraft w/ EDMS + Previous Emission Factors Count	Percent Change (%)
Raytheon Beech 1900-D	1	1	0
Raytheon Beech 55 Baron	40	40	0
Raytheon Beech 60 Duke	10	10	0
Raytheon Beech 99	8	8	0
Raytheon Beech Baron 58	16	16	0
Raytheon Beech Bonanza 36	31	31	0
Raytheon Beech D17S Staggerwing	2	2	0
Raytheon Hawker 1000	7	7	0
Raytheon Hawker 4000 Horizon	3	3	0
Raytheon Hawker 800	7	7	0
Raytheon Hawker 900	1	1	0
Raytheon King Air 100	13	13	0
Raytheon King Air 90	17	17	0
Raytheon Premier I	7	7	0
Raytheon Super King Air 200	45	45	0
Raytheon Super King Air 300	15	15	0
Robinson R22	9	9	0
Rockwell 1121 Jet Commander	5	5	0
Rockwell 1121A Jet Commander-A	5	5	0
Rockwell Commander 500	8	8	0
Rockwell Commander 680	6	6	0
Rockwell Commander 690	13	13	0
Rockwell Sabreliner 40	4	4	0
Rockwell Sabreliner 50	1	1	0
Rockwell Sabreliner 65	2	2	0
Rockwell Sabreliner 80	1	1	0
Ryan Navion B	1	1	0
Saab 340-A	2	2	0
Saab 340-B	10	10	0
Shorts 330	2	2	0
Shorts 360-100 Series	3	3	0
Sikorsky S-76 Spirit	7	7	0
Sikorsky UH-60 Black Hawk	1	1	0
T-38 Talon	6	6	0

2011 Airports Compared to 2017 Airports

The airports in the 2011 inventory and the airports in the 2017 inventory were compared to identify differences in the datasets. As expected, there were changes during the 6 years, with some airports closing and some opening. The 29 airports that closed sometime between 2011 and 2017, or that did not have activity, are listed in Table B-8. These 29 airports were small and accounted for only 0.0526% of total LTOs in 2011 combined.

348 "new" airports opened during this time period or had activity in 2017 that was absent in 2011. These new airports were small, accounting for only 0.80% of total LTOs in 2017.

> **It should be noted that some airport codes changed between 2011 and 2017 and were in fact the same airports. These airports were not included in Tables B-8 and B-9.**

These observations track with the significant increase in small aircraft facilities in the Dallas/Fort Worth area between 2011 and 2017. Many of these are very small operations, air taxis and helicopter services which have been increasing over the years.

> **No change was needed as the data seem to be capturing a new and growing trend. (See** https://www.bizjournals.com/dallas/news/2016/11/11/air-medical-group-med-trans-corp-denton-hq.html and https://www.dallasnews.com/business/technology/2018/05/08/uber-getting-plans-ground-air-taxis-dallas-los-angeles)

Table B-8. Airports in the 2011 Inventory that were not included in the 2017 Inventory (closed)

Airport Code	Airport	2011 LTO	Percent of Total 2011 LTOs
03TA	Gay Hill Farm	9	0.0002%
11TE	Flying M Ranch	1	0.0000%
1TE2	Flying F Ranch	287	0.0059%
1TX4	Shoreline Ranch	109	0.0023%
2E3	Cluck Ranch	9	0.0002%
2TA0	Darmar Medical Emergency	142	0.0029%
30TX	Farmer's Co-Op	84	0.0017%
39XS	Palo Pinto General Hospital	142	0.0029%
3E7	Pronger Bros Ranch	9	0.0002%
3TS5	Purdy-Nielsen Memorial Airpark	78	0.0016%
49TE	Stowers Ranch	9	0.0002%
4TE0	Lone Star Steel Company	9	0.0002%
4TX9	Medical Center Hospital	142	0.0029%
54XS	Boyd Field	83	0.0017%
56TE	Cardiff Brothers	9	0.0002%

Table B-8. Airports in the 2011 Inventory that were not included in the 2017 Inventory (closed)

Airport Code	Airport	2011 LTO	Percent of Total 2011 LTOs
62TX	Barge Ranch	9	0.0002%
65TA	Flying C Ranch	56	0.0011%
79TX	Ag-Air Inc	105	0.0022%
7T3	Goliad County Industrial Airpark	61	0.0013%
83R	Glen Beicker Ranch	9	0.0002%
8TX7	Skyhaven	366	0.0076%
96TS	Nuttall	9	0.0002%
LA50	Mobil	142	0.0029%
TA92	Rowan	142	0.0029%
TE89	Verhalen	58	0.0012%
TS46	P H	142	0.0029%
TS95	Aviasud Airpark	179	0.0037%
TX04	Spohn-Alice	142	0.0029%
XS73	Double D Ranch	9	0.0002%
		Total	**0.0526%**

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
00TA	Sw Region FAA	55	0.0012%
00TE	TCJC-Northeast Campus	55	0.0012%
00TS	Alpine Range	167	0.0037%
01TA	Thirty Matlock Office Center	55	0.0012%
01TX	Mims Farm	104	0.0023%
01XA	Seton Medical Center Hays	55	0.0012%
02TE	Baylor Medical Center	55	0.0012%
04XS	Napiers	55	0.0012%
05TS	Dew Drop	116	0.0026%
06XA	J & W Windy Hill	1	0.0000%
06XS	Campbell Field	116	0.0026%
07TX	Pecks	55	0.0012%
07XS	Allen Ponderosa	55	0.0012%
08TX	Cross Wind	110	0.0024%
0TA4	Erco Field	95	0.0021%
0TE2	Bell Helicopter Hurst	55	0.0012%
0TS1	Dooley	116	0.0026%
0TS2	Ultralight Intl	224	0.0049%
0TX0	Nassau Bay	228	0.0050%
0TX1	Pecan Plantation	975	0.0214%
0TX2	Heliport-Facility 5a	55	0.0012%
0TX4	Aerospatiale Helicopter Corp	55	0.0012%
0TX5	Shiloh	123	0.0027%
0TX7	Lazy K Acres	189	0.0041%
0TX8	Jacobia Field	94	0.0021%
0TX9	Card Aerodrome	94	0.0021%
0XA0	Parkland Hospital Nr 2	55	0.0012%
0XA1	Kothmann Ranch	55	0.0012%
0XA9	Methodist Mansfield Medical Center	55	0.0012%
0XS4	Eds	55	0.0012%
0XS9	French Field	93	0.0020%
10XA	Sterling	106	0.0023%
11XA	Briar Lakes Ranch	1	0.0000%
12T	Ferris Red Oak Muni	55	0.0012%
12TS	BLO	302	0.0066%
12XA	Wood Farm Airfield	96	0.0021%
13XA	Flying 5b Ranch	92	0.0020%
13XS	Presbyterian Hospital of Rockwall	55	0.0012%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
14XA	Frog Pond	1	0.0000%
15TS	Owens Country Sausage	55	0.0012%
17TA	Heli-Dyne Systems Inc	55	0.0012%
17XA	Hunter Field	1	0.0000%
18TX	Flying 'T' Ranch	1	0.0000%
19TA	Lagrone Ranch	94	0.0021%
19TS	Kvue-Tv	55	0.0012%
19XA	Baylor Medical Center Irving	55	0.0012%
19XS	Draggintail Acres	139	0.0031%
1TS4	Eds Hangar	55	0.0012%
1TS9	Four Winds	1	0.0000%
1XS3	John Peter Smith Health Network	55	0.0012%
1XS6	Hillcrest Baptist Hospital	55	0.0012%
20TA	Mag Drop	96	0.0021%
20XA	St. Luke's Hospital at The Village	55	0.0012%
20XS	Klutts Field	144	0.0032%
22TS	Gray Steel	55	0.0012%
23TE	Texas Rgnl Medical Center	55	0.0012%
24TS	North Hills Hospital	55	0.0012%
24XS	Furst Ranch	55	0.0012%
25TE	Taylor's Air Park	104	0.0023%
26XA	Solana North	55	0.0012%
27TE	Sierra Providence Hospital	55	0.0012%
27TS	Walden Ranch	55	0.0012%
27XA	Arnett Landing	95	0.0021%
2TA2	The Medical Center of Mesquite	55	0.0012%
2TE3	Weems Farm	116	0.0026%
2TE7	Beach Ranch	98	0.0022%
2TS0	Myska Field	131	0.0029%
2TS4	Circle R Ranch	108	0.0024%
2TS6	Eagle's Nest Estates	545	0.0120%
2TS7	Jamak Fabrication	55	0.0012%
2TX8	Eagle's Landing	131	0.0029%
30XA	Emergency Room at Magnolia	55	0.0012%
31XA	Indian Falls Ranch	1	0.0000%
31XS	Fly-N-Ski	94	0.0021%
32XS	Cedar Circle	55	0.0012%
33XS	Six Mile Volunteer Fire Department	55	0.0012%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
34TA	JSI	142	0.0031%
34TX	Buckmaster	55	0.0012%
34XS	Flying Hare	108	0.0024%
35TA	Texas Health Presbyterian Hospital Plano	55	0.0012%
37TA	Texas Health Presbyterian Hospital Dallas	55	0.0012%
37TS	Skinner	1	0.0000%
38XA	Walk-Air	106	0.0023%
3T6	Clark	252	0.0055%
3TX1	Paradise Point	144	0.0032%
3TX2	Flying S Farm	131	0.0029%
3TX3	Sitton Field	131	0.0029%
3TX6	Lowell Smith Jr	1	0.0000%
3TX7	Flying P	116	0.0026%
3TX8	Drop Field	116	0.0026%
3TX9	Rafter J	104	0.0023%
3XA0	Drennan	1	0.0000%
3XA8	Chicken Strip	118	0.0026%
3XS7	Bell Training Facility	55	0.0012%
41TS	Flying T Ranch	1	0.0000%
41TX	Henington	94	0.0021%
44TA	Aero Crafter Inc	55	0.0012%
45XA	Buelah	110	0.0024%
46XA	Flying A	55	0.0012%
46XS	Windy Hill	116	0.0026%
47XA	Luv Field	121	0.0027%
48TE	4m Ranch Airfield	1	0.0000%
49TS	E D S	55	0.0012%
49XS	Mccasland Ranch	1	0.0000%
4TA1	Warschun Ranch	116	0.0026%
4TX2	Stage Coach Hills	338	0.0074%
4TX4	Birk	167	0.0037%
4TX8	Addington Field	123	0.0027%
4XA7	Baylor Health Center at Irving Coppell	55	0.0012%
4XS4	Baylor Medical Center at Carrollton	55	0.0012%
51TA	Harris Methodist Southwest Helistop	55	0.0012%
51TE	Barstool Ranch	1	0.0000%
53TE	Christus Santa Rosa Westover Hills	55	0.0012%
54TA	George P Shanks	104	0.0023%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
55TE	Lebegue LSA Landing	171	0.0037%
56TA	Dallas/Fort Worth Medical Center	55	0.0012%
57TA	Trinity Meadows Race Track	55	0.0012%
58TX	Tailspin Estates	124	0.0027%
59TX	Benjamin Franklin	111	0.0024%
59XA	Texas Farms and Ranches	55	0.0012%
5TS0	Shoreline Hospital	55	0.0012%
5TX0	Hidden Valley Airpark	565	0.0124%
5TX4	Black Mark Strip	1	0.0000%
5TX5	PSF	55	0.0012%
5TX6	Hilliard Landing Area	1	0.0000%
5XA0	Hunter's Creek	95	0.0021%
5XA6	Comanche Ridge Ranch	1	0.0000%
5XA9	Venable Airpark	1	0.0000%
60TA	Air Ranch Estates	1	0.0000%
60TS	Presbyterian Hospital of Commerce	55	0.0012%
61TE	Kezer Air Ranch	266	0.0058%
65TE	Windwood Farm	103	0.0023%
66TE	The Landings	171	0.0038%
66XS	Baylie	121	0.0027%
68TS	Bishop Field	116	0.0025%
69XA	Richey Airfield	100	0.0022%
6TA3	Culp	95	0.0021%
6TA8	Bell Helicopters Auxiliary	55	0.0012%
6TS2	Dauenhauer Field	115	0.0025%
6TS5	Eds Administration Nr 1	55	0.0012%
6TS9	MCP	55	0.0012%
6TX1	Action 5	55	0.0012%
6TX5	Baptist St Anthony's Hospital	55	0.0012%
6TX7	Flying L Airpark	104	0.0023%
6TX8	Hess	167	0.0037%
6XA0	Circle Ranch	92	0.0020%
6XA4	Zadow Air	107	0.0023%
6XS2	Luscombe Acres	161	0.0035%
6XS3	Mullins Landing	149	0.0033%
70TS	Memorial Hermann Katy Hospital	55	0.0012%
73TE	Moore Pvt	95	0.0021%
73TS	Fire Department Training Center	55	0.0012%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
75TS	Venus	125	0.0027%
76TX	Spanish Oaks	1	0.0000%
76XA	High Lonesome	1	0.0000%
77TA	Blue Skies	95	0.0021%
78TX	Baylor University Medical Center Grapevine	55	0.0012%
79TS	Tallows Field	121	0.0027%
7TS1	Cowden	55	0.0012%
7TS4	Roma	1	0.0000%
7TX3	Big Town	55	0.0012%
7TX4	Hillcrest	302	0.0066%
7XA0	West Texas VA Medical Center	55	0.0012%
7XS1	Flying E Ranch	95	0.0021%
80TE	Opela	55	0.0012%
81XA	River Falls	181	0.0040%
84TE	W4 Ranch	92	0.0020%
84XS	Lang Ranch	93	0.0020%
85TS	Aerospatiale Helicopter Corp	55	0.0012%
85XA	Windmillcreek	1	0.0000%
88TS	Fort Wolters Helicopters	55	0.0012%
8TA5	Short Stop	128	0.0028%
8TA7	Stark Field	95	0.0021%
8TS1	Retta	97	0.0021%
8TS5	Stol Field	97	0.0021%
8TX1	Medical Emergency GBC	55	0.0012%
8TX6	Harper	1	0.0000%
8TX9	North Texas Medical Center	55	0.0012%
8XA7	Yacht Club	120	0.0026%
8XS2	Ayers Field	98	0.0022%
90TA	Faulkner Point	55	0.0012%
91XA	Crosscut Field	107	0.0023%
93TX	John Peter Smith Ems Building	55	0.0012%
94TE	Barbaro North	55	0.0012%
94TS	Mc David Honda	55	0.0012%
95TE	Star	55	0.0012%
97XS	Tilghman	103	0.0023%
98TA	Weatherford Rgnl Medical Center	55	0.0012%
99TA	Peacock Willow Creek	55	0.0012%
99XS	Sam Little Intl	95	0.0021%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
9F5	TCJC-South Campus	55	0.0012%
9TA4	Placid	55	0.0012%
9TA5	Charlton-Careflite	55	0.0012%
9TE0	Twin Acres	95	0.0021%
9TS4	Ladue Ranch	55	0.0012%
9TS6	Goodlett Field	97	0.0021%
9TS8	Dallas Rehabilitation Institute	55	0.0012%
9TS9	Toyota Of Dallas Inc	55	0.0012%
9TX2	Bennetts	109	0.0024%
9TX8	Infomart	55	0.0012%
9XA4	Leger	97	0.0021%
9XS7	Reeder	91	0.0020%
E34	Smiley Johnson Muni/Bass Field	920	0.0202%
T14	Taylor	123	0.0027%
T25	Aero Estates	165	0.0036%
T33	Rives Air Park	1	0.0000%
T34	Talon Air	55	0.0012%
T37	Goldthwaite Muni	1	0.0000%
T69	Alfred C 'Bubba' Thomas	5,122	0.1124%
TA01	Phillips Farm	104	0.0023%
TA08	Flying M	144	0.0032%
TA11	TSA	1,601	0.0351%
TA16	Travis Field	91	0.0020%
TA18	Sunset	102	0.0022%
TA21	Windmill Hill	1	0.0000%
TA25	Cook Canyon Ranch	1	0.0000%
TA26	Coyote Crossing	97	0.0021%
TA37	Belo Broadcasting	55	0.0012%
TA40	Dallas City Hall	55	0.0012%
TA46	Baum	95	0.0021%
TA47	Richards	195	0.0043%
TA48	Hawk Nest	55	0.0012%
TA51	Eagle	103	0.0023%
TA54	Clear Fork Ranch	55	0.0012%
TA60	Hurn	111	0.0024%
TA69	Lupton Farms	55	0.0012%
TA71	Terrell Community Hospital	55	0.0012%
TA77	Cottonpatch Aerodrome	123	0.0027%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
TA83	Short Field	1	0.0000%
TA88	Premier Aviation Inc	55	0.0012%
TA94	Creech	55	0.0012%
TA99	Bell Helicopter Plant-3	55	0.0012%
TE02	Aresti Aerodrome	104	0.0023%
TE05	Mx Ranch	55	0.0012%
TE16	Cow Pasture	97	0.0021%
TE20	Putman	55	0.0012%
TE22	Texas Scottish Rite Hospital for Children	55	0.0012%
TE24	Horseshoe Lake	1	0.0000%
TE30	Harris Hospital	55	0.0012%
TE31	Mc David Pontiac Company	55	0.0012%
TE34	Reb Folbre's Place	138	0.0030%
TE43	Parkland Health & Hospital System	55	0.0012%
TE45	Buffalo Chips Airpark	289	0.0063%
TE50	Hirok	104	0.0023%
TE52	Chigger Field	93	0.0020%
TE56	11 Tv Dallas	55	0.0012%
TE59	Holler	55	0.0012%
TE65	NRH Fire Department	55	0.0012%
TE66	LMC	55	0.0012%
TE72	Haven Field	97	0.0021%
TE79	HIG	55	0.0012%
TE80	Medical Center Arlington	55	0.0012%
TE81	Smither Field	116	0.0026%
TE82	5-State	55	0.0012%
TE93	Staggs	55	0.0012%
TS00	Fuller	160	0.0035%
TS06	Medical City Dallas Hospital	55	0.0012%
TS11	Glenmar	108	0.0024%
TS28	Northeast Community Hospital	55	0.0012%
TS40	Celina Field	93	0.0020%
TS47	Rock Creek Ranch	1	0.0000%
TS56	Ktvt Channel 11	55	0.0012%
TS58	Denton Rgnl Medical Ctr - Flow Campus	55	0.0012%
TS60	Superturf	55	0.0012%
TS63	Square Air	142	0.0031%
TS64	Kimi	55	0.0012%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
TS70	Jack Miller	167	0.0037%
TS71	Flying B Ranch	97	0.0021%
TS72	ETMC - Gun Barrel City	55	0.0012%
TS73	Stubbs Strip	160	0.0035%
TS74	Glass	123	0.0027%
TS89	Parker	93	0.0020%
TS98	Wings Over Texas	1	0.0000%
TX06	Carrington	55	0.0012%
TX08	The Ballpark in Arlington	55	0.0012%
TX15	Beggs Ranch/Aledo/	1	0.0000%
TX16	Log Cabin	95	0.0021%
TX17	ETMC - Athens	55	0.0012%
TX18	Redmond Taylor AHP	55	0.0012%
TX22	Leroux	116	0.0026%
TX29	Flying O	118	0.0026%
TX30	H E B Hospital	55	0.0012%
TX32	Bar V K	1	0.0000%
TX33	Haire	116	0.0026%
TX34	Windy Tales	103	0.0023%
TX40	Echo Lake	151	0.0033%
TX46	Blackwood Airpark	132	0.0029%
TX50	Denton Community Hospital	55	0.0012%
TX53	Police H Port-Redbird	55	0.0012%
TX55	Southland Center	55	0.0012%
TX58	Southwest Custom Aircraft	55	0.0012%
TX59	Eds Administration Nr 2	55	0.0012%
TX60	T I Company	55	0.0012%
TX65	Beechwood	55	0.0012%
TX67	Embry Ranch	97	0.0021%
TX71	JMK Intl Inc	55	0.0012%
TX74	Thomas Flying Field	97	0.0021%
TX76	BMCG	55	0.0012%
TX77	Mallick Tower	55	0.0012%
TX78	Block Ranch	104	0.0023%
TX80	Eds Superdrome	55	0.0012%
TX83	Water Department	55	0.0012%
TX84	GMF Ranch	55	0.0012%
TX85	City of Fort Worth	55	0.0012%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
TX89	Ganze Ranch Airstrip	181	0.0040%
TX90	Flight Safety Texas	55	0.0012%
TX91	Madeira Airpark	1	0.0000%
TX95	Coppenger Farm	97	0.0021%
TX96	Maxwell Field	123	0.0027%
TX98	Hawkins Private	97	0.0021%
XA0	Prose Field	123	0.0027%
XA10	Ponderosa Field	116	0.0026%
XA11	Lake Pointe Medical Center	55	0.0012%
XA18	Baylor All Saints Medical Center	55	0.0012%
XA21	Las Colinas Medical Center	55	0.0012%
XA33	Thorny Woods	101	0.0022%
XA36	Cook Children's Medical Center	55	0.0012%
XA37	Plaza Medical Center	55	0.0012%
XA42	Connies Aviation	109	0.0024%
XA45	Weedfalls	101	0.0022%
XA53	Presbyterian Hospital of Allen	55	0.0012%
XA56	Hunt Rgnl Medical Center	55	0.0012%
XA59	Medical Center of Lewisville	55	0.0012%
XA61	Baylor University Medical Center Dallas	55	0.0012%
XA62	Methodist Dallas Medical Center	55	0.0012%
XA63	AAF	55	0.0012%
XA68	Akroville	131	0.0029%
XA69	Shelton Pvt	55	0.0012%
XA72	Stocker	116	0.0026%
XA75	Double A	111	0.0024%
XA79	Baylor Rgnl Medical Center at Plano	55	0.0012%
XA83	South Padre Island	55	0.0012%
XA86	Driftwood Ranch	124	0.0027%
XA87	Coon Creek Club	55	0.0012%
XA91	Wildwood	106	0.0023%
XS02	Tarrant County Water Control	55	0.0012%
XS06	Flying B Ranch	1	0.0000%
XS14	Weese Intl	1	0.0000%
XS19	Cedar Park Rgnl Medical Center	55	0.0012%
XS34	Skylark	97	0.0021%
XS54	Arlington Marriott Hotel	55	0.0012%
XS60	Mustang Community Airfield	116	0.0026%

Table B-9. Airports (Opened) in 2017 That Did Not Have Activity in 2011

Airport Code	Airport	2017 LTO	Percent of Total 2017 LTOs
XS62	The 88	1	0.0000%
XS78	Santiago Cattle Company	91	0.0020%
XS80	Scout	1	0.0000%
XS91	Pickle Plantation	94	0.0021%
XS96	Hillwood	55	0.0012%
XS97	Methodist Charlton Medical Center	55	0.0012%
		Total	**0.8044%**

2017 and 2020 to Previous 2017 and 2020 Comparison

ERG performed data checks comparing the 2017 and 2020 inventories, similar to the checks comparing the 2011 inventory using AEDT and revised generic emission factors, and the 2011 inventory using EDMS and the previous generic emission factors. Table B-10 summarizes the counties with an absolute difference of 1000% percent or greater, comparing the new 2017 inventory created using AEDT and EPA's revised generic emission factors (from the 2017 trend inventory based on 2014 activity data) with that based on the prior EDMS model and the EPA's older emission factors. Similar to 2011, there were some emissions with large differences. ERG then evaluated the data at the airport level within those counties to identify where the underlying issues were. These airports are summarized in Table B-11. For 2017 some of these differences were clearly caused by the differences in LTO data.

> **Since the 2017 trend inventory was based on 2014 data projected to 2017 instead of actual 2017 data, the LTO and projection data used in these different approaches appeared to be correct and were correctly applied, therefore no changes were required based on this QA check.**

The data from Table B-11 showed that the LTO data matched although the emissions were significantly higher in the new 2017 inventory, as expected due to the differences in models and emission factors.

> **Therefore, no changes were required based on this QA check.**

In reviewing the data, ERG first confirmed the LTO values were correct, noting that the LTOs only increased from 4,305 to 13,300, a difference of only about 9,000 LTOs. In other cases, the emission differences were entirely due to LTO changes between 2014 and 2017 (for example see John R Armstrong Airport). If there was a large LTO change, ERG went back to the original data to ensure there were no transcription errors. ERG then checked with airports having significant changes in LTOs, verifying that the original source data was consistent with those changes.

> **For these reasons no changes were required based on this QA check.**

ERG then reviewed the data at the airport and SCC level, summarized in Table B-12. ERG confirmed the changes in emissions were due to generic military activity and the revised generic military emission factors. ERG also confirmed that in all the cases the military data with high emission differences were due to generic activity.

> **Therefore, no changes were required based on this QA check.**

Some of the variance in activity identified when comparing the 2014 and the 2017 inventories can also be attributed to the repeal of the Wright Amendment in October 2014. This amendment limited airport destinations in the Dallas/Fort Worth area (e.g., Love Field and Meacham Airports). Once the amendment was repealed, activity at Love Field and Mecham increased while activity decreased at Dallas/Fort Worth. Also, there was a decline in activity at smaller airports outside the Dallas/Fort Worth area (e.g., El Paso, Austin and Houston) where flights were being directed to when the amendment was enforced. These airports were no longer needed as a hub prior to leaving the state once the amendment was repealed.

Additionally, it was noted that for some airports the total LTOs were similar between years but shifted between SCCs. These can be seen in Table B-13. This is not unusual as specific aircraft can be used in general aviation, air taxis or commercial operations; for example, a Cessna Citation M2 may be privately owned as a general aviation aircraft or it may be owned by a business providing air taxi services, and if these services are regularly scheduled it may be considered a small commercial aircraft. It is often up to the airport to make these subjective determinations about which category the aircraft falls into as they are more likely to know how the aircraft is being used. The subjective aspect of assigning SCCs would explain why the LTOs can remain relatively consistent while the SCC assignments can vary. For aircraft specific data where the EPA updated their SCC assignments, ERG included these recent EPA changes in these inventories, which also accounted for some of the identified differences.

For these reasons, no changes were required based on this QA check.

The aircraft counts in the AEDT input and output files were also compared to confirm that all aircraft were successfully imported into AEDT, as summarized in Table B-14.

No changes were required based on this QA check.

Table B-10. Counties with The Highest Absolute Percent Changes in Emissions

County	2017 NO_x Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_x Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	111.89	0.31	36,332	13,303	4,308	209
Karnes	19.23	0.08	22,751	3,083	1,289	139
Victoria	264.02	2.38	11,009	32,018	30,422	5
Culberson	1.13	0.02	5,106	413	360	15
Wichita	553.26	10.90	4,974	80,887	75,066	8
Aransas	129.28	3.02	4,181	24,100	41,207	-42
Reeves	36.75	0.96	3,746	11,913	10,864	10
Angelina	23.86	0.66	3,540	29,500	9,541	209
Walker	24.16	0.80	2,934	14,956	10,846	38
Calhoun	8.77	0.36	2,359	6,375	5,004	27
Atascosa	6.35	0.26	2,358	4,882	3,375	45
La Salle	12.87	0.53	2,328	5,818	6,346	-8
Guadalupe	35.37	1.80	1,866	32,750	24,880	32
Matagorda	9.11	0.59	1,440	10,546	8,411	25
Howard	7.03	0.46	1,414	11,815	6,649	78
Coryell	2.18	0.16	1,294	7,609	2,351	224

Table B-10. Counties with The Highest Absolute Percent Changes in Emissions

County	2017 NO_x Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_x Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Nueces	380.64	30.55	1,146	58,159	39,755	46
McLennan	142.09	12.05	1,079	98,449	67,109	47

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission.

Table B-11. Airports with the Highest Absolute Percent Changes in Emissions Within the Previously Identified Counties

County	Airport	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Absolute Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Nueces	John R. Armstrong Memorial Field	0.02	0.000033	55,225	267	1	26,098
Jim Wells	Alice Intl	111.89	0.31	36,343	13,300	4,305	209
Karnes	Karnes County	19.22	0.07	26,580	2,836	1,050	170
Victoria	Victoria Rgnl	263.49	2.19	11,934	29,208	28,136	4
Matagorda	Palacios Muni	8.34	0.11	7,549	3,530	1,480	139
Culberson	Culberson County	1.13	0.02	6,108	300	250	20
Wichita	Sheppard AFB/Wichita Falls Muni	545.62	9.36	5,731	51,526	52,931	-3
Aransas	Aransas Co	129.27	3.02	4,185	24,000	41,110	-42
McLennan	Tstc Waco	84.01	2.05	3,995	49,256	28,878	71
Calhoun	Calhoun County	8.62	0.22	3,883	4,350	3,041	43
Reeves	Pecos Muni	36.74	0.95	3,759	11,800	10,755	10
Angelina	Angelina County	23.84	0.64	3,642	29,200	9,250	216
Walker	Huntsville Muni	24.15	0.79	2,967	14,807	10,701	38
Atascosa	Pleasanton Muni	6.34	0.25	2,474	4,640	3,140	48
La Salle	Cotulla-La Salle County	12.86	0.52	2,367	5,539	6,075	-9
Guadalupe	New Braunfels Muni	35.03	1.47	2,277	27,149	19,459	40
Howard	Big Spring Mc Mahon-Wrinkle	7.02	0.46	1,432	11,760	6,596	78
Coryell	Gatesville Muni	2.17	0.14	1,406	7,350	2,100	250
Nueces	Corpus Christi Intl	379.97	29.89	1,171	48,506	30,259	60

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and previous EPA generic emission factors.

Table B-12. SCCs With the Highest Absolute Percent Change in Emissions Within the Previously Identified Airport/County Combinations

County	Airport	SCC**	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	Alice Intl	2275001000	111.67	0.08	141,250	10,000	1,000	900
Angelina	Angelina County	2275001000	21.27	0.02	107,571	1,904	250	662
Guadalupe	New Braunfels Muni	2275001000	33.24	0.09	34,974	2,977	1,200	148
Nueces	Corpus Christi Intl	2275001000	358.33	1.12	31,936	32,089	14,158	127
McLennan	Tstc Waco	2275001000	81.10	0.42	19,212	7,263	5,316	37
Nueces	John R. Armstrong Memorial Field	2275050011	0.01	0.00	18,781	192	1	18,781
Victoria	Victoria Rgnl	2275001000	262.95	1.67	15,625	23,548	21,166	11
Reeves	Pecos Muni	2275001000	35.93	0.23	15,448	3,218	2,925	10
La Salle	Cotulla-La Salle County	2275001000	12.28	0.08	15,448	1,100	1,000	10
Atascosa	Pleasanton Muni	2275001000	6.03	0.04	14,035	540	540	0
Calhoun	Calhoun County	2275001000	8.37	0.06	14,035	750	750	0
Howard	Big Spring Mc Mahon-Wrinkle	2275001000	6.25	0.04	14,035	560	560	0
Matagorda	Palacios Muni	2275001000	8.15	0.06	14,035	730	730	0
Culberson	Culberson County	2275001000	1.12	0.01	14,035	100	100	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	545.44	3.86	14,035	48,846	48,846	0
Walker	Huntsville Muni	2275001000	23.24	0.16	14,032	2,082	2,082	0
Aransas	Aransas Co	2275001000	128.42	1.28	9,903	11,500	16,250	-29

* High percent change due to updates to Military EF update

**Military LTOs were all generic

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Dallas/Fort Worth Intl	2275050012	6.26	0.92	583	8,482	795	967
Tarrant	Dallas/Fort Worth Intl	2275020000	4,491.64	3,577.72	26	287,772	354,184	-19
Tarrant	Dallas/Fort Worth Intl	2275060012	155.69	2.04	7,521	30,897	8,206	277
Harris	George Bush Intercontinental/Houston	2275050012	0.40	2.39	-83	1,778	2,502	-29
Harris	George Bush Intercontinental/Houston	2275020000	2,010.35	1,485.23	35	165,570	206,746	-20
Harris	George Bush Intercontinental/Houston	2275060011	0.90	0.02	5,189	11,434	1,063	976
Harris	George Bush Intercontinental/Houston	2275060012	200.19	188.07	6	88,193	90,915	-3
Harris	George Bush Intercontinental/Houston	2275050011	0.14	0.01	1,464	4,238	502	744
Harris	George Bush Intercontinental/Houston	2275001000	2.59	0.71	266	236	847	-72
Dallas	Dallas Love Field	2275060011	0.24	1.07	-77	3,079	6,115	-50
Dallas	Dallas Love Field	2275020000	661.37	439.63	50	69,693	55,306	26
Dallas	Dallas Love Field	2275050011	0.69	0.12	488	21,293	1,295	1,545
Dallas	Dallas Love Field	2275060012	3.99	14.25	-72	10,232	11,616	-12
Dallas	Dallas Love Field	2275050012	1.94	30.62	-94	9,100	19,394	-53
Dallas	Dallas Love Field	2275001000	6.06	0.97	526	543	2,172	-75
Harris	William P Hobby	2275001000	5.45	0.11	4,967	489	1,575	-69
Harris	William P Hobby	2275020000	505.28	529.75	-5	59,171	84,375	-30
Harris	William P Hobby	2275050011	0.68	0.05	1,296	20,954	694	2,921

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO$_X$ Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO$_X$ Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Harris	William P Hobby	2275060011	0.22	0.01	2,091	2,770	901	207
Harris	William P Hobby	2275060012	4.97	20.24	-75	9,929	17,964	-45
Harris	William P Hobby	2275050012	1.71	12.14	-86	8,540	15,342	-44
Travis	Austin-Bergstrom Intl	2275060011	0.00	0.55	-100	2	7,457	-100
Travis	Austin-Bergstrom Intl	2275001000	0.08	0.08	-7	90	68	32
Travis	Austin-Bergstrom Intl	2275020000	648.50	745.94	-13	63,306	85,937	-26
Travis	Austin-Bergstrom Intl	2275050011	0.21	0.07	185	7,515	1,627	362
Travis	Austin-Bergstrom Intl	2275060012	1.36	9.76	-86	597	13,203	-95
Travis	Austin-Bergstrom Intl	2275050012	30.97	12.00	158	21,851	13,911	57
Denton	Northwest Rgnl	2275050011	2.90	2.80	3	89,146	86,262	3
Denton	Northwest Rgnl	2275060011	0.01	0.01	-41	73	123	-41
Denton	Northwest Rgnl	2275050012	0.09	0.09	3	572	553	3
Denton	Northwest Rgnl	2275060012	0.10	0.17	-40	260	436	-40
Tarrant	Fort Worth Meacham Intl	2275050011	1.76	1.07	65	54,082	32,832	65
Tarrant	Fort Worth Meacham Intl	2275050012	3.41	2.06	65	20,929	12,708	65
Tarrant	Fort Worth Meacham Intl	2275060012	1.73	1.53	13	4,469	3,949	13
Tarrant	Fort Worth Meacham Intl***	2275001000	7.96	0.03	30,451	713	330	116
Tarrant	Fort Worth Meacham Intl	2275060011	0.10	0.09	13	1,245	1,101	13
Tarrant	Fort Worth Meacham Intl	2275020000	0.93	0.27	239	96	30	223
Bexar	San Antonio Intl	2275050012	1.12	10.22	-89	6,516	10,748	-39

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO$_X$ Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO$_X$ Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Bexar	San Antonio Intl	2275020000	570.76	531.01	7	44,689	52,295	-15
Bexar	San Antonio Intl	2275060012	3.72	16.65	-78	8,075	13,152	-39
Bexar	San Antonio Intl	2275060011	0.17	0.57	-69	2,203	4,771	-54
Bexar	San Antonio Intl	2275050011	0.55	0.07	667	16,822	1,214	1,285
Bexar	San Antonio Intl	2275001000	26.96	1.07	2,423	2,416	665	263
Collin	Collin County Rgnl At Mc Kinney	2275060012	0.48	0.23	106	1,227	595	106
Collin	Collin County Rgnl At Mc Kinney	2275050011	1.56	0.34	353	47,973	10,586	353
Collin	Collin County Rgnl At Mc Kinney***	2275001000	0.25	0.00	19,567	23	16	39
Collin	Collin County Rgnl At Mc Kinney	2275050012	3.00	6.15	-51	18,564	37,974	-51
Collin	Collin County Rgnl At Mc Kinney	2275060011	0.03	0.01	106	342	166	106
Potter	Rick Husb+ Amarillo Intl	2275050012	1.10	0.47	131	6,617	2,926	126
Potter	Rick Husb+ Amarillo Intl	2275020000	43.37	33.49	30	7,264	7,252	0
Potter	Rick Husb+ Amarillo Intl	2275050011	0.56	0.25	126	17,087	7,556	126
Potter	Rick Husb+ Amarillo Intl	2275060011	0.11	0.10	19	1,433	1,203	19
Potter	Rick Husb+ Amarillo Intl	2275060012	15.04	1.67	798	8,816	4,319	104
Potter	Rick Husb+ Amarillo Intl***	2275001000	275.54	0.88	31,220	24,675	11,136	122
Denton	Denton Muni***	2275001000	1.17	0.01	12,271	105	120	-12
Denton	Denton Muni	2275060011	0.02	0.02	-2	215	219	-2
Denton	Denton Muni	2275050012	2.83	10.16	-72	17,490	62,746	-72
Denton	Denton Muni	2275050011	1.47	0.57	158	45,199	17,491	158

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Denton	Denton Muni	2275020000	0.11	0.17	-34	11	18	-37
Denton	Denton Muni	2275060012	0.30	0.31	-3	767	787	-3
Tarrant	Fort Worth Alliance	2275050012	2.02	2.04	-1	12,210	12,596	-3
Tarrant	Fort Worth Alliance***	2275001000	68.88	0.68	10,073	6,169	8,571	-28
Tarrant	Fort Worth Alliance	2275020000	233.61	70.31	232	4,871	2,945	65
Tarrant	Fort Worth Alliance	2275050011	1.03	1.06	-3	31,552	32,545	-3
Tarrant	Fort Worth Alliance	2275060012	0.74	2.38	-69	1,055	2,638	-60
Harris	David Wayne Hooks Memorial	2275020000	0.02	0.02	-2	2	2	-2
Harris	David Wayne Hooks Memorial	2275050012	2.46	3.73	-34	14,647	23,073	-37
Harris	David Wayne Hooks Memorial	2275050011	1.22	1.94	-37	37,607	59,624	-37
Harris	David Wayne Hooks Memorial	2275001000	8.19	0.11	7,581	734	1,350	-46
Harris	David Wayne Hooks Memorial	2275060012	0.52	0.71	-27	1,340	1,829	-27
Harris	David Wayne Hooks Memorial	2275060011	0.03	0.04	-22	399	510	-22
El Paso	El Paso Intl	2275050011	0.40	0.50	-20	12,173	15,284	-20
El Paso	El Paso Intl	2275060011	0.13	0.18	-30	1,490	2,283	-35
El Paso	El Paso Intl	2275020000	187.26	202.23	-7	17,272	21,326	-19
El Paso	El Paso Intl	2275050012	0.82	1.00	-18	4,712	5,955	-21
El Paso	El Paso Intl***	2275001000	117.10	0.30	39,025	10,487	3,730	181
El Paso	El Paso Intl	2275060012	8.70	3.25	168	7,339	8,459	-13
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	545.44	3.86	14,035	48,846	48,846	0

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO$_X$ Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO$_X$ Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Wichita	Sheppard AFB/Wichita Falls Muni	2275050012	0.12	0.12	0	748	748	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275020000	0.34	5.32	-94	30	1,405	-98
Wichita	Sheppard AFB/Wichita Falls Muni	2275050011	0.06	0.06	0	1,932	1,932	0
Harris	West Houston	2275060012	0.15	0.16	-4	391	408	-4
Harris	West Houston	2275050012	2.34	2.47	-6	14,434	15,278	-6
Harris	West Houston	2275060011	0.01	0.01	-4	109	114	-4
Harris	West Houston	2275050011	1.21	1.28	-6	37,301	39,483	-6
Williamson	Georgetown Muni	2275060012	0.14	0.09	66	365	220	66
Williamson	Georgetown Muni	2275060011	0.01	0.00	65	102	62	65
Williamson	Georgetown Muni	2275050011	1.21	0.27	354	37,131	8,174	354
Williamson	Georgetown Muni	2275050012	2.33	4.75	-51	14,368	29,322	-51
Williamson	Georgetown Muni	2275001000	2.57	0.01	34,981	231	93	148
Bexar	Stinson Muni	2275001000	47.97	0.40	11,834	4,296	5,088	-16
Bexar	Stinson Muni	2275020000	0.02	0.01	97	2	1	97
Bexar	Stinson Muni	2275060011	0.03	0.03	-15	371	436	-15
Bexar	Stinson Muni	2275060012	0.52	0.61	-15	1,330	1,564	-15
Bexar	Stinson Muni	2275050011	1.04	0.85	23	32,012	26,118	23
Bexar	Stinson Muni	2275050012	2.01	1.64	23	12,387	10,107	23
Dallas	Addison	2275060012	1.09	1.35	-19	2,805	3,480	-19
Dallas	Addison	2275001000	1.80	0.01	12,312	161	183	-12

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Dallas	Addison	2275060011	0.06	0.08	-19	782	970	-19
Dallas	Addison	2275050012	2.09	1.97	6	12,824	12,199	5
Dallas	Addison	2275020000	0.49	1.12	-56	51	112	-54
Dallas	Addison	2275050011	1.08	1.02	5	33,139	31,525	5
McLennan	TSTC Waco	2275060012	0.01	0.01	16	21	18	16
McLennan	TSTC Waco	2275020000	0.02	0.01	99	2	1	99
McLennan	TSTC Waco	2275060011	0.00	0.00	17	6	5	17
McLennan	TSTC Waco	2275050011	0.98	0.55	78	30,256	16,971	78
McLennan	TSTC Waco	2275001000	81.10	0.42	19,212	7,263	5,316	37
McLennan	TSTC Waco	2275050012	1.90	1.06	78	11,708	6,567	78
Nueces	Corpus Christi Intl	2275001000	358.33	1.12	31,936	32,089	14,158	127
Nueces	Corpus Christi Intl	2275050012	0.40	0.84	-52	2,491	5,160	-52
Nueces	Corpus Christi Intl	2275020000	16.38	26.36	-38	2,930	4,732	-38
Nueces	Corpus Christi Intl	2275050011	0.21	0.05	347	6,436	1,439	347
Nueces	Corpus Christi Intl	2275060011	0.06	0.08	-22	809	1,040	-22
Nueces	Corpus Christi Intl	2275060012	4.58	1.45	217	3,750	3,732	1
Medina	Hondo Muni	2275050012	2.17	2.25	-4	13,376	13,883	-4
Medina	Hondo Muni	2275050011	1.12	1.17	-4	34,567	35,877	-4
Webb	Laredo Intl	2275020000	60.13	43.76	37	2,886	5,992	-52
Webb	Laredo Intl****	2275001000	201.74	0.22	91,435	18,070	2,519	617

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Webb	Laredo Intl	2275050011	0.48	0.02	2,346	14,622	598	2,346
Webb	Laredo Intl	2275050012	1.06	0.36	198	5,658	2,153	163
Webb	Laredo Intl	2275060011	0.08	0.01	1,004	1,004	92	995
Webb	Laredo Intl	2275060012	8.52	0.13	6,561	5,544	333	1,567
Harris	Ellington Field	2275001000	137.16	9.15	1,398	12,283	13,567	-9
Harris	Ellington Field	2275060012	1.30	7.11	-82	3,330	16,546	-80
Harris	Ellington Field	2275020000	9.40	19.84	-53	997	7,582	-87
Harris	Ellington Field	2275060011	0.07	0.08	-9	928	7,268	-87
Harris	Ellington Field	2275050011	0.68	0.05	1,210	20,809	2,357	783
Harris	Ellington Field	2275050012	1.30	4.05	-68	8,052	6,283	28
Tarrant	Gr+ Prairie Muni***	2275001000	21.22	0.24	8,658	1,900	3,066	-38
Tarrant	Gr+ Prairie Muni	2275060012	0.03	0.01	106	73	35	106
Tarrant	Gr+ Prairie Muni	2275050011	1.02	0.74	38	31,401	22,820	38

Table B-13. Airport/SCC Combinations Within the Top 25 Airports the Highest Activity

County	Airport*	SCC	2017 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	Emissions Percent Change (%)**	2017 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2017 LTO w/ EDMS + Previous Emission Factors from 2014 Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Gr+ Prairie Muni	2275050012	1.97	1.43	38	12,151	8,831	38
Tarrant	Gr+ Prairie Muni	2275060011	0.00	0.00	101	20	10	101
		Total	**11,871.77**	**8,137.52**	**46**	**2,063,504**	**2,040,522**	**1**

*Airports with total aircraft LTO's greater than 45,000

** High percent change due to updates to Military EF update

***Military LTOs were all

****There were some specific differences, but the majority were generic military LTOs.

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table B-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Aerostar PA-60	2	2	0
Agusta A-109	2	2	0
Air Tractor 802	1	1	0
Air Tractor AT-502	1	1	0
Air Tractor AT-502B	1	1	0
Air Tractor AT-602	1	1	0
Airbus A300B2-100 Series	1	1	0
Airbus A300B2-200 Series	1	1	0
Airbus A300B4-600 Series	2	2	0
Airbus A300F4-600 Series	8	8	0
Airbus A310-200 Series	6	6	0
Airbus A310-300 Series	1	1	0
Airbus A319-100 Series	14	14	0
Airbus A320-100 Series	1	1	0
Airbus A320-200 Series	13	13	0
Airbus A321-100 Series	10	10	0
Airbus A321-200 Series	1	1	0
Airbus A330-200 Series	2	2	0
Airbus A330-200 Series Freighter	1	1	0
Airbus A330-300 Series	3	3	0
Airbus A340-200 Series	1	1	0
Airbus A350-800 Series	1	1	0
Airbus A350-900 series	1	1	0
Airbus A380-800 Series/Trent 970	2	2	0
Antonov 12 Cub	1	1	0
Antonov 124 Ruslan	3	3	0
Antonov AN28 Cash	1	1	0
ATR 42-200	4	4	0
ATR 42-320	1	1	0
ATR 72-200	4	4	0
Aviat Husky A1B	2	2	0
Ayres S2R-T34 Turbo-Thrush	1	1	0
BAE Jetstream 31	4	4	0
BAE Jetstream 32	1	1	0
BAE Jetstream 32-EP	1	1	0
BAE Jetstream 41	4	4	0
Bell 206 JetRanger	2	2	0
Bell 407 / Rolls-Royce 250-C47B	2	2	0

Table B-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Bell UH-1 Iroquois	1	1	0
Boeing 717-200 Series	5	5	0
Boeing 727-100 Series	1	1	0
Boeing 727-200 Series	13	13	0
Boeing 737-100 Series	12	12	0
Boeing 737-200 Series	1	1	0
Boeing 737-300 Series	16	16	0
Boeing 737-300 Series Freighter	1	1	0
Boeing 737-400 Series	22	22	0
Boeing 737-400 Series Freighter	1	1	0
Boeing 737-500 Series	2	2	0
Boeing 737-600 Series	2	2	0
Boeing 737-700 Series	20	20	0
Boeing 737-800 Series	23	23	0
Boeing 737-800 with winglets	1	1	0
Boeing 737-900 Series	15	15	0
Boeing 737-900-ER	6	6	0
Boeing 747-200 Series	13	13	0
Boeing 747-400 Series	4	4	0
Boeing 747-400 Series Freighter	3	3	0
Boeing 747-800 Freighter	3	3	0
Boeing 757-200 Series	1	1	0
Boeing 757-200 Series Freighter	1	1	0
Boeing 757-300 Series	3	3	0
Boeing 767-200 ER	10	10	0
Boeing 767-200 Series	1	1	0
Boeing 767-300 ER	12	12	0
Boeing 767-300 ER Freighter	1	1	0
Boeing 767-400 ER	4	4	0
Boeing 777-200 Series	6	6	0
Boeing 777-200-LR	2	2	0
Boeing 777-300 ER	2	2	0
Boeing 777-300 Series	1	1	0
Boeing 787-900 Dreamliner	5	5	0
Boeing DC-10-10 Series	6	6	0
Boeing DC-10-30 Series	5	5	0
Boeing DC-10-40 Series	1	1	0
Boeing DC-6	1	1	0

Table B-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Boeing DC-8 Series 60	2	2	0
Boeing DC-9-10 Series	1	1	0
Boeing DC-9-20 Series	17	17	0
Boeing DC-9-30 Series	12	12	0
Boeing F/A-18 Hornet	1	1	0
Boeing MD-11	5	5	0
Boeing MD-11-ER	1	1	0
Boeing MD-82	23	23	0
Boeing MD-83	1	1	0
Boeing MD-88	3	3	0
Boeing MD-90	6	6	0
Bombardier Challenger 300	16	16	0
Bombardier Challenger 600	3	3	0
Bombardier Challenger 601	3	3	0
Bombardier Challenger 604	5	5	0
Bombardier CL-415	1	1	0
Bombardier CRJ-200	19	19	0
Bombardier CRJ-700	24	24	0
Bombardier CRJ-900	16	16	0
Bombardier Global Express	17	17	0
Bombardier Learjet 24	1	1	0
Bombardier Learjet 25	1	1	0
Bombardier Learjet 31	3	3	0
Bombardier Learjet 35	2	2	0
Bombardier Learjet 40	2	2	0
Bombardier Learjet 45	3	3	0
Bombardier Learjet 55	2	2	0
Bombardier Learjet 60	3	3	0
CASA 295	1	1	0
CASA CN-235-100	1	1	0
Cessna 150 Series	3	3	0
Cessna 172 Skyhawk	9	9	0
Cessna 182	3	3	0
Cessna 206	2	2	0
Cessna 208 Caravan	13	13	0
Cessna 210 Centurion	4	4	0
Cessna 310	2	2	0
Cessna 337 Skymaster	2	2	0

Table B-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Cessna 340	2	2	0
Cessna 402	1	1	0
Cessna 414	3	3	0
Cessna 421 Golden Eagle	2	2	0
Cessna 425 Conquest I	2	2	0
Cessna 441 Conquest II	1	1	0
Cessna 500 Citation I	2	2	0
Cessna 501 Citation ISP	8	8	0
Cessna 525 CitationJet	3	3	0
Cessna 525A CitationJet	1	1	0
Cessna 525B CitationJet	1	1	0
Cessna 525C CitationJet	1	1	0
Cessna 550 Citation II	2	2	0
Cessna 560 Citation Excel	4	4	0
Cessna 560 Citation V	1	1	0
Cessna 560 Citation XLS	1	1	0
Cessna 650 Citation III	6	6	0
Cessna 680 Citation Sovereign	3	3	0
Cessna 750 Citation X	4	4	0
Cirrus SR20	2	2	0
Cirrus SR22	3	3	0
Convair CV-440	10	10	0
Convair CV-580	1	1	0
Dassault Falcon 10	15	15	0
Dassault Falcon 200	1	1	0
Dassault Falcon 2000	2	2	0
Dassault Falcon 2000-EX	5	5	0
Dassault Falcon 50	3	3	0
Dassault Falcon 900	1	1	0
Dassault Falcon 900-EX	1	1	0
DeHavilland DHC-2 Mk III Beaver	1	1	0
DeHavilland DHC-3 Otter	1	1	0
DeHavilland DHC-6-100 Twin Otter	1	1	0
Dornier 228-100 Series	1	1	0
Dornier 328 Jet	1	1	0
EADS Socata TB-10 Tobago	1	1	0
EADS Socata TB-20 Trinidad	1	1	0
EADS Socata TBM-700	2	2	0

Table B-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Eclipse 500 / PW610F	2	2	0
Embraer 500	3	3	0
Embraer 505	2	2	0
Embraer EMB120 Brasilia	6	6	0
Embraer ERJ135	13	13	0
Embraer ERJ135 Legacy Business	1	1	0
Embraer ERJ135-ER	1	1	0
Embraer ERJ135-LR	1	1	0
Embraer ERJ140	19	19	0
Embraer ERJ145	24	24	0
Embraer ERJ145-EU	1	1	0
Embraer ERJ145-LR	1	1	0
Embraer ERJ145-XR	1	1	0
Embraer ERJ170	11	11	0
Embraer ERJ175	24	24	0
Embraer ERJ175-LR	1	1	0
Embraer ERJ190	4	4	0
Embraer ERJ195	1	1	0
Fairchild SA-226-T Merlin III	1	1	0
Fairchild SA-226-TC Metro II	1	1	0
Fairchild SA-227-AC Metro III	1	1	0
Fairchild SA-26-T Merlin II	1	1	0
Falcon 7X	5	5	0
Grumman A-6 Intruder	1	1	0
Grumman G-21G Goose	1	1	0
Grumman G-73 Mallard	1	1	0
Gulfstream G100	1	1	0
Gulfstream G150	8	8	0
Gulfstream G200	7	7	0
Gulfstream G280	1	1	0
Gulfstream G300	1	1	0
Gulfstream G350	1	1	0
Gulfstream G400	1	1	0
Gulfstream G450	3	3	0
Gulfstream G550	7	7	0
Gulfstream I	1	1	0
Gulfstream II	1	1	0
Gulfstream II-B	1	1	0

Table B-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Gulfstream IV-SP	1	1	0
Gulfstream V-SP	1	1	0
Hawker HS-125 Series 1	3	3	0
Hawker HS-125 Series 400	1	1	0
Hawker HS-125 Series 600	1	1	0
Hughes 500D	2	2	0
Ilyushin 76 Candid	2	2	0
Israel IAI-1124 Westwind I	1	1	0
Israel IAI-1124-A Westwind II	2	2	0
Israel IAI-1125 Astra	1	1	0
Lancair 360	1	1	0
Let 410	1	1	0
Lockheed C-130 Hercules	2	2	0
Lockheed C-141 Starlifter	1	1	0
Lockheed P-3 Orion ANP:P3A	1	1	0
Maule MT-7-235	2	2	0
Mitsubishi MU-2	3	3	0
Mitsubishi MU-300 Diamond	1	1	0
Mooney M20-K	3	3	0
MRJ90	1	1	0
Partenavia P.68 Victor	1	1	0
Piaggio P.180 Avanti	2	2	0
Pilatus PC-12	7	7	0
Pilatus PC-6 Porter	1	1	0
Pilatus Turbo Trainer PC-9	1	1	0
Piper PA-23 Apache/Aztec	3	3	0
Piper PA-24 Comanche	3	3	0
Piper PA-28 Cherokee Series	7	7	0
Piper PA-30 Twin Comanche	1	1	0
Piper PA-31 Navajo	1	1	0
Piper PA-31T Cheyenne	2	2	0
Piper PA-32 Cherokee Six	2	2	0
Piper PA-34 Seneca	3	3	0
Piper PA-42 Cheyenne Series	1	1	0
Piper PA46-TP Meridian	4	4	0
Raytheon Beech 18	5	5	0
Raytheon Beech 1900-C	2	2	0
Raytheon Beech 1900-D	1	1	0

Table B-14. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Raytheon Beech 55 Baron	3	3	0
Raytheon Beech 60 Duke	1	1	0
Raytheon Beech 99	1	1	0
Raytheon Beech Baron 58	1	1	0
Raytheon Beech Bonanza 36	3	3	0
Raytheon Beechjet 400	3	3	0
Raytheon Hawker 800	8	8	0
Raytheon King Air 100	1	1	0
Raytheon King Air 90	4	4	0
Raytheon Premier I	2	2	0
Raytheon Super King Air 200	9	9	0
Raytheon Super King Air 300	6	6	0
Robinson R22	3	3	0
Robinson R44 Raven / Lycoming O-540-F1B5	1	1	0
Rockwell 1121 Jet Commander	1	1	0
Rockwell 1121B Jet Commander-B	1	1	0
Rockwell Commander 500	1	1	0
Rockwell Commander 690	1	1	0
Rockwell Sabreliner 40	1	1	0
Rockwell Sabreliner 65	1	1	0
Saab 2000	1	1	0
Shorts 330	1	1	0
Sikorsky CH-53 Sea Stallion	2	2	0
Sikorsky S-76 Spirit	1	1	0
Sikorsky UH-60 Black Hawk	1	1	0
SOCATA TBM 850	1	1	0
T-38 Talon	1	1	0

After the controlled inventory was developed by applying the airport level APU and GSE control strategies to the uncontrolled inventory, ERG compared the two inventories to confirm the control strategies were incorporated correctly. Table B-15 shows the difference in NO_X emissions between the controlled and uncontrolled 2017 inventories.

> **No changes were required based on this QA check as the differences between the uncontrolled and controlled estimates reflected an expected decline in emissions.**

Table B-15. Comparison of Controlled and Uncontrolled 2017 Emissions

Airport	Uncontrolled 2017 NO_X Emissions (tons)	Controlled 2017 NO_X Emissions (tons)	Percent Change (%)
Abilene Rgnl	114.95	114.79	-0.14
Austin-Bergstrom Intl	731.96	730.92	-0.14
Corpus Christi Intl	381.53	380.70	-0.22
Curtis Field	1.03	0.99	-4.03
El Paso Intl	326.29	321.10	-1.59
George Bush Intercontinental/Houston	2,336.08	2,279.82	-2.41
Lubbock Preston Smith Intl	125.77	124.01	-1.40
Rick Husband Amarillo Intl	340.33	338.14	-0.64
San Angelo Rgnl/Mathis Field	7.70	7.33	-4.77
San Antonio Intl	634.50	620.77	-2.17
Valley Intl	225.23	222.25	-1.33
William P Hobby	561.04	543.25	-3.17
		Average	**-1.83**

ERG performed the same comparison checks for 2020 as was done for 2017. The new 2020 statewide inventory (projected from the new 2017 baseline inventories) was compared to the previous 2020 inventory (developed from the Trend Analysis using the 2014 as the baseline). As expected, Tables B-16 to B-19 show differences/trends that are very similar to those seen in Tables B-10 to B-13. The small differences are due to the fact that the previous and recently projected 2020 inventories used factors based on the TAF data which have been updated since the 2014 inventory. ERG also confirmed that the aircraft used in the 2020 inventories matched the original aircraft used in the 2017 baseline as noted in Table B-20. Table B-21 shows the difference in NO_X emissions between the controlled and uncontrolled 2020 inventories, similar to Table B-15 for 2017.

No changes were required based on this QA check.

Table B-16. Counties with the Highest Absolute Percent Changes in Emissions

County	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	111.89	0.31	36,331	13,303	4,308	209
Karnes	19.23	0.08	22,690	3,089	1,294	139
Victoria	264.03	2.39	10,966	31,957	30,540	5
Culberson	1.13	0.02	5,091	416	362	15
Wichita	552.44	10.92	4,960	80,959	75,272	8
Aransas	129.28	3.02	4,181	24,102	41,209	-42
Reeves	36.75	0.96	3,745	11,916	10,866	10
Angelina	23.86	0.66	3,539	29,507	9,547	209
Walker	24.16	0.80	2,933	14,960	10,848	38
Atascosa	6.35	0.26	2,356	4,888	3,380	45
La Salle	12.87	0.53	2,327	5,825	6,351	-8
Calhoun	8.77	0.36	2,322	6,425	5,084	26
Guadalupe	35.61	1.83	1,845	36,353	25,322	44
Matagorda	9.11	0.60	1,432	10,611	8,459	25
Howard	7.03	0.46	1,413	11,816	6,650	78
Coryell	2.18	0.16	1,292	7,615	2,355	223
Nueces	382.57	31.09	1,130	57,961	40,471	43
McLennan	142.56	12.30	1,059	101,910	68,799	48

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors.

Table B-17. Airports with the Highest Absolute Percent Changes in Emissions Within the Previously Identified Counties.

County	Airport	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from Trends Analysis[a]	Emissions Percent Change (%)*	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from Trends Analysis[a]	LTO Percent Change (%)
Nueces	John R. Armstrong Memorial Field	0.02	0.000034	55,632	274	1	26,346
Jim Wells	Alice Intl	111.89	0.31	36,343	13,300	4,305	209
Karnes	Karnes County	19.22	0.07	26,580	2,836	1,050	170
Victoria	Victoria Rgnl	263.83	2.20	11,917	29,537	28,210	5
Matagorda	Palacios Muni	8.34	0.11	7,549	3,530	1,480	139
Culberson	Culberson County	1.13	0.02	6,108	300	250	20
Wichita	Sheppard AFB/Wichita Falls Muni	549.62	9.36	5,773	52,407	52,931	-1
Aransas	Aransas Co	129.27	3.02	4,185	24,000	41,110	-42
McLennan	TSTC Waco	84.08	2.07	3,970	50,287	29,084	73
Calhoun	Calhoun County	8.62	0.22	3,830	4,350	3,084	41
Reeves	Pecos Muni	36.74	0.95	3,759	11,800	10,755	10
Angelina	Angelina County	23.84	0.64	3,642	29,200	9,250	216
Walker	Huntsville Muni	24.15	0.79	2,967	14,807	10,701	38
Atascosa	Pleasanton Muni	6.34	0.25	2,474	4,640	3,140	48
La Salle	Cotulla-La Salle County	12.86	0.52	2,367	5,539	6,075	-9
Guadalupe	New Braunfels Muni	35.27	1.50	2,252	30,615	19,799	55
Howard	Big Spring Mc Mahon-Wrinkle	7.02	0.46	1,432	11,760	6,596	78
Coryell	Gatesville Muni	2.17	0.14	1,406	7,350	2,100	250
Nueces	Corpus Christi Intl	381.89	30.42	1,155	48,145	30,797	56

* Percent change greater than 1,000%

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table B-18. SCCs With the Highest Absolute Percent Change in Emissions Within the Previously Identified Airport/County Combinations.

County	Airport	SCC**	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)*	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Jim Wells	Alice Intl	2275001000	111.67	0.08	141,250	10,000	1,000	900
Angelina	Angelina County	2275001000	21.27	0.02	107,571	1,904	250	662
Guadalupe	New Braunfels Muni	2275001000	33.24	0.10	34,372	2,977	1,220	144
Nueces	Corpus Christi Intl	2275001000	358.33	1.14	31,378	32,089	14,409	123
McLennan	TSTC Waco	2275001000	81.10	0.42	19,075	7,263	5,354	36
Nueces	John R. Armstrong Memorial Field	2275050011	0.01	0.00	18,989	198	1	18,989
Victoria	Victoria Rgnl	2275001000	262.95	1.68	15,584	23,548	21,222	11
Reeves	Pecos Muni	2275001000	35.93	0.23	15,448	3,218	2,925	10
La Salle	Cotulla-La Salle County	2275001000	12.28	0.08	15,448	1,100	1,000	10
Atascosa	Pleasanton Muni	2275001000	6.03	0.04	14,035	540	540	0
Calhoun	Calhoun County	2275001000	8.37	0.06	14,035	750	750	0
Howard	Big Spring Mc Mahon-Wrinkle	2275001000	6.25	0.04	14,035	560	560	0
Matagorda	Palacios Muni	2275001000	8.15	0.06	14,035	730	730	0
Culberson	Culberson County	2275001000	1.12	0.01	14,035	100	100	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275001000	545.44	3.86	14,035	48,846	48,846	0
Walker	Huntsville Muni	2275001000	23.24	0.16	14,032	2,082	2,082	0
Aransas	Aransas Co	2275001000	128.42	1.28	9,903	11,500	16,250	-29

*High percent change due to updates to Military EF update

**Military LTOs were all generic

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission

Table B-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Dallas/Fort Worth Intl	2275050012	6.56	0.98	570	8,891.83	850.36	946
Tarrant	Dallas/Fort Worth Intl	2275060012	75.29	2.18	3,347	14,941.21	8,774.03	70
Tarrant	Dallas/Fort Worth Intl	2275020000	5,231.63	3,825.47	37	335,181.92	378,710.16	-11
Harris	George Bush Intercontinental/Houston	2275020000	2,260.41	1,590.24	42	186,164.88	221,363.95	-16
Harris	George Bush Intercontinental/Houston	2275050012	0.41	2.56	-84	1,834.80	2,678.59	-32
Harris	George Bush Intercontinental/Houston	2275060011	0.57	0.02	2,998	7,170.37	1,137.80	530
Harris	George Bush Intercontinental/Houston	2275001000	2.59	0.76	242	236.17	907.02	-74
Harris	George Bush Intercontinental/Houston	2275050011	0.14	0.01	1,407	4,372.14	537.33	714
Harris	George Bush Intercontinental/Houston	2275060012	125.54	201.37	-38	55,307.21	97,343.26	-43
Dallas	Dallas Love Field	2275060011	0.25	1.14	-78	3,172.20	6,499.51	-51
Dallas	Dallas Love Field	2275020000	694.46	467.29	49	73,180.34	58,786.55	24
Dallas	Dallas Love Field	2275060012	4.11	15.15	-73	10,542.23	12,346.76	-15
Dallas	Dallas Love Field	2275050012	1.95	32.55	-94	9,120.67	20,613.91	-56
Dallas	Dallas Love Field	2275001000	6.06	1.03	489	543.00	2,308.35	-76
Dallas	Dallas Love Field	2275050011	0.69	0.13	455	21,339.80	1,376.04	1,451
Harris	William P Hobby	2275060012	4.94	21.46	-77	9,868.73	19,046.89	-48
Harris	William P Hobby	2275060011	0.22	0.01	1,954	2,753.67	955.33	188
Harris	William P Hobby	2275001000	5.45	0.11	4,679	488.50	1,670.42	-71
Harris	William P Hobby	2275020000	551.77	561.68	-2	64,614.55	89,460.73	-28
Harris	William P Hobby	2275050012	1.77	12.88	-86	8,799.00	16,266.61	-46
Harris	William P Hobby	2275050011	0.70	0.05	1,256	21,589.26	735.39	2,836
Travis	Austin-Bergstrom Intl	2275050011	0.21	0.08	170	7,550.22	1,724.90	338

Table B-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Travis	Austin-Bergstrom Intl	2275060011	0.00	0.59	-100	2.01	7,907.31	-100
Travis	Austin-Bergstrom Intl	2275050012	31.11	12.73	144	21,953.40	14,750.63	49
Travis	Austin-Bergstrom Intl	2275060012	1.37	10.35	-87	599.36	14,000.77	-96
Travis	Austin-Bergstrom Intl	2275020000	759.99	790.99	-4	74,189.57	91,126.04	-19
Travis	Austin-Bergstrom Intl	2275001000	0.08	0.09	-12	90.00	72.06	25
Denton	Northwest Rgnl	2275060012	0.08	0.18	-54	208.89	454.60	-54
Denton	Northwest Rgnl	2275050011	2.97	2.86	4	91,319.17	87,886.42	4
Denton	Northwest Rgnl	2275050012	0.09	0.09	4	585.61	563.37	4
Denton	Northwest Rgnl	2275060011	0.00	0.01	-54	58.34	127.86	-54
Tarrant	Fort Worth Meacham Intl	2275050012	3.63	2.12	71	22,259.68	13,049.60	71
Tarrant	Fort Worth Meacham Intl	2275060012	1.78	1.57	13	4,602.18	4,054.93	13
Tarrant	Fort Worth Meacham Intl***	2275001000	7.96	0.03	29,650	712.50	338.53	110
Tarrant	Fort Worth Meacham Intl	2275050011	1.87	1.10	71	57,521.36	33,715.51	71
Tarrant	Fort Worth Meacham Intl	2275060011	0.10	0.09	13	1,281.93	1,130.53	13
Tarrant	Fort Worth Meacham Intl	2275020000	0.93	0.28	230	96.33	30.58	215
Bexar	San Antonio Intl	2275050012	1.07	10.97	-90	6,250.65	11,538.62	-46
Bexar	San Antonio Intl	2275050011	0.52	0.08	582	16,052.34	1,303.77	1,131
Bexar	San Antonio Intl	2275020000	646.78	570.05	13	50,638.77	56,139.66	-10
Bexar	San Antonio Intl***	2275001000	26.96	1.15	2,250	2,416.00	714.30	238
Bexar	San Antonio Intl	2275060012	3.63	17.87	-80	8,133.90	14,118.42	-42
Bexar	San Antonio Intl	2275060011	0.18	0.61	-71	2,229.44	5,121.47	-56
Collin	Collin County Rgnl At Mc Kinney	2275050011	1.67	0.35	380	51,321.69	10,700.21	380

Table B-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Collin	Collin County Rgnl At Mc Kinney	2275060012	0.48	0.23	104	1,226.96	601.72	104
Collin	Collin County Rgnl At Mc Kinney	2275060011	0.03	0.01	104	342.04	167.54	104
Collin	Collin County Rgnl At Mc Kinney	2275050012	3.21	6.21	-48	19,859.57	38,383.47	-48
Collin	Collin County Rgnl At Mc Kinney***	2275001000	0.25	0.00	19,357	22.50	16.35	38
Potter	Rick Husb+ Amarillo Intl	2275050011	0.56	0.25	126	17,370.08	7,677.11	126
Potter	Rick Husb+ Amarillo Intl	2275050012	1.11	0.48	131	6,726.58	2,972.68	126
Potter	Rick Husb+ Amarillo Intl	2275020000	47.75	34.03	40	7,997.10	7,368.16	9
Potter	Rick Husb+ Amarillo Intl***	2275001000	275.54	0.89	30,724	24,675.36	11,315.21	118
Potter	Rick Husb+ Amarillo Intl	2275060012	12.24	1.70	619	7,174.79	4,388.25	64
Potter	Rick Husb+ Amarillo Intl	2275060011	0.09	0.10	-5	1,166.53	1,222.34	-5
Denton	Denton Muni	2275060012	0.30	0.32	-6	767.19	814.77	-6
Denton	Denton Muni	2275060011	0.02	0.02	-5	214.86	227.28	-5
Denton	Denton Muni	2275050011	1.49	0.59	153	45,904.02	18,111.38	153
Denton	Denton Muni	2275020000	0.11	0.17	-37	11.03	18.23	-39
Denton	Denton Muni***	2275001000	1.17	0.01	11,847	105.11	124.36	-15
Denton	Denton Muni	2275050012	2.88	10.52	-73	17,763.14	64,970.05	-73
Harris	David Wayne Hooks Memorial	2275050011	1.29	1.97	-35	39,543.91	60,695.05	-35
Harris	David Wayne Hooks Memorial	2275060012	0.52	0.72	-28	1,340.35	1,862.10	-28
Harris	David Wayne Hooks Memorial	2275060011	0.03	0.04	-23	398.59	519.15	-23
Harris	David Wayne Hooks Memorial***	2275001000	8.19	0.11	7,446	733.50	1,374.04	-47
Harris	David Wayne Hooks Memorial	2275050012	2.59	3.80	-32	15,400.85	23,487.17	-34
Harris	David Wayne Hooks Memorial	2275020000	0.02	0.02	-3	2.00	2.07	-3

Table B-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Tarrant	Fort Worth Alliance	2275050012	2.06	2.07	-1	12,399.42	12,800.31	-3
Tarrant	Fort Worth Alliance	2275020000	244.31	71.45	242	5,093.82	2,993.07	70
Tarrant	Fort Worth Alliance	2275060012	0.77	2.42	-68	1,089.07	2,681.27	-59
Tarrant	Fort Worth Alliance	2275050011	1.04	1.07	-3	32,041.14	33,073.49	-3
Tarrant	Fort Worth Alliance***	2275001000	68.88	0.69	9,911	6,168.50	8,709.74	-29
Williamson	Georgetown Muni***	2275001000	2.57	0.01	34,649	230.50	93.76	146
Williamson	Georgetown Muni	2275060011	0.01	0.00	64	101.81	62.17	64
Williamson	Georgetown Muni	2275050012	2.48	4.79	-48	15,314.97	29,602.18	-48
Williamson	Georgetown Muni	2275060012	0.14	0.09	64	365.19	222.17	64
Williamson	Georgetown Muni	2275050011	1.29	0.27	380	39,577.41	8,252.04	380
Harris	West Houston	2275060011	0.01	0.01	-8	109.00	118.68	-8
Harris	West Houston	2275050012	2.44	2.58	-5	15,067.53	15,942.70	-5
Harris	West Houston	2275050011	1.27	1.34	-5	38,937.97	41,200.38	-5
Harris	West Houston	2275060012	0.15	0.17	-8	391.00	425.73	-8
El Paso	El Paso Intl	2275060012	7.95	3.39	134	6,704.98	8,830.89	-24
El Paso	El Paso Intl	2275020000	201.89	211.12	-4	18,621.34	22,263.04	-16
El Paso	El Paso Intl	2275060011	0.11	0.19	-39	1,361.63	2,383.46	-43
El Paso	El Paso Intl***	2275001000	117.10	0.31	37,377	10,487.00	3,893.96	169
El Paso	El Paso Intl	2275050012	0.82	1.05	-22	4,712.86	6,216.39	-24
El Paso	El Paso Intl	2275050011	0.40	0.52	-24	12,174.09	15,956.20	-24
Wichita	Sheppard AFB/Wichita Falls Muni	2275020000	0.38	5.32	-93	34.00	1,405.00	-98
Wichita	Sheppard AFB/Wichita Falls Muni***	2275001000	545.44	3.86	14,035	48,845.50	48,846.00	0

Table B-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Wichita	Sheppard AFB/Wichita Falls Muni	2275050011	0.06	0.06	0	1,932.28	1,932.00	0
Wichita	Sheppard AFB/Wichita Falls Muni	2275050012	0.12	0.12	0	747.72	748.00	0
Bexar	Stinson Muni	2275020000	0.02	0.01	94	2.00	1.03	94
Bexar	Stinson Muni	2275060012	0.52	0.62	-16	1,329.79	1,589.50	-16
Bexar	Stinson Muni	2275050011	1.05	0.86	22	32,441.98	26,536.45	22
Bexar	Stinson Muni	2275060011	0.03	0.03	-16	370.71	442.79	-16
Bexar	Stinson Muni	2275050012	2.03	1.66	22	12,553.83	10,268.81	22
Bexar	Stinson Muni***	2275001000	47.97	0.41	11,645	4,296.00	5,170.01	-17
Mclennan	TSTC Waco***	2275001000	81.10	0.42	19,075	7,263.00	5,353.97	36
Mclennan	TSTC Waco	2275050012	1.94	1.07	81	11,995.49	6,613.60	81
Mclennan	TSTC Waco	2275020000	0.02	0.01	97	2.00	1.01	97
Mclennan	TSTC Waco	2275060011	0.00	0.00	16	5.89	5.07	16
Mclennan	TSTC Waco	2275050011	1.01	0.56	81	30,999.10	17,092.33	81
Mclennan	TSTC Waco	2275060012	0.01	0.01	16	21.11	18.26	16
Medina	Hondo Muni	2275050012	2.23	2.31	-4	13,752.33	14,274.40	-4
Medina	Hondo Muni	2275050011	1.16	1.20	-4	35,539.17	36,887.60	-4
Dallas	Addison	2275020000	0.49	1.14	-57	51.38	114.14	-55
Dallas	Addison	2275060012	1.09	1.37	-21	2,805.43	3,544.60	-21
Dallas	Addison	2275050011	1.06	1.04	1	32,511.99	32,114.15	1
Dallas	Addison	2275060011	0.06	0.08	-21	782.08	987.84	-21
Dallas	Addison***	2275001000	1.80	0.01	12,084	161.00	186.78	-14
Dallas	Addison	2275050012	2.05	2.01	2	12,580.92	12,426.86	1

Table B-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

County	Airport*	SCC	2020 NO_X Emissions (tons) w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 NO_X Emissions (tons) w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	Emissions Percent Change (%)**	2020 LTO w/ AEDT + Revised Emission Factors from the 2017 Inventory Effort	2020 LTO w/ EDMS + Previous Emission Factors from the Trends Analysis[a]	LTO Percent Change (%)
Nueces	Corpus Christi Intl	2275060011	0.06	0.08	-34	700.08	1,058.16	-34
Nueces	Corpus Christi Intl***	2275001000	358.33	1.14	31,378	32,089.00	14,409.46	123
Nueces	Corpus Christi Intl	2275060012	3.96	1.47	169	3,245.05	3,797.79	-15
Nueces	Corpus Christi Intl	2275020000	18.95	26.83	-29	3,388.41	4,815.58	-30
Nueces	Corpus Christi Intl	2275050011	0.20	0.05	330	6,288.36	1,464.04	330
Nueces	Corpus Christi Intl	2275050012	0.39	0.85	-54	2,434.34	5,251.48	-54
Tarrant	Gr+ Prairie Muni	2275050012	2.06	1.44	43	12,731.55	8,913.87	43
Tarrant	Gr+ Prairie Muni***	2275001000	21.22	0.24	8,577	1,900.00	3,095.25	-39
Tarrant	Gr+ Prairie Muni	2275060012	0.03	0.01	104	72.73	35.66	104
Tarrant	Gr+ Prairie Muni	2275050011	1.07	0.75	43	32,901.24	23,035.04	43
Tarrant	Gr+ Prairie Muni	2275060011	0.00	0.00	99	20.27	10.19	99
Brazoria	Pearl+ Rgnl	2275050012	2.12	2.28	-7	13,067.10	14,078.15	-7
Brazoria	Pearl+ Rgnl	2275060012	0.07	0.08	-11	175.95	196.87	-11
Brazoria	Pearl+ Rgnl	2275050011	1.10	1.18	-7	33,768.40	36,382.17	-7
Brazoria	Pearl+ Rgnl	2275060011	0.00	0.00	-11	49.05	54.81	-11
Webb	Laredo Intl	2275050012	1.08	0.36	201	5,756.82	2,170.40	165
Webb	Laredo Intl	2275050011	0.48	0.02	2,369	14,875.67	602.55	2,369
Webb	Laredo Intl	2275060011	0.05	0.01	650	686.96	92.47	643
Webb	Laredo Intl	2275020000	68.14	44.12	54	3,270.73	6,040.74	-46
Webb	Laredo Intl***	2275001000	201.74	0.22	90,693	18,070.00	2,539.24	612
Webb	Laredo Intl	2275060012	6.68	0.13	5,076	4,015.39	335.31	1,097
Harris	Ellington Field***	2275001000	137.16	9.15	1,398	12,283.00	13,567.46	-9

Table B-19. Airport/SCC Combinations Within the Top 26 Airports the Highest Activity.

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Harris	Ellington Field	2275050011	0.68	0.05	1,210	20,809.14	2,356.89	783
Harris	Ellington Field	2275060012	1.30	7.11	-82	3,329.80	16,545.80	-80
Harris	Ellington Field	2275060011	0.07	0.08	-9	927.70	7,268.07	-87
Harris	Ellington Field	2275020000	9.40	19.84	-53	996.50	7,582.27	-87
Harris	Ellington Field	2275050012	1.30	4.05	-68	8,052.36	6,282.52	28
		Total	**13,013**	**8,673**	**50**	**2,176,811**	**2,183,522**	**-0.31**

*Airports with total aircraft LTO's greater than 45,000

** High percent change due to updates to Military EF update

***Military LTOs were all generic

a. Trend Analysis was based on the 2014 baseline inventory using EDMS and older EPA generic emission factors

Table B-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Aerostar PA-60	2	2	0
Agusta A-109	2	2	0
Air Tractor 802	1	1	0
Air Tractor AT-502	1	1	0
Air Tractor AT-502B	1	1	0
Air Tractor AT-602	1	1	0
Airbus A300B2-100 Series	1	1	0
Airbus A300B2-200 Series	1	1	0
Airbus A300B4-600 Series	2	2	0
Airbus A300F4-600 Series	8	8	0
Airbus A310-200 Series	6	6	0
Airbus A310-300 Series	1	1	0
Airbus A319-100 Series	14	14	0
Airbus A320-100 Series	1	1	0
Airbus A320-200 Series	13	13	0
Airbus A321-100 Series	10	10	0
Airbus A321-200 Series	1	1	0
Airbus A330-200 Series	2	2	0
Airbus A330-200 Series Freighter	1	1	0
Airbus A330-300 Series	3	3	0
Airbus A340-200 Series	1	1	0
Airbus A350-800 Series	1	1	0
Airbus A350-900 series	1	1	0
Airbus A380-800 Series/Trent 970	2	2	0
Antonov 12 Cub	1	1	0
Antonov 124 Ruslan	3	3	0
Antonov AN28 Cash	1	1	0
ATR 42-200	4	4	0
ATR 42-320	1	1	0
ATR 72-200	4	4	0
Aviat Husky A1B	2	2	0
Ayres S2R-T34 Turbo-Thrush	1	1	0
BAE Jetstream 31	4	4	0
BAE Jetstream 32	1	1	0
BAE Jetstream 32-EP	1	1	0
BAE Jetstream 41	4	4	0
Bell 206 JetRanger	2	2	0
Bell 407 / Rolls-Royce 250-C47B	2	2	0

Table B-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Bell UH-1 Iroquois	1	1	0
Boeing 717-200 Series	5	5	0
Boeing 727-100 Series	1	1	0
Boeing 727-200 Series	13	13	0
Boeing 737-100 Series	12	12	0
Boeing 737-200 Series	1	1	0
Boeing 737-300 Series	16	16	0
Boeing 737-300 Series Freighter	1	1	0
Boeing 737-400 Series	22	22	0
Boeing 737-400 Series Freighter	1	1	0
Boeing 737-500 Series	2	2	0
Boeing 737-600 Series	2	2	0
Boeing 737-700 Series	20	20	0
Boeing 737-800 Series	23	23	0
Boeing 737-800 with winglets	1	1	0
Boeing 737-900 Series	15	15	0
Boeing 737-900-ER	6	6	0
Boeing 747-200 Series	13	13	0
Boeing 747-400 Series	4	4	0
Boeing 747-400 Series Freighter	3	3	0
Boeing 747-800 Freighter	3	3	0
Boeing 757-200 Series	1	1	0
Boeing 757-200 Series Freighter	1	1	0
Boeing 757-300 Series	3	3	0
Boeing 767-200 ER	10	10	0
Boeing 767-200 Series	1	1	0
Boeing 767-300 ER	12	12	0
Boeing 767-300 ER Freighter	1	1	0
Boeing 767-400 ER	4	4	0
Boeing 777-200 Series	6	6	0
Boeing 777-200-LR	2	2	0
Boeing 777-300 ER	2	2	0
Boeing 777-300 Series	1	1	0
Boeing 787-900 Dreamliner	5	5	0
Boeing DC-10-10 Series	6	6	0
Boeing DC-10-30 Series	5	5	0
Boeing DC-10-40 Series	1	1	0
Boeing DC-6	1	1	0

Table B-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Boeing DC-8 Series 60	2	2	0
Boeing DC-9-10 Series	1	1	0
Boeing DC-9-20 Series	17	17	0
Boeing DC-9-30 Series	12	12	0
Boeing F/A-18 Hornet	1	1	0
Boeing MD-11	5	5	0
Boeing MD-11-ER	1	1	0
Boeing MD-82	23	23	0
Boeing MD-83	1	1	0
Boeing MD-88	3	3	0
Boeing MD-90	6	6	0
Bombardier Challenger 300	16	16	0
Bombardier Challenger 600	3	3	0
Bombardier Challenger 601	3	3	0
Bombardier Challenger 604	5	5	0
Bombardier CL-415	1	1	0
Bombardier CRJ-200	19	19	0
Bombardier CRJ-700	24	24	0
Bombardier CRJ-900	16	16	0
Bombardier Global Express	17	17	0
Bombardier Learjet 24	1	1	0
Bombardier Learjet 25	1	1	0
Bombardier Learjet 31	3	3	0
Bombardier Learjet 35	2	2	0
Bombardier Learjet 40	2	2	0
Bombardier Learjet 45	3	3	0
Bombardier Learjet 55	2	2	0
Bombardier Learjet 60	3	3	0
CASA 295	1	1	0
CASA CN-235-100	1	1	0
Cessna 150 Series	3	3	0
Cessna 172 Skyhawk	9	9	0
Cessna 182	3	3	0
Cessna 206	2	2	0
Cessna 208 Caravan	13	13	0
Cessna 210 Centurion	4	4	0
Cessna 310	2	2	0
Cessna 337 Skymaster	2	2	0

Table B-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Cessna 340	2	2	0
Cessna 402	1	1	0
Cessna 414	3	3	0
Cessna 421 Golden Eagle	2	2	0
Cessna 425 Conquest I	2	2	0
Cessna 441 Conquest II	1	1	0
Cessna 500 Citation I	2	2	0
Cessna 501 Citation ISP	8	8	0
Cessna 525 CitationJet	3	3	0
Cessna 525A CitationJet	1	1	0
Cessna 525B CitationJet	1	1	0
Cessna 525C CitationJet	1	1	0
Cessna 550 Citation II	2	2	0
Cessna 560 Citation Excel	4	4	0
Cessna 560 Citation V	1	1	0
Cessna 560 Citation XLS	1	1	0
Cessna 650 Citation III	6	6	0
Cessna 680 Citation Sovereign	3	3	0
Cessna 750 Citation X	4	4	0
Cirrus SR20	2	2	0
Cirrus SR22	3	3	0
Convair CV-440	10	10	0
Convair CV-580	1	1	0
Dassault Falcon 10	15	15	0
Dassault Falcon 200	1	1	0
Dassault Falcon 2000	2	2	0
Dassault Falcon 2000-EX	5	5	0
Dassault Falcon 50	3	3	0
Dassault Falcon 900	1	1	0
Dassault Falcon 900-EX	1	1	0
DeHavilland DHC-2 Mk III Beaver	1	1	0
DeHavilland DHC-3 Otter	1	1	0
DeHavilland DHC-6-100 Twin Otter	1	1	0
Dornier 228-100 Series	1	1	0
Dornier 328 Jet	1	1	0
EADS Socata TB-10 Tobago	1	1	0
EADS Socata TB-20 Trinidad	1	1	0
EADS Socata TBM-700	2	2	0

Table B-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Eclipse 500 / PW610F	2	2	0
Embraer 500	3	3	0
Embraer 505	2	2	0
Embraer EMB120 Brasilia	6	6	0
Embraer ERJ135	13	13	0
Embraer ERJ135 Legacy Business	1	1	0
Embraer ERJ135-ER	1	1	0
Embraer ERJ135-LR	1	1	0
Embraer ERJ140	19	19	0
Embraer ERJ145	24	24	0
Embraer ERJ145-EU	1	1	0
Embraer ERJ145-LR	1	1	0
Embraer ERJ145-XR	1	1	0
Embraer ERJ170	11	11	0
Embraer ERJ175	24	24	0
Embraer ERJ175-LR	1	1	0
Embraer ERJ190	4	4	0
Embraer ERJ195	1	1	0
Fairchild SA-226-T Merlin III	1	1	0
Fairchild SA-226-TC Metro II	1	1	0
Fairchild SA-227-AC Metro III	1	1	0
Fairchild SA-26-T Merlin II	1	1	0
Falcon 7X	5	5	0
Grumman A-6 Intruder	1	1	0
Grumman G-21G Goose	1	1	0
Grumman G-73 Mallard	1	1	0
Gulfstream G100	1	1	0
Gulfstream G150	8	8	0
Gulfstream G200	7	7	0
Gulfstream G280	1	1	0
Gulfstream G300	1	1	0
Gulfstream G350	1	1	0
Gulfstream G400	1	1	0
Gulfstream G450	3	3	0
Gulfstream G550	7	7	0
Gulfstream I	1	1	0
Gulfstream II	1	1	0
Gulfstream II-B	1	1	0

Table B-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Gulfstream IV-SP	1	1	0
Gulfstream V-SP	1	1	0
Hawker HS-125 Series 1	3	3	0
Hawker HS-125 Series 400	1	1	0
Hawker HS-125 Series 600	1	1	0
Hughes 500D	2	2	0
Ilyushin 76 Candid	2	2	0
Israel IAI-1124 Westwind I	1	1	0
Israel IAI-1124-A Westwind II	2	2	0
Israel IAI-1125 Astra	1	1	0
Lancair 360	1	1	0
Let 410	1	1	0
Lockheed C-130 Hercules	2	2	0
Lockheed C-141 Starlifter	1	1	0
Lockheed P-3 Orion ANP:P3A	1	1	0
Maule MT-7-235	2	2	0
Mitsubishi MU-2	3	3	0
Mitsubishi MU-300 Diamond	1	1	0
Mooney M20-K	3	3	0
MRJ90	1	1	0
Partenavia P.68 Victor	1	1	0
Piaggio P.180 Avanti	2	2	0
Pilatus PC-12	7	7	0
Pilatus PC-6 Porter	1	1	0
Pilatus Turbo Trainer PC-9	1	1	0
Piper PA-23 Apache/Aztec	3	3	0
Piper PA-24 Comanche	3	3	0
Piper PA-28 Cherokee Series	7	7	0
Piper PA-30 Twin Comanche	1	1	0
Piper PA-31 Navajo	1	1	0
Piper PA-31T Cheyenne	2	2	0
Piper PA-32 Cherokee Six	2	2	0
Piper PA-34 Seneca	3	3	0
Piper PA-42 Cheyenne Series	1	1	0
Piper PA46-TP Meridian	4	4	0
Raytheon Beech 18	5	5	0
Raytheon Beech 1900-C	2	2	0
Raytheon Beech 1900-D	1	1	0

Table B-20. Comparison to Confirm All Aircraft Were Included in AEDT Run

Aircraft	AEDT Input Count of Aircraft	AEDT Output Count of Aircraft	Percent Change (%)
Raytheon Beech 55 Baron	3	3	0
Raytheon Beech 60 Duke	1	1	0
Raytheon Beech 99	1	1	0
Raytheon Beech Baron 58	1	1	0
Raytheon Beech Bonanza 36	3	3	0
Raytheon Beechjet 400	3	3	0
Raytheon Hawker 800	8	8	0
Raytheon King Air 100	1	1	0
Raytheon King Air 90	4	4	0
Raytheon Premier I	2	2	0
Raytheon Super King Air 200	9	9	0
Raytheon Super King Air 300	6	6	0
Robinson R22	3	3	0
Robinson R44 Raven / Lycoming O-540-F1B5	1	1	0
Rockwell 1121 Jet Commander	1	1	0
Rockwell 1121B Jet Commander-B	1	1	0
Rockwell Commander 500	1	1	0
Rockwell Commander 690	1	1	0
Rockwell Sabreliner 40	1	1	0
Rockwell Sabreliner 65	1	1	0
Saab 2000	1	1	0
Shorts 330	1	1	0
Sikorsky CH-53 Sea Stallion	2	2	0
Sikorsky S-76 Spirit	1	1	0
Sikorsky UH-60 Black Hawk	1	1	0
SOCATA TBM 850	1	1	0
T-38 Talon	1	1	0

Table B-21. Comparison of Controlled and Uncontrolled 2020 Emissions

Airport	Uncontrolled 2020 NO_X Emissions (tons)	Controlled 2020 NO_X Emissions (tons)	Percent Change (%)
Abilene Rgnl	115.18	115.01	-0.14
Austin-Bergstrom Intl	851.64	850.42	-0.14
Corpus Christi Intl	383.63	382.70	-0.24
Curtis Field	1.03	0.99	-4.03
El Paso Intl	340.98	335.43	-1.63
George Bush Intercontinental/Houston	2519.71	2459.59	-2.39
Lubbock Preston Smith Intl	132.45	130.53	-1.45
Rick Husband Amarillo Intl	342.08	339.83	-0.66
San Angelo Rgnl/Mathis Field	7.49	7.12	-4.91
San Antonio Intl	714.50	698.94	-2.18
Valley Intl	232.09	228.89	-1.38
William P Hobby	611.49	592.07	-3.18
		Average	**-1.86**

E. Reconciliation with User Requirements

ERG applied basic quality assurance/quality control (QA/QC) considerations to conduct this project. As per the requirements of a Category III QAPP, 10% of these estimates were validated by ensuring that the emission estimates for 2011, 2017 and 2020 were consistent with the previous 2011 inventory, the 2017 trend inventories, and the 2020 trend inventories, respectively. Below is a summary of the QA findings:

- Variance between earlier EDMS estimates and output from the FAA's new AEDT model were consistent with the FAA's expectations.
- Elevated activity levels at Sheppard airport appear to be realistic as it is the largest mixed-use Air Force airbase in the U.S.
- Increased air taxi activities in the Dallas/Fort Worth area have been noted by independent data sources.
- Correct application of new EPA generic military emission factors that replace factors that are three decades old.
- Repeal of the Wright Amendment accounted for changes for airports in the Dallas/Fort Worth Area as well as smaller connecting airports in El Paso, Houston, and Austin.

Based on the QA checks one corrective action was required and made:

- Revised the 2011 Hondo Municipal Airport LTO data to use the FAA actual 2011 values from TAF in lieu of the grown 2008 local data using TAF growth rates that were in error.

APPENDIX 13

DALLAS-FORT WORTH MOVES2014A-BASED REASONABLE FURTHER PROGRESS ON-ROAD INVENTORIES AND CONTROL STRATEGY REDUCTIONS FOR 2011, 2017, 2018, 2020, AND 2021

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-Road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021

Collin | Dallas | Denton | Ellis | Johnson
Kaufman | Parker | Rockwall | Tarrant | Wise

August 2018

North Central Texas
Council of Governments

What is NCTCOG?

The North Central Texas Council of Governments is a voluntary association of cities, counties, school districts, and special districts which was established in January 1966 to assist local governments in **planning** for common needs, **cooperating** for mutual benefit, and **coordinating** for sound regional development.

It serves a 16-county metropolitan region centered around the two urban centers of Dallas and Fort Worth. Currently the Council has **236 members**, including 16 counties, 168 cities, 24 independent school districts, and 28 special districts. The area of the region is approximately **12,800 square miles**, which is larger than nine states, and the population of the region is about **7 million** which is larger than 38 states.

NCTCOG's structure is relatively simple; each member government appoints a voting representative from the governing body. These voting representatives make up the **General Assembly** which annually elects a 17-member Executive Board. The **Executive Board** is supported by policy development, technical advisory, and study committees, as well as a professional staff of 350.

NCTCOG's offices are located in Arlington in the Centerpoint Two Building at 616 Six Flags Drive (approximately one-half mile south of the main entrance to Six Flags Over Texas).

North Central Texas Council of Governments
P. O. Box 5888
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NCTCOG's Department of Transportation

Since 1974 NCTCOG has served as the Metropolitan Planning Organization (MPO) for transportation for the Dallas-Fort Worth area. NCTCOG's Department of Transportation is responsible for the regional planning process for all modes of transportation. The department provides technical support and staff assistance to the Regional Transportation Council and its technical committees, which compose the MPO policy-making structure. In addition, the department provides technical assistance to the local governments of North Central Texas in planning, coordinating, and implementing transportation decisions.

Prepared in cooperation with the Texas Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration, and Federal Transit Administration.

Dallas-Fort Worth MOVES2014a-Based Reasonable Further Progress On-Road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021

Collin | Dallas | Denton | Ellis | Johnson
Kaufman | Parker | Rockwall | Tarrant | Wise

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ABSTRACT

TITLE: Dallas-Fort Worth Motor Vehicle Emissions Simulator 2014a (MOVES2014a) – Based Reasonable Further Progress On-Road Inventories and Control Strategy Reductions for 2011, 2017, 2018, 2020, and 2021

DATE: August 2018

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SUBJECT: Reasonable Further Progress

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ABSTRACT:

The North Central Texas Council of Governments conducted a Reasonable Further Progress on-road mobile emissions inventories to support the Texas Commission on Environmental Quality to develop the Reasonable Further Progress State Implementation Plan for the Dallas-Fort Worth 10-county nonattainment area for the pollutant ozone. The 10 nonattainment counties are Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise. This report documents the on-road mobile methodologies applied and estimated emission results for analysis years 2011, 2017,

2018, 2020, and 2021. The estimated emissions are reported for oxides of nitrogen, volatile organic compounds, carbon monoxide, carbon dioxide, sulfur dioxide, ammonia, particulate matter with aerodynamic diameters equal to or less than 2.5 microns, and particulate matter with aerodynamic diameters equal to or less than 10 microns.

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GLOSSARY OF ABBREVIATIONS

ABY	Adjusted Base Year
ASM	Acceleration Simulation Mode
ASWT	Average School Season Weekday
ATR	Automatic Traffic Recorder
CAAA	Clean Air Act Amendments
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DFW	Dallas-Fort Worth
DFX	Dallas-Fort Worth Travel Model for the Expanded Area
EPA	Environmental Protection Agency
GISDK	Geographic Information System Developer Kit
HBW	Home-Based Work
HNW	Home-Based Non-Work
HOV	High Occupancy Vehicle
HPMS	Highway Performance Monitoring System
I/M	Inspection & Maintenance Program
LED	Low Emission Diesel
MPA	Metropolitan Planning Area
MPO	Metropolitan Planning Organization
MOVES2014a	Motor Vehicle Emissions Simulator 2014a
NAAQS	National Ambient Air Quality Standards
NCT	North Central Texas
NCTCOG	North Central Texas Council of Governments
NH_3	Ammonia
NHB	Non-Home Based
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of Nitrogen
NPMRDS	National Performance Management Research Data Set
NSWD	Non-Summer Week Day
O_3	Ozone
OBD	On-board Diagnostic Systems
Pb	Lead
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter 2.5 Microns
PM_{10}	Particulate Matter 10 Microns
ppb	parts per billion
RFG	Reformulated Gasoline
RFP	Reasonable Further Progress
RPM	Revolutions Per Minute
SHI	Source Hours Idling
SHP	Source Hours Parked
SHO	Source Hours Operating
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SUT	Source Use Types
TCEQ	Texas Commission on Environmental Quality
TOD	Time-of-Day
TSZ	Traffic Survey Zone
TTI	Texas Transportation Institute
TxDMV	Texas Department of Motor Vehicles
TxDOT	Texas Department of Transportation
TxLED	Texas Low Emissions Diesel
VDF	Volume Delay Function
VHT	Vehicle Hours of Travel
VMT	Vehicle Miles of Travel
VOC	Volatile Organic Compounds

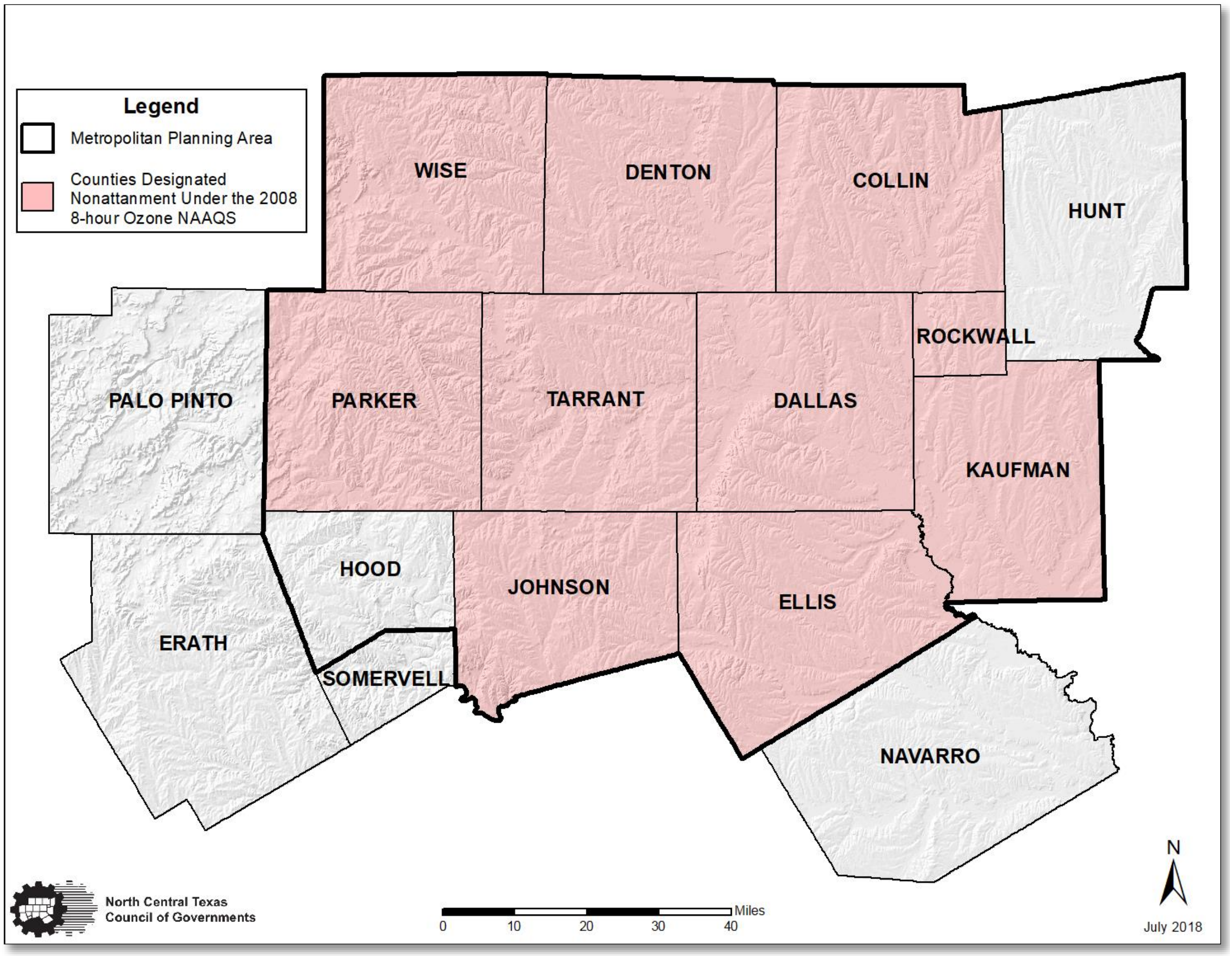
TABLE OF CONTENTS

TABLE OF EXHIBITS

CHAPTER 1: INTRODUCTION

The North Central Texas Council of Governments (NCTCOG) ~~conducted~~ developed emissions inventories to support the Texas Commission on Environmental Quality's (TCEQ) efforts on developing the Reasonable Further Progress (RFP) analysis for the State Implementation Plan (SIP) revision for the 2008 8-Hour Ozone National Ambient Air Quality Standard (NAAQS). The inventory covers the Dallas-Fort Worth (DFW) 10-county area designated by the United States (U.S.) Environmental Protection Agency's (EPA) as nonattainment for the 2008 8-hour ozone standard: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise counties, as shown in Exhibit 1.1. The RFP analysis years include an RFP base, milestone, milestone contingency, attainment, and an attainment contingency year (2011, 2017, 2018, 2020, and 2021, respectively). Pollutants being evaluated are volatile organic compounds (VOC), carbon monoxide, nitrogen oxides (NO_X), carbon dioxide, sulfur dioxide, ammonia, particulate matter with aerodynamic diameters equal to or less than 2.5 microns, and particulate matter with aerodynamic diameters equal to or less than 10 microns.

Exhibit 1.1: Dallas-Fort Worth 10-County Nonattainment Area Map



This report documents the methodology and results of the RFP emissions inventories. Chapter 1 outlines the background, purpose and scope, and modeling approach; and provides a summary of the 10-county estimated emissions totals, activity and control reduction summaries.

Chapter 2 documents the procedures used to develop regional vehicle activity estimates in terms of vehicle miles of travel (VMT) and average vehicle speed. These procedures include development of adjustment factors to more accurately reflect regional conditions. Seasonal and hourly adjustment factors were applied to produce 2011, 2017, 2018, 2020, and 2021 analysis year vehicle activity and report vehicle activity in hourly periods. Consistent with previous emissions inventory practices, a comparison was made between travel demand model VMT estimates and appropriate Highway Performance Monitoring System (HPMS) VMT to develop HPMS adjustment factors. Also, a nonrecurring congestion adjustment was applied to account for vehicle emissions due to traffic accidents not captured in the standard four-step travel modeling process.

Chapter 3 documents the parameters and inputs used to develop on-road mobile source emission factors by utilizing the U.S. EPA's Motor Vehicle Emission Simulator version 2014a (MOVES2014a) model. Regionally specific calculations, procedures, MOVES2014a emission factors, and adjustments are provided to better reflect regional vehicle emissions emitted. The calculations and procedures include source use type age distribution, fuel engine fractions, vehicle registration, hourly VMT, and trip length distribution. Also accounted for are low emission diesel NO_X adjustments and VMT mix.

Chapter 4 documents the 10-county nonattainment area vehicle emission calculation procedure and estimates.

Chapter 5 summarizes emissions of all pollutants by county and analysis years.

The Appendices contains supplemental information, including a table containing all pollutants calculated, and electronic data supporting the DFW RFP Emissions Inventory.

Background

The Clean Air Act Amendments (CAAA) of 1990 requires the EPA to set NAAQS for widespread pollutants considered harmful to public health and the environment. The EPA set NAAQS for six of the principal pollutants; ozone, particulate matter (PM), carbon monoxide, sulfur dioxide, nitrogen dioxide, and lead.

With the signing of the CAAA into law, the four counties of Collin, Dallas, Denton, and Tarrant in the DFW area were designated as nonattainment under the 1-Hour Ozone NAAQS. The law also requires the EPA to periodically review the NAAQS to ensure they provide adequate health and environmental protection, and to update these standards as necessary. Upon completion of a scientific review of the 1-Hour Ozone NAAQS, EPA determined this standard was insufficient to protect human health. As a result, the EPA developed the 1997 8-Hour Ozone NAAQS, <85 parts per billions (ppb), to place greater emphasis on prolonged exposure to pollutants. In April 2004, EPA announced Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant counties comprise the new DFW nine-county nonattainment area for the pollutant ozone under the 1997 8-Hour Ozone NAAQS, with an effective designation date of June 15, 2004. The nine-county nonattainment area received a "Moderate" ozone classification with an attainment date of June 15, 2010. As a result of not reaching attainment by June 2010, the DFW area was classified as "serious" with the new attainment date of June 2013.

On July 20, 2012, the DFW area was reclassified as "moderate" nonattainment for the 2008 8-Hour Ozone NAAQS (≤75 ppb), Wise County was added as the tenth nonattainment county. On December 23, 2014, a District of Columbia Circuit ruled against the EPA, establishing July 20, 2018, as the attainment date for moderate nonattainment areas, which is exactly six years from the official date of designation. This change required the 2015-2017 design value to determine moderate nonattainment area's attainment status. In addition, these areas had to model a 2017 future year under the 75 ppb standard.

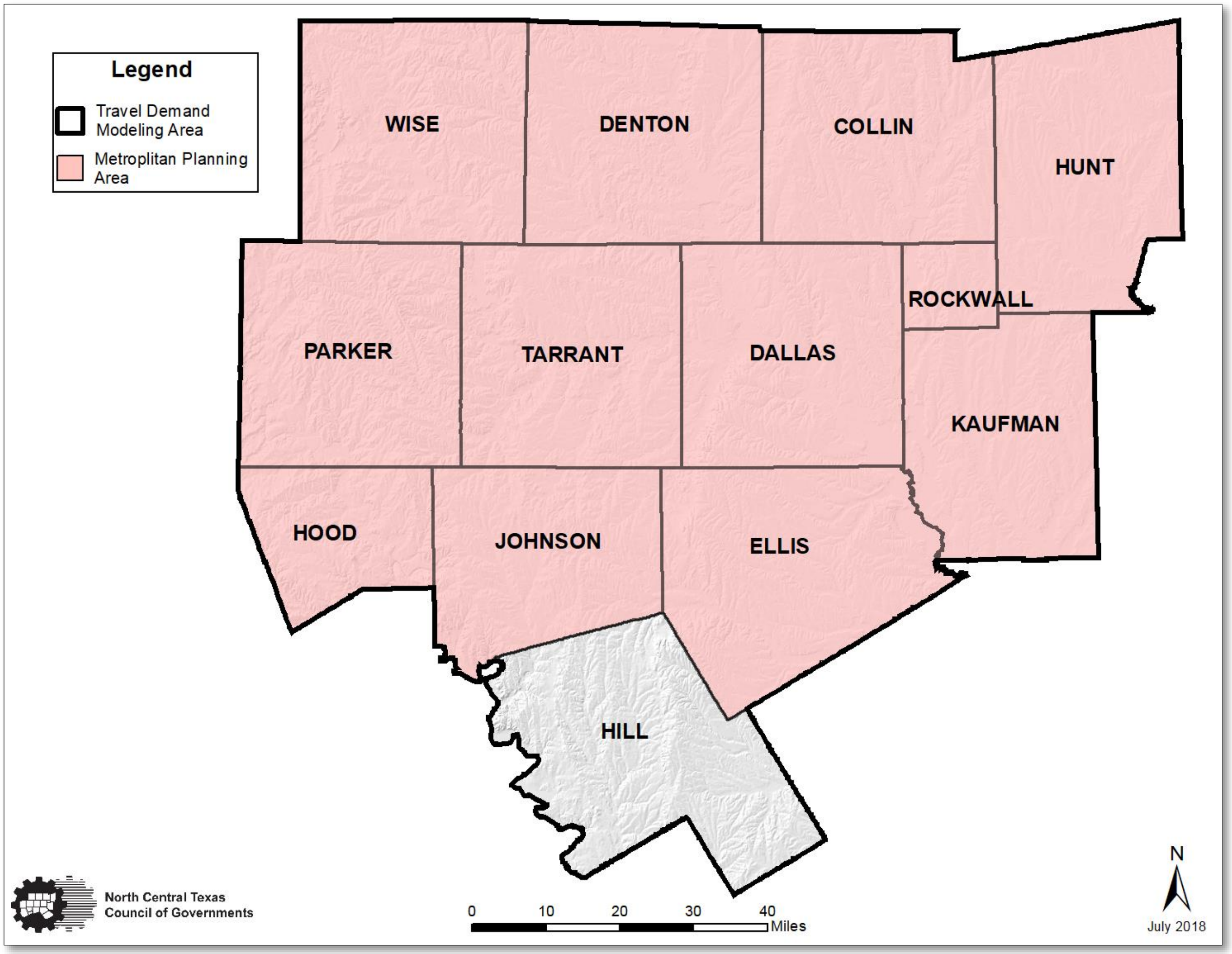
TCEQ, the State's environmental agency, is required under the CAAA to submit SIP revisions documenting the emission of ozone precursors are declining at rates to achieve the NAAQS. The SIP is an air quality plan containing a collection of regulations and measures to reduce emissions from stationary, area, mobile (on-road and non-road) sources, and demonstrate attainment of the air quality standards. The section of the SIP that outlines the plan to achieve these emissions reductions is subsequently defined as the "Reasonable Further Progress" (RFP) plan.

On-road mobile is a key component of the SIP, as a SIP places emission limits on on-road mobile sources. These on-road mobile emission limits are termed motor vehicle emission budgets and have a direct impact on transportation planning. NCTCOG serves as the Metropolitan Planning Organization for transportation in the DFW area and was contracted by the TCEQ to develop on-road mobile source emission inventories for the region consistent with the EPA's requirements for demonstrating RFP. NCTCOG applies a four-step travel demand model process using TransCAD software to forecast regional vehicle activity and utilizes EPA's MOVES2014a with a post-processing application to estimate regional mobile source emissions.

Modeling Approach

The DFW Travel Model for the Expanded Area (DFX) is utilized to estimate VMT and emissions for the 2011, 2017, 2018, 2020, and 2021 analysis years for summer weekday. DFX's modeling domain includes Collin, Dallas, Denton, Ellis, Hill, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise counties. Hill County is not part of the North Central Texas (NCT) Metropolitan Planning Area (MPA) boundary; however, to capture travel from outside areas, Hill County is included in the modeling domain. The NCT 12-county MPA and the 13-county DFX modeling domain is shown in Exhibit 1.2.

Exhibit 1.2: Dallas-Fort Worth Travel Demand Modeling Domain Map



Several components of the model were updated as part of this model expansion. These include improvements to the mode-choice model; vehicle ownership model; external stations; volume-delay-function; transit assignment; and traffic assignment convergence criteria, which are discussed in Chapter 2. Emissions are quantified by grouping control strategy scenarios as a model run. Exhibit 1.3 describes the control strategy scenarios modeled for all the analysis years.

Exhibit 1.3: Emissions Inventory Scenarios Modeled

Reasonable Further Progress Scenarios	Input Files
Adjusted Base Year[2]	ABY
Pre-1990 Federal Motor Vehicle Control Program (FMVCP)	PR90
FMVCP Tier 1 FMVCP Tier 2 FMVCP – Heavy-Duty 2007	FMVCP
Fuel Controls (FC)[3]	FC
Expanded Inspection & Maintenance (I/M)	IM
Texas Low-Emission Diesel[4]	TxLED

[1] In the table above, each scenario contains the control strategies of all previous scenarios.

[2] Base year (2011) VMT is used for all analysis years.

[3] Includes fuel controls (reformulated gasoline and ultra-low-sulfur diesel)

[4] I/M emission factors will be used to estimate TxLED emission benefits.

Final RFP on-road emission estimates by pollutant for summer weekday for each analysis year are shown in Exhibits 1.4 through 1.6. Exhibits 1.7 through 1.9 show the emissions reductions resulting from the application of each control scenario. These emission estimates and reductions are provided for the 10-county 2008 8-hour ozone nonattainment area. The CAAA 182(b)(1) requires moderate areas newly designated as nonattainment to show, within a six-year period, a 15 percent emissions reduction in VOC, not NO_X from the baseline year (January 1, 2012 – December 31, 2017). Appendix D contains the detailed emissions by county, pollutant, and by time-of-day for all NCT counties modeled.

VMT for summer weekday for each analysis year are shown in Exhibit 1.10. Appendix E contains the summarized VMT estimates by analysis year for all NCT counties modeled.

Exhibit 1.4: On-Road Emissions for the DFW 10-County Nonattainment Area

Summer Season, Midweek On-Road Emissions (tons/day)					
Nitrogen Oxides					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	768.26	768.19	768.17	768.11
PR90	767.76	903.58	921.03	957.91	974.43
FMVCP	343.42	215.51	193.79	161.24	147.72
FC	266.43	158.31	130.30	107.01	97.78
IM	245.30	146.42	121.47	100.14	91.75
TxLED	239.07	142.81	118.25	97.50	89.33
Volatile Organic Compounds					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	305.37	305.29	304.69	304.65
PR90	301.15	349.79	356.44	370.27	376.55
FMVCP	134.92	94.82	88.94	80.04	76.02
FC	115.88	79.42	72.23	64.87	61.59
IM	102.25	69.26	63.08	56.73	53.88
TxLED	102.25	69.26	63.08	56.73	53.88

[1] In the table above, each scenario contains the control strategies of all previous scenarios.

Exhibit 1.5: On-Road Emissions for Wise County

Summer Season, Midweek On-Road Emissions (tons/day)					
Nitrogen Oxides					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	18.26	18.26	18.25	18.25
PR90	18.39	20.78	21.31	22.29	22.78
FMVCP	8.66	5.55	5.10	4.43	4.14
FC	7.49	4.62	4.04	3.52	3.31
IM	7.49	4.62	4.04	3.52	3.31
TxLED	7.24	4.46	3.89	3.39	3.18
Volatile Organic Compounds					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	4.89	4.89	4.88	4.88
PR90	4.80	5.55	5.68	5.90	6.01
FMVCP	2.29	1.54	1.45	1.29	1.21
FC	2.05	1.36	1.25	1.12	1.05
IM	2.05	1.36	1.25	1.12	1.05
TxLED	2.05	1.36	1.25	1.12	1.05

[1] In the table above, each scenario contains the control strategies of all previous scenarios.

Exhibit 1.6: On-Road Emissions for the DFW Nine-County Nonattainment Area

Summer Season, Midweek On-Road Emissions (tons/day)					
Nitrogen Oxides					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	750.00	749.94	749.92	749.86
PR90	749.37	882.80	899.72	935.61	951.66
FMVCP	334.76	209.96	188.69	156.81	143.58
Fuel Controls	258.94	153.69	126.27	103.49	94.47
I/M	237.81	141.81	117.44	96.62	88.45
TxLED	231.83	138.35	114.36	94.10	86.14
Volatile Organic Compounds					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	300.48	300.40	299.81	299.77
PR90	296.35	344.24	350.76	364.37	370.54
FMVCP	132.63	93.27	87.49	78.75	74.81
Fuel Controls	113.82	78.06	70.98	63.75	60.54
I/M	100.19	67.90	61.83	55.61	52.83
TxLED	100.19	67.90	61.83	55.61	52.83

[1] In the table above, each scenario contains the control strategies of all previous scenarios.

Exhibit 1.7: Control Strategy Emission Reductions for the DFW 10-County Nonattainment Area

Summer Season, Midweek On-Road Emission Reductions (tons/day)						
Nitrogen Oxides						
		2011	**2017**	**2018**	**2020**	**2021**
Inventory	**PR90**	767.76	903.58	921.03	957.91	974.43
	Control Strategies	239.07	142.81	118.25	97.50	89.33
Reductions	**FMVCP**	424.34	688.07	727.24	796.67	826.71
	FC	76.99	57.20	63.49	54.23	49.95
	IM	21.13	11.89	8.83	6.87	6.03
	TxLED	6.23	3.62	3.22	2.64	2.43
	Total	**528.69**	**760.77**	**802.78**	**860.41**	**885.10**
Volatile Organic Compounds						
		2011	**2017**	**2018**	**2020**	**2021**
Inventory	**PR90**	301.15	349.79	356.44	370.27	376.55
	Control Strategies	102.25	69.26	63.08	56.73	53.88
Reductions	**FMVCP**	166.24	254.97	267.50	290.22	300.53
	FC	19.04	15.40	16.70	15.17	14.43
	IM	13.63	10.16	9.15	8.14	7.71
	TxLED	0.00	0.00	0.00	0.00	0.00
	Total	**198.90**	**280.53**	**293.36**	**313.54**	**322.67**

Exhibit 1.8: Control Strategy Emission Reductions for Wise County

Summer Season, Midweek On-Road Emission Reductions (tons/day)						
Nitrogen Oxides						
		2011	**2017**	**2018**	**2020**	**2021**
Inventory	**PR90**	18.39	20.78	21.31	22.29	22.78
	Control Strategies	7.24	4.46	3.89	3.39	3.18
Reductions	**FMVCP**	9.73	15.24	16.21	17.87	18.63
	FC	1.17	0.93	1.07	0.91	0.83
	IM	N/A	N/A	N/A	N/A	N/A
	TxLED	0.25	0.16	0.15	0.13	0.12
	Total	**11.15**	**16.32**	**17.42**	**18.90**	**19.60**
Volatile Organic Compounds						
		2011	**2017**	**2018**	**2020**	**2021**
Inventory	**PR90**	4.80	5.55	5.68	5.90	6.01
	Control Strategies	2.05	1.36	1.25	1.12	1.05
Reductions	**FMVCP**	2.51	4.01	4.23	4.61	4.79
	FC	0.23	0.18	0.20	0.17	0.16
	IM	N/A	N/A	N/A	N/A	N/A
	TxLED	0.00	0.00	0.00	0.00	0.00
	Total	**2.75**	**4.19**	**4.43**	**4.78**	**4.96**

Exhibit 1.9: Control Strategy Emission Reductions for the Nine-County Nonattainment Area

Summer Season, Midweek On-Road Emission Reductions (tons/day)						
Nitrogen Oxides						
		2011	**2017**	**2018**	**2020**	**2021**
Inventory	**PR90**	749.37	882.80	899.72	935.61	951.66
	Control Strategies	231.83	138.35	114.36	94.10	86.14
Reductions	**FMVCP**	414.61	672.83	711.03	778.80	808.08
	FC	75.82	56.27	62.43	53.33	49.11
	IM	21.13	11.89	8.83	6.87	6.03
	TxLED	5.98	3.46	3.08	2.52	2.30
	Total	**517.54**	**744.45**	**785.36**	**841.51**	**865.52**
Volatile Organic Compounds						
		2011	**2017**	**2018**	**2020**	**2021**
Inventory	**PR90**	296.35	344.24	350.76	364.37	370.54
	Control Strategies	100.19	67.90	61.83	55.61	52.83
Reductions	**FMVCP**	163.72	250.96	263.27	285.61	295.74
	FC	18.81	15.22	16.50	15.00	14.26
	IM	13.63	10.16	9.15	8.14	7.71
	TxLED	0.00	0.00	0.00	0.00	0.00
	Total	**196.16**	**276.34**	**288.93**	**308.76**	**317.71**

Exhibit 1.10: Vehicle Miles of Travel for the DFW 10-County Nonattainment Area

Summer Season, Midweek Vehicle Miles of Travel (miles/day)					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	191,251,636	191,251,636	191,251,636	191,251,636
PR90	191,251,636	219,457,725	223,163,467	231,949,231	235,603,162
FMVCP	191,251,636	219,457,725	223,163,467	231,949,231	235,603,162
FC	191,251,636	219,457,725	223,163,467	231,949,231	235,603,162
IM	191,251,636	219,457,725	223,163,467	231,949,231	235,603,162
TxLED	191,251,636	219,457,725	223,163,467	231,949,231	235,603,162

Exhibit 1.11: Vehicle Miles of Travel for Wise County

Summer Season, Midweek Vehicle Miles of Travel (miles/day)					
	2011	**2017**	**2018**	**2020**	**2021**
ABY	N/A	3,538,731	3,538,731	3,538,731	3,538,731
PR90	3,538,731	4,056,522	4,151,131	4,312,239	4,395,107
FMVCP	3,538,731	4,056,522	4,151,131	4,312,239	4,395,107
FC	3,538,731	4,056,522	4,151,131	4,312,239	4,395,107
IM	3,538,731	4,056,522	4,151,131	4,312,239	4,395,107
TxLED	3,538,731	4,056,522	4,151,131	4,312,239	4,395,107

Exhibit 1.12: Vehicle Miles of Travel for the Nine-County Nonattainment Area

Summer Season, Midweek Vehicle Miles of Travel (miles/day)					
	2011	**2017**	**2018**	**2020**	**2021**
ABY		187,712,905	187,712,905	187,712,905	187,712,905
PR90	187,712,905	215,401,203	219,012,336	227,636,992	231,208,055
FMVCP	187,712,905	215,401,203	219,012,336	227,636,992	231,208,055
FC	187,712,905	215,401,203	219,012,336	227,636,992	231,208,055
IM	187,712,905	215,401,203	219,012,336	227,636,992	231,208,055
TxLED	187,712,905	215,401,203	219,012,336	227,636,992	231,208,055

CHAPTER 2: VEHICLE ACTIVITY ESTIMATION PROCEDURES

This chapter discusses the methodology used in estimating the vehicle activity measures influencing air quality in the North Central Texas area. These measures include: vehicle miles of travel (VMT) and average speed. The current Dallas-Fort Worth Travel Model for the Expanded Area (DFX) covers the 12-county Metropolitan Planning Area (MPA) of Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise counties, plus Hill County. The VMT and speeds were estimated with the DFX using a link-based methodology for each time period.

Dallas-Fort Worth Expanded Travel Model

The source of VMT estimates for the Reasonable Further Progress (RFP) Emission Inventories for the nonattainment counties is the network-based DFX executed by the North Central Texas Council of Governments (NCTCOG) Transportation Department in the TransCAD environment. TransCAD is a Geographic Information System-based commercial travel demand software package for transportation planning. DFX supports federally required regional transportation planning efforts for the Dallas-Fort Worth (DFW) area. Since 1974, NCTCOG has served as the Metropolitan Planning Organization (MPO) for the DFW area. The Transportation Department provides technical support and staff assistance to the Regional Transportation Council and its technical committees that comprise the MPO policy-making structure.

Multimodal Transportation Analysis Process

The forecasting technique of the DFX is based on a four-step sequential process designed to model travel behavior and predict travel demand at regional, sub-area, or corridor levels. These four steps are: Trip Generation, Trip Distribution, Mode Choice, and Roadway Assignment.

The roadway network developed for the RFP Emissions Inventories contains over 30,000 unique segments constructed to replicate the transportation system of the coverage area. For this RFP inventory, the transportation network was developed for the years 2011, 2017, 2018, 2020, and 2021. Each facility link in the network has the following attributes:

- Network Node Numbers (defining the beginning and end of each link)
- Number of Operational Lanes in the AM PM Peak and Off-Peak Periods
- Functional Classification
- Divided/Undivided Roadway Code
- Type of Traffic Control at Each End of the Link
- Traffic Direction (One- or Two-Way)
- Length of Link
- Estimated Loaded Speeds in Each Period
- Speed Limit
- Traffic Survey Zone
- Tolls
- Area Type
- Free-Flow Speeds
- Hourly Capacities
- Truck Exclusion Code
- Length of Link

Every roadway segment in the network falls in one of the functional classes of centroid connectors, freeways, principal arterials, minor arterials, collectors, ramps, frontage roads, and high occupancy vehicle (HOV) lanes.

Trip purposes in the DFX are defined in one of four ways: home-based work (HBW), which includes trips from home to work or work to home; home-based non-work (HNW), which includes non-work trips beginning or ending at home; non-home based (NHB), which includes trips where home is neither the origin nor the destination; and other trips that include all truck trips as well as all external-internal, internal-external, and external-external vehicle trips.

The model process begins with an estimate of the socio-economic variables for each zone. The data is organized by traffic survey zone (TSZ), the smallest zone size available in the DFX. There are 5,386 TSZs in the model (5,303 internal zones plus 83 externals). The data for each TSZ includes: zone centroid; median household income; number of households; population; basic, retail, and service employment; and land area. This level of detail is retained in all four modeling steps.

The Trip Generation Model generates the number of weekday person trips sent to and received from each zone. The Trip Distribution Model determines the trip interaction between each zone and the rest of the zones in the MPA. The Mode Choice Model divides the person trips into two categories of transit and automobile trips. The Assignment Model loads the auto demand onto the roadway network, and the transit passenger trips onto the transit network, commonly referred to as the four-step transportation modeling process. The DFX model application is written by NCTCOG staff in the TransCAD script language known as the Geographic Information System Developer Kit (GISDK), and integrated with a user interface developed in visual basic programming language.

Trip Generation Model

The Trip Generation Model is a computer program written in GISDK script language by NCTCOG staff. The Trip Generation Model converts the population and employment data into person trip ends and outputs the total number of trips produced by and attracted to each zone by trip purpose. The 2011, 2017, 2018, 2020, and 2021 population and employment forecasts were generated with the Disaggregate Residential Allocation Model/Employment Allocation Model using travel times from the Roadway and Transit Assignment Steps consistent with current planning practice. The data can be seen in Exhibit 2.1. The cross-classified trip production model is stratified by income quartile and household size. The allocation of TSZ households into the four income quartiles and six household size categories is based on distribution curves developed from the United States Census Population data. The cross-classified trip attraction model is stratified by area type, employment type (basic, retail, and service), and, for the case of the HBW trip purpose, income quartile. Area type designations are a function of the population and employment density of a zone.

Exhibit 2.1: Socio-Economic Demographic Summary

DFW Nonattainment Area					
Analysis Year	**2011**	**2017**	**2018**	**2020**	**2021**
Population	6,341,202	7,137,178	7,277,987	7,524,572	7,647,835
Number of Households	2,299,092	2,541,704	2,591,691	2,678,167	2,721,382
Employment Types					
Basic	931,999	1,112,279	1,134,264	1,138,900	1,141,186
Retail	382,816	439,942	448,857	465,249	473,497
Service	2,663,566	3,076,418	3,137,179	3,238,685	3,289,499
Total Employment	3,978,381	4,628,639	4,720,300	4,842,834	4,904,182

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The Trip Generation Model allows the user to input trip rates and trip generation units associated with special generators such as regional shopping malls, hospitals, and colleges/universities. At the end of the generation process, HBW trips are balanced to the estimated trip attractions. All other purposes are balanced to the estimated trip productions in that zone. Because of the uniqueness of the NHB trips, zonal productions for NHB trips are later set equal to the attractions in a given zone.

The regional trip productions and attractions are balanced for each trip purpose. The total trip attractions are balanced to the estimated trip productions in that zone for all other trip purposes.

Trip Distribution Model

The Trip Distribution Model creates the production-attraction person trip tables for each of the 5,386 model zones. The Trip Distribution Model uses the person trips produced by and attracted to each zone, generated in the Trip Generation Model, plus zone-to-zone minimum travel time information from the roadway network to estimate the number of person trips between each pair of zones for each trip purpose. All estimates of roadway travel times include a representation of the time needed for locating a parking space, paying for parking, and walking from the car to the final destination. Estimates of these terminal times were derived from NCTCOG’s 1994 Workplace Survey and 1996 Household Travel Survey. NCTCOG is in the process of updating the trip distribution model component based on 2009 household survey data. The model uses a gamma-based gravity formulation technique to estimate the zone-to-zone interchange of trips. Iterations of the gravity model are required to ensure that the estimated number of zonal trips received equals the projected number of trip attractions generated by the Trip Generation Model.

Mode Choice Model

The Mode Choice Model determines the mode of travel and auto occupancy. Using the information regarding trip maker characteristics (e.g., income and auto ownership), roadway and transit system characteristics (e.g., in-vehicle time and out-of-vehicle time), and travel costs (e.g., auto operating costs, parking costs, and transit fare), the model splits the trips among all applicable modes of travel. The model uses a nested logic formulation for all the trip purposes. The “other” trips are assumed to be vehicle trips with one occupant and are not processed by the Mode Choice Model. The trip purposes of HBW, HNW, and NHB have nine choice sets: drive alone, two occupant shared ride, three + occupancy shared ride, walk access to bus service, auto access to bus service, walk access to rail service, auto access to rail service, walk access to bus and rail service with transfer, and auto access to bus and rail service with transfer.

Roadway Assignment

The Roadway Assignment Model consists of simultaneous user equilibrium origin-destination assignments of drive alone, shared-ride, and truck vehicle classes for three separate time-of-day periods (6:30 a.m. – 8:59 a.m. Morning Peak, 3:00 p.m. – 6:29 p.m. Evening Peak, and the 18-Hour Off-peak). The drive alone vehicle class is kept separate from the shared-ride vehicle class so that HOV assignments can be performed as an integral part of an equilibrium assignment. Trucks are kept separate from the other vehicle classes so that the modeled truck volumes on all links can be tracked, and a separate value-of-time can be defined for them. A generalized cost path building technique is embedded within the model, in which the iterative calculation of zone-to-zone impedances are based on weighting factors applied to the capacity-restrained travel time, the distance (representing fuel cost), and tolls. As is standard with all User Equilibrium procedures, the TransCAD program uses an iterative process to achieve a convergent solution in which no travelers can improve their path by shifting routes. Since the results of the three time-of-day assignments can be combined to obtain total weekday modeled volumes, validation checks can be performed with either time-of-day or weekday observed traffic counts.

Speed Estimation Procedure

The link speed in the DFX is estimated by dividing the length of the link by its loaded travel time. The loaded travel time is the sum of the free-flow travel time, traffic congestion delay, and the delay caused by the traffic control devices (e.g., stop signs, yield signs, and signals). These three elements of the loaded travel time are all functions of the link volume to capacity ratio. These functions are programmed in the volume delay function (VDF) that is an essential input to the traffic assignment step. The result of the traffic assignment step is the final time-period-specific average loaded speeds for each of the 30,000 plus links in the roadway network. The VMT and vehicle hours of travel (VHT) for different time periods is included in the output as well to obtain an overall average speed (VMT/VHT) for any desired length of time.

The free-flow (uncongested) speed is defined as the speed limit. Free-flow speeds are an important link attribute since they are the base for calculating the congested (loaded) speeds in the Traffic Assignment step.

The VDF in the DFX uses a conical congestion delay form defined for each link functional classification, a non-linear delay curve based on the Webster's uniform delay formulation at signalized intersections, and a linear delay curve for the stop and yield controlled approaches.

The volume-delay functions were originally calibrated based on more than 8,000 traffic counts collected in 2004. These functions were later adjusted based on National Performance Management Research Data Set (NPMRDS) and 2014 time-of-day traffic counts collected at about 20,000 locations. NPMRDS contained travel time data by 5-minute interval.

Finally, all of the delay elements are added to the uncongested travel time (based on the free-flow speeds) to produce the total loaded travel time on each roadway segment. Appendix E contains speeds by county for each hour of the day. The resulting congested DFX county speeds, weighted by VMT, are listed in Exhibit 2.2.

Exhibit 2.2: Average Congested Speeds

County	2011	2017	2018	2020	2021
Collin	35.83	35.80	35.48	35.13	34.90
Dallas	35.55	35.94	35.71	35.64	35.54
Denton	36.56	37.57	37.22	36.70	36.48
Ellis	45.62	46.92	46.74	46.26	46.01
Johnson	42.12	41.94	41.83	41.51	41.35
Kaufman	46.29	46.35	46.01	45.29	44.89
Parker	44.24	44.06	43.89	43.73	43.62
Rockwall	40.15	40.81	40.56	40.08	39.87
Tarrant	36.48	37.49	37.28	37.16	37.04
Wise	45.82	44.71	44.54	44.39	44.27
Weighted 10-County Average	**37.01**	**37.59**	**37.36**	**37.17**	**37.03**

Local Street VMT

The roadway network of the DFX does not contain the details of local (residential) streets. However, a VMT estimate is possible based on data provided by the travel model. Local street VMT is calculated for each county by multiplying the number of intrazonal trips by the intrazonal trip length and then adding the VMT from the zone centroid connectors. The temporal distribution is assumed to be the same as for non-local streets.

Adjustments

Seasonal, Daily, and Hourly Adjustments

The vehicle activity data used for this analysis is representative of the summer season. This section outlines the process used to convert the DFX non-summer weekday (NSWD) activity to summer (June, July, and August) weekday activity. Automatic Traffic Recorder (ATR) data, collected by TxDOT, is used to calculate the necessary conversions. For 2011 analysis year, 2011 ATR was used to convert NSWD activity to summer. For 2017, 2018, 2020, and 2021 analysis years, ATR data averaged over five years (2012-2016) was used to convert NSWD activity to summer.

Seasonal and Daily Adjustments

ATR data is organized into five day types: Sunday, Monday, Midweek (Tuesday, Wednesday, and Thursday), Friday, and Saturday. To adjust the representative average school season weekday (ASWT) data from the DFX to summer weekday, an ASWT to summer ATR conversion ratio is calculated. The summer portion of the ratio includes traffic volumes recorded between June and August. Seasonal midweek (Tuesday-Thursday) adjustments by area type for DFX counties are listed in Exhibit 2.3.

Exhibit 2.3: Seasonal/Daily Adjustment Factors

	County Type	Midweek
2011 DFX Counties (ASWT to Summer)	Core (Dallas/Tarrant)	1.040
	Rural (Collin/Denton)	1.050
	Perimeter (Other Counties)	1.081
2017, 2018, 2020 & 2021 DFX Counties (ASWT to Summer)	Core (Dallas/Tarrant)	1.010
	Rural (Collin/Denton)	0.998
	Perimeter (Other Counties)	1.054

Hourly Adjustments

Daily volumes recorded for midweek, described above, are aggregated by hour to determine the percent of daily traffic occurring during each hour, representing hourly vehicle activity estimates. The DFX county midweek is further detailed by utilizing a time period volume for aggregation, as opposed to the daily volumes provided for the other day types. These time periods correspond to the time periods utilized in the DFX where AM Peak is 6:30 a.m. to 8:59 a.m., PM Peak is 3:00 p.m. to 6:29 p.m., and Off-Peak represents all other hours of the day (12:00 a.m. to 6:29 a.m., 9:00 a.m. to 2:59 p.m., and 6:30 p.m. to 11:59 p.m.). Periods split by mid-hour times utilize an equal division of traffic recorded during the hour. The hourly adjustments for DFX counties are shown in Exhibit 2.4.

Exhibit 2.4: Average 2012-2016 Hourly Distribution Factors[1]

Hours	County Groups		
	Core/Urban	Rural	Perimeter
12:00 a.m. – 12:59 a.m.	0.94%	0.68%	1.08%
1:00 a.m. – 1:59 a.m.	0.61%	0.44%	0.83%
2:00 a.m. – 2:59 a.m.	0.56%	0.36%	0.76%
3:00 a.m. – 3:59 a.m.	0.62%	0.35%	0.90%
4:00 a.m. – 4:59 a.m.	1.11%	0.61%	1.40%
5:00 a.m. – 5:59 a.m.	2.96%	1.73%	2.81%
6:00 a.m. – 6:29 a.m.	2.90%	2.21%	2.32%
6:30 a.m. – 6:59 a.m.	2.90%	2.21%	2.32%
7:00 a.m. – 7:59 a.m.	7.14%	6.38%	6.08%
8:00 a.m. – 8:59 a.m.	6.31%	6.42%	5.49%
9:00 a.m. – 9:59 a.m.	5.16%	5.32%	5.30%
10:00 a.m. – 10:59 a.m.	4.77%	4.89%	5.47%
11:00 a.m. – 11:59 a.m.	4.95%	5.24%	5.61%
12:00 p.m. – 12:59 p.m.	5.20%	5.65%	5.74%
1:00 p.m. – 1:59 p.m.	5.36%	5.76%	5.94%
2:00 p.m. –2:59 p.m.	5.79%	5.91%	6.27%
3:00 p.m. – 3:59 p.m.	6.55%	6.45%	6.74%
4:00 p.m. – 4:59 p.m.	7.33%	7.38%	7.33%
5:00 p.m. – 5:59 p.m.	7.52%	8.34%	7.53%
6:00 p.m. – 6:29 p.m.	3.15%	3.80%	2.92%
6:30 p.m. – 6:59 p.m.	3.15%	3.80%	2.92%
7:00 p.m. – 7:59 p.m.	4.60%	5.52%	4.35%
8:00 p.m. – 8:59 p.m.	3.55%	4.08%	3.46%
9:00 p.m. – 9:59 p.m.	3.02%	3.16%	2.78%
10:00 p.m. – 10:59 p.m.	2.31%	2.08%	2.10%
11:00 p.m. – 11:59 p.m.	1.55%	1.21%	1.55%

Source: TxDOT

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[1] The 24-hour totals may be less than or greater than 100% due to rounding.

Model VMT Adjustments (HPMS vs. DFX)

Consistent with previous emission inventory practices, the DFW MPO used TxDOT's Highway Performance Monitoring System (HPMS) data to adjust modeled VMT to reflect the HPMS data for consistent reporting across the State. This adjustment is based on EPA's guidance for emission inventory development.

NCTCOG performed a validation on the DFX model in 2014 in order to meet the transportation conformity requirements per the *Code of Federal Regulation*s, which states, "Network-based travel models must be validated against observed counts (peak and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination" (40CFR §93.122(b)(1)(i). NCTCOG incorporated the updated DFX model validation which is based on 2010 demographics. Exhibit 2.5 shows the calculation performed to develop the new HPMS adjustment factor, 0.9703, based on a comparison of 2010 VMT for HPMS and DFX.

Exhibit 2.5: 2010 DFW and HPMS VMT Analysis

Model VMT Adjustment Factor	
	2010 VMT
HPMS (ASWT)[1]	165,292,084
DFX (ASWT)	170,346,118
HPMS/DFX Ratio	0.9703

[1]Annual Average Daily Traffic to ASWT conversion factor applied.

Nonrecurring Congestion

According to a paper published in the January 1987 Institute of Transportation Engineers Journal by Jeffrey A. Lindley entitled Urban Freeway Congestion: Quantification of the Problem and Effectiveness of Potential Solutions, congestion due to traffic incidents accounts for twice as much as congestion from bottleneck situations. Congestion due to incidents, or nonrecurring congestion, causes emissions not represented in the VMT-based calculations of the base emissions. In order to include these effects, the delay caused by nonrecurring congestion is added to the freeway travel times and congestion delay due to bottlenecks to obtain an increased freeway travel time, which translates into reduced speed on freeway facilities. Reducing the freeway speeds increases volatile organic compounds (VOC) and oxides of nitrogen (NO_X) emissions by 4.9 percent, resulting in a factor of 1.049 for freeway VOC and NO_X emissions in urban and rural counties. This is thought to be a conservative estimate of increased emissions due to nonrecurring congestion. Arterial street emissions are not significantly affected by incidents because alternate routes on the arterial system are generally available; therefore, this factor is not applied to non-freeway type facilities.

VMT Estimates

The RFP VMT estimates are located in Exhibit 2.6 for all counties in the nonattainment area. VMT is summarized by 2011, 2017, 2018, 2020 and 2021 model years for each county. Appendix E contains the VMT by county for each hour for all counties.

Exhibit 2.6: Vehicle Miles of Travel

DFW Nonattainment Area					
County	**2011**	**2017**	**2018**	**2020**	**2021**
Collin	21,878,235	26,267,831	26,906,397	28,460,810	29,173,045
Dallas	74,439,892	83,276,006	84,318,522	86,540,958	87,352,141
Denton	18,575,666	21,121,344	21,551,320	22,440,507	22,822,768
Ellis	6,774,544	8,051,780	8,264,272	8,767,257	9,025,573
Johnson	4,952,616	5,904,299	6,033,090	6,366,463	6,527,777
Kaufman	5,734,878	7,025,002	7,238,266	7,687,597	7,907,878
Parker	4,921,961	6,156,798	6,320,018	6,630,680	6,776,194
Rockwall	2,436,477	2,798,689	2,857,891	3,001,820	3,066,582
Tarrant	47,998,636	54,799,454	55,522,560	57,740,902	58,556,096
Wise	3,538,731	4,056,522	4,151,131	4,312,239	4,395,107
Total	**191,251,636**	**219,457,725**	**223,163,467**	**231,949,231**	**235,603,162**

CHAPTER 3 ESTIMATION OF OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates, county-level analysis years 2011, 2017, 2018, 2020, and 2021 weekday estimates of the source hours parked (SHP), starts, source hours idling (SHI), and auxiliary power units (APU) hours are required by hour and vehicle (SHI and APU hours are for diesel combination long-haul trucks only). One of the main components of the SHP and starts off-network activity estimation is the analysis year county-level vehicle population. Appendix A contains the vehicle population and hourly SHP, starts, SHI, and APU hours.

Texas A&M Transportation Institute's (TTI) MOVESpopulationBuild module is used to convert Motor Vehicle Emissions Simulator version 2014a (MOVES2014a) based Texas Department of Motor Vehicles registration data for each county into 13 MOVES2014a source use type (SUT) population (or vehicle population). The county-level SHP, starts, SHI, and APU hours of off-network activity were developed using the "OffNetActCalc" utility and methodology provided by TTI.

Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year weekday estimates of SHP by hour and vehicle type. For each hour, the county-level vehicle type SHP was calculated by taking the difference between the vehicle type total available hours minus the vehicle type vehicle hours travelled (VHT). Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type population. The Source Hours Operating (SHO) was calculated using the link vehicle miles of travel (VMT) and speeds and the VMT mixes by MOVES road-type category. Appendix A includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and vehicle type for all analysis years.

Vehicle Type Total Available Hours

The vehicle type total available hours is typically calculated as the vehicle type population times the number of hours in the time period. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type vehicle.

Vehicle Type VHT

To calculate the VHT for a given link, the VMT was allocated to each vehicle type using the Texas Department of Transportation district-level vehicle type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link vehicle type VHT. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process. This SHO calculation was performed for each link in a given hour, aggregating the VHT to one value per vehicle type per hour.

Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year weekday estimates of starts by hour and vehicle type. The vehicle type hourly default starts per vehicle were multiplied by the analysis year county-level vehicle type vehicle population to estimate the county-level vehicle type starts by hour. Appendix A includes the 24-hour summaries of the county-level vehicle type starts by hour for each analysis year.

For the hourly default starts per vehicle, the MOVES defaults were used. The MOVES activity output was used to estimate the hourly starts per vehicle for a MOVES weekday run by dividing the MOVES start output by the MOVES vehicle population output. These MOVES national default starts per vehicle do not vary by year, only by MOVES day type. For this weekday analysis, the MOVES national default “weekday” starts per vehicle were used.

Estimation of SHI and APU Hours

The remaining activity measures needed to estimate the off-network emissions using the mass per activity emissions rates are the hourly, county-level analysis year weekday heavy-duty diesel truck (SUT 62, fuel type 2 [CLhT_Diesel]) SHI and APU hours (hotelling activity). During hotelling, the truck’s main engine is assumed to be in idling mode or its APU is in use. To calculate the SHI and APU hours activity, the hotelling hours activity were calculated, which was then allocated to the SHI and APU hours components.

The hotelling activity was based on information from a Texas Commission on Environmental Quality extended idling study, which produced 2017 winter weekday extended idling estimates for each Texas County. Hotelling scaling factors (by analysis year) were applied to the base 2017 winter weekday hotelling values from the study to estimate the 24-hour hotelling by analysis year. Hotelling hourly factors were then applied to allocate the 24-hour hotelling by analysis year to each hour of the day. To ensure that valid hourly hotelling values are used, the hourly hotelling activity was compared to the CLhT_Diesel hourly SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHI and APU hours factors were then applied to the hotelling hours to produce the hourly SHI and APU hours of activity. Appendix A incudes the 24-hour summaries of the county-level estimates of hotelling hours, SHI, and APU hours for each analysis year.

Hotelling Activity Scaling Factors

To estimate the analysis year county-level 24-hour hotelling activity, county-level hotelling activity scaling factors were developed using the county-level 2017 winter weekday link-level VMT and speeds, the VMT mix (by MOVES road type), the county-level analysis year weekday link-level VMT and speeds, and the VMT mix (by MOVES road type). The 2017 winter weekday link-level VMT and speeds were developed using a process similar to the 2011, 2017, 2018, 2020, and 2021 weekday link-level VMT speed estimation. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process. For the base weekday vehicle type VMT mix, the 2017 weekday vehicle type VMT mix was used.

For each link in the 2017 winter weekday link-level VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday vehicle type VMT mix. This VMT allocation was performed for each link and hour in the 2017 winter weekday link-level VMT and speeds, with the individual link VMT aggregated by hour to produce the CLhT_Diesel hourly and 24- hour 2017 weekday VMT. Using a similar allocation process, the analysis year weekday CLhT_Diesel hourly and 24-hour VMT was calculated using the analysis year weekday link-level VMT and speeds and the analysis year vehicle type VMT mix. The county- level 24-hour hotelling activity scaling factors by analysis year were calculated by dividing the analysis year and day type CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2017 winter weekday VMT.

Hotelling Activity Hourly Factors

To allocate the analysis year weekday county-level 24-hour hotelling activity to each hour of the day, hotelling activity hourly factors were used. These hotelling activity hourly factors were calculated as the inverse of the analysis year weekday CLhT_Diesel hourly VHT fractions. The analysis year weekday CLhT_Diesel hourly VHT fractions were calculated using the hourly analysis year weekday CLhT_Diesel VHT. The hourly analysis year weekday CLhT_Diesel VHT was converted to hourly fractions, therefore creating analysis year weekday CLhT_Diesel hourly VHT fractions. The inverse of these hourly VHT fractions were calculated and the inverse for each hour was divided by the sum of the inverse hourly VHT fractions across all hours to calculate the county-level analysis year weekday hotelling activity hourly factors for each analysis year.

County-Level CLhT_Diesel Hotelling Activity by Hour Estimation

The four analysis years’ weekday CLhT_Diesel hotelling activity by hour was calculated by multiplying the 24-hour 2004 weekday hotelling hours by the analysis year hotelling activity scaling factor and by the analysis year hotelling activity hourly factors. For each hour, the analysis year weekday hotelling activity was then compared to the analysis year weekday CLhT_Diesel SHP to estimate the final analysis year weekday hotelling activity by hour. If the analysis year weekday hotelling activity value was greater than the analysis year weekday SHP value, then the final analysis year weekday hotelling activity for that hour was set to the analysis year weekday CLhT_Diesel SHP value. Otherwise, the final analysis year weekday hotelling activity for that hour was set to the base analysis year weekday hotelling activity value. All calculations (scaling factors, hotelling activity hourly factors, and hotelling activity by hour calculations) were performed by county and analysis year (i.e., 10 hotelling activity scaling factors were calculated per analysis year).

County-Level CLhT_Diesel SHI and APU Hours Estimation

Weekday hourly county-level hotelling activity for all analysis years was then allocated to SHI and APU hours activity components using the aggregate extended idle mode and APU mode fractions. For each hour, the analysis year weekday hotelling activity was multiplied by the SHI fraction to calculate the analysis year weekday hourly SHI activity and by the APU fraction to calculate the analysis year weekday hourly APU activity.

The aggregate SHI and the APU fractions were estimated using model year travel fractions (based on source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the MOVES default hotelling activity distribution (i.e., a bi-modal distribution of 1.0 SHI prior to the 2010 model year and a 0.7/0.3 SHI/APU activity allocation for 2010 and later model years). The associated travel fractions were applied to the appropriate extended idle and APU operating mode fractions (of the hotelling operating mode distribution) by model year and summed within each mode to estimate the aggregate (across model years) individual SHI and APU fractions (which sum to 1.0).

CHAPTER 4: EMISSION FACTOR ESTIMATION PROCEDURE

MOVES201a and Input Parameters

The Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator version 2014a (MOVES2014a) is used to develop vehicle emission factors to conduct the Reasonable Further Progress (RFP) emission inventory for the Dallas-Fort Worth (DFW) 10-county ozone nonattainment area for analysis years 2011, 2017, 2018, 2020, and 2021. The emission factors are one component in the equation to determine vehicle emissions emitted from the region's on-road vehicles. MOVES2014a parameters used to develop emissions inventory are listed in Exhibits 4.1 through 4.5 with the appropriate data source and/or methodology applied. Information listed applies to all counties unless otherwise specified. Referenced files identifying specific local data are included in Appendix A. MOVES2014a input files utilizing these parameters and data for each county are included in Appendix B.

Exhibit 4.1: MOVES2014 Modeled Pollutants

Command	Input Parameter Values and Molecular Formulas	Description
Pollutant	VOC, CO, NO_X, CO_2, SO_2, NH_3, $PM_{2.5}$, and PM_{10},	Volatile Organic Compounds (VOC), Carbon Monoxide (CO), Nitrogen Oxides (NO_X), Carbon Dioxide (CO_2), Sulfur Dioxide (SO_2), ammonia (NH_3), Particulate Matter with aerodynamic diameters equal to or less than 2.5 microns ($PM_{2.5}$), and Particulate Matter with aerodynamic diameters equal to or less than 10 microns (PM_{10}).

Exhibit 4.2: MOVES2014a External Conditions

Command	Input Parameter Values	Description
Calendar Year	2011, 2017, 2018, 2020 and 2021	RFP analysis years
Altitude	1	Low altitude; EPA default
Evaluation Month	7	Representing Summer
Minimum/Maximum Temperature	N/A	See Hourly Temperatures
Hourly Temperatures	Average Summer (June, July and August)	2011 County specific, provided by the Texas Commission on Environmental Quality (TCEQ)
Relative Humidity	Average Summer (June, July and August)	2011 County specific, provided by TCEQ
Barometric Pressure	Average Summer (June, July and August)	2011 County specific, provided by TCEQ

Exhibit 4.3: MOVES2014a Input Parameters

Input Parameter	Description	Source
Source Type Population	Input number of vehicles in geographic area to be modeled for each vehicle, and apply the appropriate growth factors for each analysis year. Texas A&M Transportation Institute's (TTI) MOVESpopulationBuild module is used to convert MOVES2014a based Texas Department of Motor Vehicles (TxDMV) registration data for each county into 13 MOVES2014a SUT population.	2011 and 2014 TxDMV registration data
Source Type Age Distribution	Input provides distribution of vehicle counts by age for each calendar year and vehicle type. TxDMV registration data used to estimate age distribution of vehicle types up to 30 years. Distribution of Age fractions should sum up to 1.0 for all vehicle types for each analysis year.	2011 and 2014 TxDMV registration data MOVES2014a default used for buses
Vehicle Type Vehicle Miles of Travel	County specific vehicle miles of travel (VMT) distributed to six highway performance monitoring system (HPMS) Vehicle types.	Travel Model Output
Average Speed Distribution	Input average speed data specific to vehicle type, road type, and time of day/type of day into 16 speed bins. Sum of speed distribution to all speed bins for each road type, vehicle type, and time/day type is 1.0.	Travel Model Output

Exhibit 4.3: MOVES2014a Input Parameters (continued)

Input Parameter	Description	Source
Road Type Distribution (VMT Fractions)	Input county specific VMT by road type. VMT fraction distributed between the road type and must sum to 1.0 for each source type.	Travel Model Output
Ramp Fraction	Input county specific fraction of ramp driving time on rural and urban restricted roadway type.	Travel Model Output
Fuel Supply	Input to assign existing fuels to counties, months, and years, and to assign the associated market share for each fuel.	TCEQ, EPA Fuel Surveys and default MOVES2014a input where local data unavailable
Meteorology	Regional average summer data on temperature and humidity.	2011 data provided by TCEQ
Fuel Formulation	Input county specific fuel properties in the MOVES2014a database.	TCEQ, EPA Fuel Surveys, and default MOVES2014a input where local data unavailable
Inspection and Maintenance Coverage	Input inspection and maintenance (I/M) coverage record for each combination of pollutants, process, county, fuel type, regulatory class and model year are specified using this input.	State I/M program data provided by TCEQ
Fuel Engine Fraction / Diesel Fraction (AVFT)	Input fuel engine fractions (i.e. Gasoline vs. Diesel Engines types in the vehicle population) for all vehicle types.	2011 and 2014 TxDMV registration data MOVES2014a default used for light duty vehicles and buses

Exhibit 4.4 MOVES2014a I/M Descriptive Inputs for Subject Counties

2011						
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data[2]						
I/M Program ID	20	21	22	23	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	112	MOVES2014a
Source Use Type	21, 31, 32	21, 31, 32	52, 54	21, 31, 32	21, 31, 32	MOVES2014a
Begin Model Year	1996	1987	1987	1987	1996	Annual testing; program specifications[3]
End Model Year	2009	1995	2009	1995	2009	Annual testing; program specifications
Inspection Frequency	1	1	1	1	1	Annual testing; program specifications[4]
Test Standards Description	Exhaust OBD[5] Check	ASM[6] 2525/ 5015 Phase-in Cut points	Two-mode, 2500 RPM[7]/Idle Test	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	Annual testing; program specifications[8]
Test Standards ID	51	23	12	41	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32[9]					MOVES2014a

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[2] Wise County does not have an I/M Program

[3] Inputs provided by the TCEQ

[4] Inputs provided by the TCEQ

[5] On-board Diagnostic

[6] Acceleration Simulation Mode

[7] Revolutions Per Minute

[8] Inputs provided by the TCEQ

[9] http://www.epa.gov/otaq/models/moves/documents/420b15007.pdf

Exhibit 4.4. MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2017						
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data						
I/M Program ID	20	21	22	23	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	112	MOVES2014a
Source Use Type	21, 31, 32	21, 31, 32	52, 54	21, 31, 32	21, 31, 32	MOVES2014a
Begin Model Year	1996	1993	1993	1993	1996	Annual testing; program specifications
End Model Year	2015	1995	2015	1995	2015	Annual testing; program specifications
Inspection Frequency	1	1	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	ASM 2525/ 5015 Phase-in Cut points	Two-mode, 2500 RPM/ Idle Test	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	23	12	41	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32					Expected compliance (%) - MOVES2014a Default

Exhibit 4.4. MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2018						
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data						
I/M Program ID	20	21	22	23	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	112	MOVES2014a
Source Use Type	21, 31, 32	21, 31, 32	52, 54	21, 31, 32	21, 31, 32	MOVES2014a
Begin Model Year	1996	1994	1994	1994	1996	Annual testing; program specifications
End Model Year	2016	1995	2016	1995	2016	Annual testing; program specifications
Inspection Frequency	1	1	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	ASM 2525/5015 Phase-in Cut points	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	23	12	41	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32					Expected compliance (%) - MOVES2014a Default

Exhibit 4.4. MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2020				
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data				
I/M Program ID	20	22	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	MOVES2014a
Source Use Type	21, 31, 32	52, 54	21, 31, 32	MOVES2014a
Begin Model Year	1996	1996	1996	Annual testing; program specifications
End Model Year	2018	2018	2018	Annual testing; program specifications
Inspect Frequency	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	12	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32			Expected compliance (%) - MOVES2014a Default

Exhibit 4.4. MOVES2014a I/M Descriptive Inputs for Subject Counties (continued)

2021				
Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data				
I/M Program ID	20	22	24	MOVES2014a
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	MOVES2014a
Source Use Type	21, 31, 32	52, 54	21, 31, 32	MOVES2014a
Begin Model Year	1997	1997	1997	Annual testing; program specifications
End Model Year	2019	2019	2019	Annual testing; program specifications
Inspect Frequency	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap and OBD Check	Annual testing; program specifications
Test Standards ID	51	12	45	MOVES2014a
I/M Compliance	93.12% for source use type 21, 91.26% for source use type 31 and 85.67% for source use type 32			Expected compliance (%) - MOVES2014a Default

Exhibit 4.5. Fuel Formulations

	Pre-1990 Controls			2011		
Counties	**Core**	**Perimeter**	**All**	**Core**	**Perimeter**	**All**
Fuel Type	**Gasoline**		**Diesel**	**Gasoline**		**Diesel**
Fuel Formulation ID	10001	10002	32500	10707	10727	30572
Fuel Subtype ID	10	10	20	12	12	20
RVP	7.80	8.70	0.00	6.99	7.39	0.00
Sulfur Level	429.96	432.12	2,500.00	24.80	29.27	5.72
Ethanol Volume	0.00	0.00	0.00	9.70	9.78	0.00
Methyl Tertiary Butyl Ether (MTBE) Volume	0.00	0.00	0.00	0.00	0.00	0.00
Ethyl Tertiary Butyl Ether (ETBE) Volume	0.00	0.00	0.00	0.00	0.00	0.00
Tertiary Amyl Methyl Ether (TAME) Volume	0.00	0.00	0.00	0.00	0.00	0.00
Aromatic Content	26.40	26.40	0.00	14.48	25.23	0.00
Olefin Content	11.90	11.90	0.00	11.79	11.16	0.00
Benzene Content	1.64	1.64	0.00	0.48	0.96	0.00
e200	46.04	50.00	0.00	47.19	49.08	0.00
e300	81.43	83.00	0.00	85.22	81.36	0.00
Vol To Wt Percent Oxy	0.00	0.00	0.00	0.3653	0.3653	0.00
BioDiesel Ester Volume	0.00	0.00	0.00	0.00	0.00	0.00
Cetane Index	0.00	0.00	0.00	0.00	0.00	0.00
PAH Content	0.00	0.00	0.00	0.00	0.00	0.00
T50	207.90	199.82	0.00	209.44	204.74	0.00
T90	336.54	329.41	0.00	325.41	334.89	0.00

Exhibit 4.5. Fuel Formulations (continued)

	2017			2018, 2020, 2021		
Counties	**Core**	**Perimeter**	**All**	**Core**	**Perimeter**	**All**
Fuel Type	**Gasoline**		**Diesel**	**Gasoline**		**Diesel**
Fuel Formulation ID	17724	17734	30572	18724	18734	30011
Fuel Subtype ID	12	12	20	12	12	20
RVP	7.00	7.54	0	7.00	7.80	0
Sulfur Level	22.11	21.28	6.37	10.00	10.00	11.00
Ethanol Volume	9.67	9.66	0	9.67	9.66	0
MTBE Volume	0	0	0	0	0	0
ETBE Volume	0	0	0	0	0	0
TAME Volume	0	0	0	0	0	0
Aromatic Content	14.74	25.35	0	14.74	25.35	0
Olefin Content	10.74	8.33	0	10.74	8.33	0
Benzene Content	0.46	0.76	0	0.46	0.61	0
e200	49.21	49.45	0	49.21	49.45	0
e300	85.13	82.68	0	85.13	82.68	0
Vol To Wt Percent Oxy	0.3653	0.3653	0	0.3653	0.3653	0
BioDiesel Ester Volume	0	0	0	0	0	0
Cetane Index	0	0	0	0	0	0
PAH Content	0	0	0	0	0	0
T50	202.52	203.73	0	202.52	203.73	0
T90	325.77	327.68	0	325.77	327.68	0

Notes: (TTI, January 2018): **Pre-1990 controls** gasoline: used select MOVES 1990 default formulations (see defaults: fuelformulationID [FFID] 1007 and 1034) with RVP adjustment (for FFID 1034), and replaced the default FFIDs with unique, arbitrary values. Pre-1990 diesel sulfur: based on NIPER U.S. refiner survey summary information which placed average sulfur for the typical No. 2 diesel, within the post-1979/pre-1993 regulation period, in the 2500-3000 ppm range. **2011/2017** gasoline: used Texas summer gasoline data from EPA DFW RFG compliance surveys and TCEQ/ERG statewide surveys from each year. TTI calculated gasoline grade averages then the overall weighted composites using 2011 and 2016 [latest] gasoline sales fractions (based on Texas annual reformulated and conventional gasoline volumes from EIA "Prime Supplier Sales Volumes for Petroleum Products" data). TTI updated TCEQ/ERG survey summary results using the MOVES fuel region aggregations (instead of the original TxDOT District aggregation). Diesel sulfur: TTI aggregated data to the state level to calculate average diesel sulfur content. **2018 and later** (future) gasoline: formulations are the same as 2017 (based on latest local survey data), except for RFG, average sulfur level was set to the expected future year value (i.e., MOVES default [Tier 3 annual average standard]); and for conventional gasoline the regulated properties RVP, sulfur level, and benzene content were replaced with expected future year values (i.e., the appropriate MOVES defaults). Diesel sulfur: set to the expected Texas future year value (conservative level based on local data and also within the ULSD annual average standard).

Area Specific Calculations and Procedures

SourceUse Type Distribution

Sourceuse type age distributions are calculated from TxDMV vehicle registration data. July data sets of 2014 utilized for light- and heavy-duty vehicle classes. MOVES2014a default values are used for bus categories. Light-duty registration data for Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise counties are weighted for commute patterns with the County-to-County Worker Flow data from the 2013 five-year American Community Survey. Exhibit 4.6 identifies the percentages applied for this weighted adjustment. The TTI methodology is applied to the heavy-duty vehicle data for developing registration for all heavy-duty vehicles. These files are included in Appendix A.

Exhibit 4.6: County-to-County Worker Flow[10]

	County of Employment									
Resident County	**Collin**	**Dallas**	**Denton**	**Ellis**	**Johnson**	**Kaufman**	**Parker**	**Rockwall**	**Tarrant**	**Wise**
Collin	65.38%	10.25%	5.08%	0.28%	0.20%	0.97%	0.05%	7.63%	0.87%	0.00%
Dallas	19.09%	65.97%	10.19%	10.73%	1.32%	15.83%	0.98%	23.65%	7.69%	0.69%
Denton	11.45%	7.85%	75.56%	0.37%	0.17%	0.66%	0.94%	0.58%	3.30%	3.12%
Ellis	0.16%	1.79%	0.17%	79.39%	1.43%	0.74%	0.10%	0.00%	0.55%	0.21%
Hood	0.03%	0.06%	0.05%	0.10%	2.27%	0.00%	2.39%	0.00%	0.53%	0.37%
Hunt	0.76%	0.42%	0.13%	0.12%	0.00%	4.37%	0.03%	9.42%	0.03%	0.00%
Johnson	0.05%	0.32%	0.32%	3.46%	76.23%	0.00%	1.45%	0.16%	3.21%	0.69%
Kaufman	0.29%	1.57%	0.14%	0.74%	0.02%	72.64%	0.00%	3.59%	0.11%	0.02%
Parker	0.02%	0.14%	0.09%	0.06%	0.52%	0.02%	77.41%	0.00%	2.57%	5.86%
Rockwall	0.68%	1.23%	0.14%	0.12%	0.06%	3.70%	0.00%	53.95%	0.06%	0.13%
Tarrant	2.02%	10.29%	7.36%	4.63%	17.47%	1.06%	14.11%	1.02%	80.26%	10.75%
Wise	0.07%	0.11%	0.76%	0.01%	0.31%	0.02%	2.55%	0.00%	0.82%	78.15%

Source: 2013 5-year American Community Survey.

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[10] The sum of each county maybe less than or more than 100% due to rounding.

Fuel Engine Fractions

Diesel fractions for heavy-duty vehicle categories utilized 12-county summed yearly July registration data for modeling 2011, 2017, 2018, 2020 and 2021 analysis years. July 2011 registration data is used for modeling 2011 and July 2014 is used for modeling 2017, 2018, 2020, and 2021 analysis years. Light-duty and bus categories utilize MOVES2014 default values. All diesel fraction files, included in Appendix A, list specific data used for this analysis.

MOVES2014 Emission Factors

MOVES2014a emission factors for all the control scenarios are reported in Appendix C.

Adjustments

Adjustments are applied to the emission factors in a post-process step. Texas Low Emission Diesel (TxLED) NO_X Adjustment is applied to the emission factors. VMT Mix adjustment is applied simultaneously with the emission calculation procedure discussed in Chapter 4.

TxLED NOx Adjustment

NO_X emission factors for diesel vehicle classes are adjusted to apply the federal low emission diesel program. Exhibit 4.7 lists the appropriate adjustment for each vehicle class.

Exhibit 4.7: TxLED NO_x Adjustments

Source Use Type	Adjustment Factors				
	2011	2017	2018	2020	2021
Passenger Car	0.9413	0.9483	0.9501	0.9508	0.9509
Passenger Truck	0.9465	0.9495	0.9498	0.9501	0.9505
Light Commercial Truck	0.9429	0.9465	0.9469	0.9481	0.9481
Intercity Bus	0.9417	0.9426	0.9430	0.9439	0.9443
Transit Bus	0.9419	0.9428	0.9432	0.9441	0.9445
School Bus	0.9420	0.9428	0.9431	0.9439	0.9444
Refuse Truck	0.9438	0.9458	0.9463	0.9474	0.9479
Single Unit Short-Haul Truck	0.9491	0.9511	0.9512	0.9515	0.9516
Single Unit Long-Haul Truck	0.9495	0.9512	0.9513	0.9516	0.9516
Motor Home	0.9439	0.9453	0.9458	0.9467	0.9471
Combination Short-Haul Truck	0.9460	0.9489	0.9491	0.9499	0.9502
Combination Long-Haul Truck	0.9438	0.9469	0.9474	0.9482	0.9490

Source: NCTCOG

Sourceusetype Population

TxDMV registration data was used for developing sourceusetype (SUT) population for DFW area. July 2011 registration data is used for developing 2011 SUT population and July 2014 registration date is used for developing 2017, 2018, 2020, and 2021 analysis years SUT population. For years 2017, 2018, 2020, and 2021 VMT growth rate was used to forecast SUT population. Exhibit 4.8 summarizes the SUT by county for all analysis years. All SUT population files are included in Appendix A.

Exhibit 4.8: Sourceusetype Population

Counties	2011	2017	2018	2020	2021
Collin	566,217	671,965	683,311	710,212	721,399
Dallas	1,668,348	1,915,291	1,947,630	2,024,308	2,056,198
Denton	455,549	544,958	554,161	575,981	585,048
Ellis	122,968	136,468	138,776	144,236	146,505
Johnson	118,988	134,802	137,079	142,478	144,717
Kaufman	76,000	88,533	90,029	93,573	95,045
Parker	93,542	109,135	110,979	115,347	117,163
Rockwall	61,947	71,756	72,967	75,839	77,033
Tarrant	1,289,964	1,492,912	1,518,118	1,577,885	1,602,745
Wise	52,630	59,144	60,145	62,512	63,497
Total	**4,506,153**	**5,224,964**	**5,313,195**	**5,522,371**	**5,609,350**

Vehicle Miles of Travel Mix (or Fractions)

VMT Mix is applied to the emission factors in a post-process methodology. The VMT mix enables assignment of emission factors by vehicle type to a total volume to calculate emissions on a link or functional class. VMT mix is estimated for rural and urban freeways, arterials, collectors and high occupancy vehicle lanes for three time periods.

Vehicle counts reported in the latest available Texas Department of Transportation (TxDOT) Vehicle Classification Report provide a base for the distribution of vehicles by type and functional class for the freeway, arterial, and collector VMT Mixes. The number of vehicles in each of the 12 axle-based categories are combined into intermediate groups, and then disaggregated into MOVES2014a Source Use Types by applying appropriate TxDMV registration data and/or MOVES2014a defaults. Exhibit 4.9 outlines this process. For each functional class, the values are aggregated across the total vehicles to determine the fraction of vehicles from each class. Motorcycles are allocated as 0.1 percent for each functional class, subtracted from the Light-duty Gasoline Vehicles category.

This “temporary” VMT mix calculation is then redistributed using local truck and non-truck splits identified by the DFX model. This process is performed for each of the three functional classes and three time periods, where AM peak is 6:30 a.m. to 8:59 a.m., PM peak is 3:00 p.m. to 6:29 p.m., and Off-Peak represents all other hours of the day. Motorcycles, light-duty vehicles, and two-axle light-duty trucks are classified as non-trucks. Trucks and heavy-duty vehicles with three axles or more, to include buses, are defined as trucks.

Exhibit 4.9: Vehicle Classification Process

Axle-Based Vehicle Classifications		Intermediate Groups/HPMSVtypeID[11]		Detailed Groups	
C	**Passenger Vehicles**	PV	Light-Duty Vehicles (25)	Passenger Car	Passenger Gasoline Vehicle
					Passenger Diesel Vehicle
					Motorcycle (MC)[12]
P	**2 Axle, 4 Tire Single Unit**			Passenger Truck	Passenger Gasoline Truck
					Passenger Gasoline Truck
				Light Commercial Truck	Light Commercial Gasoline Truck
					Light Commercial Gasoline Truck
B	**Buses**	Bus	Buses (40)	School Bus	Gasoline School Bus*
					Diesel School Bus*
				Transit Bus	Gasoline Transit Bus*
					Diesel Transit Bus*
				Diesel Intercity Bus*	
SU2	**2 Axle, 6 Tire Single Unit**	Heavy-Duty Trucks	Single Unit Heavy-Duty Vehicles (50)	Single Unit Short-haul Truck	Single Unit Short-haul Gasoline Truck*
SU3	**3 Axle, Singe Unit**				Single Unit Short-haul Diesel Truck*
SU4	**4+ Axle, Single Unit**			Single Unit Long-haul Truck	Single Unit Long-haul Gasoline Truck*
SE4	**3 or 4 Axle, Single Trailer**				Single Unit Long-haul Diesel Truck*

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[11] HPMS – Highway Performance Monitoring System

[12] Motorcycles are allocated as 0.1 percent for each functional class, subtracted from the light-duty vehicles.

Exhibit 4.9. Vehicle Classification Process (continued)

Axle-Based Vehicle Classifications		Intermediate Groups/HPMSVtypeID[2]		Detailed Groups	
SE5	**5 Axle, Single Trailer**	Heavy-Duty Trucks	Combination Heavy-Duty Vehicles (60)	Combination Short-haul Truck	Combination Short-haul Gasoline Truck*
SE4	**3 or 4 Axle, Single Trailer**				
SD5	**5 Axle, Multi Trailer**				Combination Short-haul Diesel Truck*
SD6	**6 Axle, Multi Trailer**			Combination Long-haul Diesel Truck*	
SD7	**7+ Axle, Multi Trailer**				

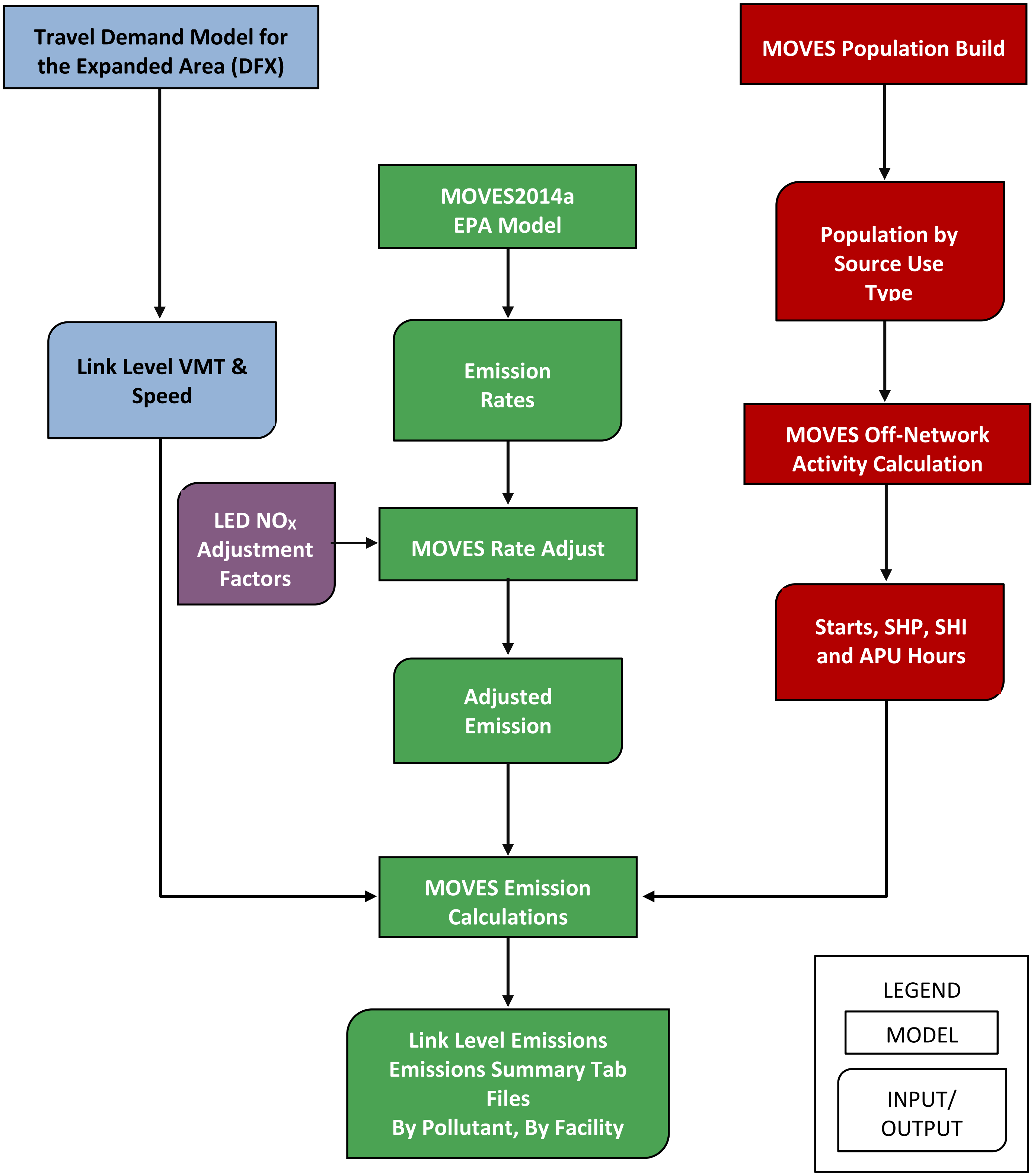
*Categories calculated using MOVES2014a defaults

CHAPTER 5: EMISSION CALCULATION PROCEDURE

Emissions estimates are calculated using *“TTI emissions inventory estimation utilities using moves: movesutl”* developed by the Texas A&M Transportation Institute (TTI). This software combines vehicle activity and emission factors to create emission estimates.

Exhibit 5.1 outlines the emission calculation modeling process that is used to calculate the emissions estimates for the Dallas-Fort Worth (DFW) ozone nonattainment area. Different procedures were applied for DFW Expanded Travel Demand Model (DFX) counties outlined in the following sections.

Exhibit 5.1: MOVES2014a Emission Modeling Process



CHAPTER 6: SUMMARY OF VEHICLE MILES OF TRAVEL, SPEED, AND EMISSIONS

Vehicle Miles of Travel Estimates

Appendix E contains the summarized VMT estimates by the analysis year and time-of-day (TOD) for the counties.

Speed Estimates

Appendix E contains the summarized speeds by the analysis year and TOD for the counties.

Emission Estimates

The final county emission estimates for each analysis year and control scenarios are summarized in Exhibit 6.1. Additional modeled pollutants not shown in this section are available in Appendices D and E.

Appendix D contains the detailed emissions for all counties by analysis year, control scenarios TOD.

Appendix E contains the summarized emissions for all counties by analysis year, control scenarios TOD.

Exhibit 6.1: Final Emission Estimates for the 10-County Nonattainment Area

Oxides of Nitrogen Emissions (tons/day) **Summer Season, Midweek**					
Adjusted Base Year					
County	**2011**	**2017**	**2018**	**2020**	**2021**
Collin	N/A	82.26	82.23	82.18	82.14
Dallas	N/A	285.35	285.31	285.53	285.57
Denton	N/A	74.40	74.40	74.35	74.33
Ellis	N/A	35.56	35.56	35.56	35.55
Johnson	N/A	23.26	23.25	23.25	23.25
Kaufman	N/A	27.48	27.48	27.49	27.49
Parker	N/A	23.10	23.10	23.10	23.10
Rockwall	N/A	10.93	10.93	10.89	10.89
Tarrant	N/A	187.65	187.67	187.58	187.55
Wise	N/A	18.26	18.26	18.25	18.25
Total	**N/A**	**768.25**	**768.19**	**768.18**	**768.12**
Pre-90 Controls					
County	**2011**	**2017**	**2018**	**2020**	**2021**
Collin	82.33	99.71	102.24	107.97	110.58
Dallas	284.72	329.01	333.85	344.09	348.14
Denton	74.40	84.69	86.57	89.30	90.91
Ellis	35.88	44.78	46.11	48.89	50.31
Johnson	23.38	28.55	29.27	30.93	31.73
Kaufman	27.91	34.18	35.21	37.38	38.43
Parker	23.58	29.63	30.52	32.23	33.01
Rockwall	10.99	12.66	12.94	13.41	13.69
Tarrant	186.18	219.59	223.01	231.42	234.85
Wise	18.39	20.78	21.31	22.29	22.78
Total	**767.76**	**903.58**	**921.03**	**957.91**	**974.43**

Exhibit 6.1: Final Emission Estimates for the 10-County Nonattainment Area (continued)

Nitrogen Oxides Emissions (tons/day)
Summer Season, Midweek

FMVCP

County	2011	2017	2018	2020	2021
Collin	35.44	22.44	20.23	16.99	15.63
Dallas	129.28	79.49	71.12	58.58	53.33
Denton	32.25	19.46	17.53	14.43	13.24
Ellis	16.39	10.85	9.83	8.31	7.70
Johnson	10.53	6.75	6.06	5.05	4.64
Kaufman	12.87	8.37	7.59	6.43	5.94
Parker	10.39	7.17	6.58	5.70	5.34
Rockwall	5.22	3.30	3.00	2.53	2.34
Tarrant	82.38	52.14	46.75	38.80	35.43
Wise	8.66	5.55	5.10	4.43	4.14
Total	**343.41**	**215.52**	**193.79**	**161.25**	**147.73**

Fuel Controls

County	2011	2017	2018	2020	2021
Collin	26.62	15.84	12.89	10.65	9.75
Dallas	97.32	56.44	45.66	37.00	33.54
Denton	24.95	14.18	11.66	9.44	8.64
Ellis	14.11	8.89	7.58	6.36	5.89
Johnson	8.69	5.23	4.36	3.59	3.29
Kaufman	10.96	6.74	5.71	4.80	4.43
Parker	10.39	7.17	6.58	5.70	5.34
Rockwall	4.31	2.59	2.21	1.86	1.72
Tarrant	61.59	36.62	29.62	24.09	21.88
Wise	7.49	4.62	4.04	3.52	3.31
Total	**266.43**	**158.32**	**130.31**	**107.01**	**97.79**

Exhibit 6.1: Final Emission Estimates for the 10-County Nonattainment Area (continued)

Nitrogen Oxides Emissions (tons/day)
Summer Season, Midweek

Inspection/Maintenance

County	2011	2017	2018	2020	2021
Collin	24.34	14.55	11.93	9.89	9.08
Dallas	88.66	51.70	42.19	34.33	31.22
Denton	23.06	13.14	10.89	8.85	8.11
Ellis	13.34	8.43	7.24	6.09	5.65
Johnson	8.08	4.88	4.10	3.38	3.10
Kaufman	10.29	6.35	5.42	4.58	4.24
Parker	9.89	6.83	6.28	5.46	5.12
Rockwall	4.02	2.43	2.09	1.76	1.64
Tarrant	56.15	33.49	27.30	22.27	20.29
Wise	7.49	4.62	4.04	3.52	3.31
Total	**245.32**	**146.42**	**121.48**	**100.13**	**91.76**

TxLED

County	2011	2017	2018	2020	2021
Collin	23.77	14.22	11.64	9.65	8.86
Dallas	86.65	50.55	41.17	33.51	30.47
Denton	22.43	12.81	10.59	8.61	7.89
Ellis	12.87	8.14	6.98	5.88	5.45
Johnson	7.85	4.75	3.98	3.29	3.02
Kaufman	9.94	6.15	5.24	4.42	4.09
Parker	9.52	6.59	6.06	5.27	4.94
Rockwall	3.90	2.35	2.02	1.71	1.59
Tarrant	54.91	32.79	26.68	21.78	19.84
Wise	7.24	4.46	3.89	3.39	3.18
Total	**239.08**	**142.81**	**118.25**	**97.51**	**89.33**

Exhibit 6.1: Final Emission Estimates for the 10-County Nonattainment Area (continued)

Volatile Organic Compounds (tons/day) Summer Season, Midweek					
Adjusted Base Year					
County	**2011**	**2017**	**2018**	**2020**	**2021**
Collin	N/A	35.37	35.36	35.28	35.26
Dallas	N/A	119.49	119.45	119.26	119.26
Denton	N/A	29.55	29.54	29.47	29.47
Ellis	N/A	9.53	9.53	9.51	9.51
Johnson	N/A	7.88	7.88	7.87	7.87
Kaufman	N/A	7.31	7.31	7.29	7.29
Parker	N/A	6.41	6.41	6.40	6.40
Rockwall	N/A	4.04	4.04	4.03	4.03
Tarrant	N/A	80.89	80.88	80.70	80.68
Wise	N/A	4.89	4.89	4.88	4.88
Total	**N/A**	**305.36**	**305.29**	**304.69**	**304.65**
Pre-90 Controls					
County	**2011**	**2017**	**2018**	**2020**	**2021**
Collin	34.96	42.17	43.21	45.49	46.57
Dallas	118.35	134.69	136.87	141.03	142.83
Denton	29.07	33.68	34.43	35.78	36.45
Ellis	9.33	11.01	11.28	11.91	12.23
Johnson	7.73	9.22	9.41	9.89	10.12
Kaufman	7.23	8.82	9.08	9.64	9.91
Parker	6.32	7.80	8.00	8.37	8.53
Rockwall	4.00	4.61	4.71	4.92	5.02
Tarrant	79.36	92.23	93.75	97.35	98.88
Wise	4.80	5.55	5.68	5.90	6.01
Total	**301.15**	**349.78**	**356.42**	**370.28**	**376.55**

Exhibit 6.1: Final Emission Estimates for the 10-County Nonattainment Area (continued)

Volatile Organic Compounds (tons/day) Summer Season, Midweek					
FMVCP					
County	**2011**	**2017**	**2018**	**2020**	**2021**
Collin	14.80	10.84	10.23	9.31	8.90
Dallas	53.53	36.36	33.97	30.37	28.78
Denton	12.42	8.91	8.41	7.60	7.25
Ellis	4.44	3.09	2.89	2.59	2.45
Johnson	3.66	2.60	2.43	2.18	2.06
Kaufman	3.36	2.31	2.15	1.91	1.80
Parker	2.82	2.06	1.94	1.75	1.65
Rockwall	1.92	1.33	1.25	1.13	1.07
Tarrant	35.68	25.77	24.21	21.91	20.84
Wise	2.29	1.54	1.45	1.29	1.21
Total	**134.92**	**94.81**	**88.93**	**80.04**	**76.01**
Fuel Controls					
County	**2011**	**2017**	**2018**	**2020**	**2021**
Collin	12.58	8.97	8.19	7.44	7.12
Dallas	45.03	29.85	26.98	24.08	22.82
Denton	10.58	7.44	6.81	6.15	5.86
Ellis	4.02	2.70	2.46	2.19	2.07
Johnson	3.36	2.31	2.11	1.88	1.78
Kaufman	2.94	1.97	1.79	1.59	1.49
Parker	2.82	2.06	1.94	1.75	1.65
Rockwall	1.76	1.19	1.09	0.98	0.93
Tarrant	30.73	21.56	19.63	17.69	16.82
Wise	2.05	1.36	1.25	1.12	1.05
Total	**115.87**	**79.41**	**72.25**	**64.87**	**61.59**

Exhibit 6.1: Final Emission Estimates for the 10-County Nonattainment Area (continued)

Volatile Organic Compounds (tons/day)
Summer Season, Midweek

Inspection/Maintenance

County	2011	2017	2018	2020	2021
Collin	11.05	7.80	7.14	6.48	6.20
Dallas	39.57	25.91	23.45	20.96	19.87
Denton	9.34	6.50	5.95	5.37	5.12
Ellis	3.57	2.37	2.17	1.94	1.83
Johnson	2.96	2.01	1.84	1.65	1.56
Kaufman	2.62	1.74	1.58	1.41	1.33
Parker	2.51	1.81	1.71	1.55	1.46
Rockwall	1.56	1.04	0.96	0.86	0.82
Tarrant	27.01	18.71	17.05	15.39	14.64
Wise	2.05	1.36	1.25	1.12	1.05
Total	**102.24**	**69.25**	**63.10**	**56.73**	**53.88**

TxLED

County	2011	2017	2018	2020	2021
Collin	11.05	7.80	7.14	6.48	6.20
Dallas	39.57	25.91	23.45	20.96	19.87
Denton	9.34	6.50	5.95	5.37	5.12
Ellis	3.57	2.37	2.17	1.94	1.83
Johnson	2.96	2.01	1.84	1.65	1.56
Kaufman	2.62	1.74	1.58	1.41	1.33
Parker	2.51	1.81	1.71	1.55	1.46
Rockwall	1.56	1.04	0.96	0.86	0.82
Tarrant	27.01	18.71	17.05	15.39	14.64
Wise	2.05	1.36	1.25	1.12	1.05
Total	**102.24**	**69.25**	**63.10**	**56.73**	**53.88**

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CHAPTER 7: LIST OF APPENDICES

Appendix A: MOVES2014a External Files

Appendix B: MOVES2014a Input and Output Database Files

Appendix C: MOVES2014a Emission Factor Files

Appendix D: County Emission Estimates (Tab-delimited Format)

Appendix E: Inventory Summary Files (Tab-delimited Format)

Appendix F: SCC and XML Files

Appendix G: Project Quality Control Report and Travel Model Validation Report

Appendix H: Supplement Files (MOVES RunSpecs and MYSQL Script)

Appendix I: Electronic Data Submittal Description

APPENDIX 14

PRODUCTION OF HGB REASONABLE FURTHER PROGRESS ON-ROAD MOBILE EMISSIONS INVENTORIES

DALLAS-FORT WORTH AND HOUSTON-GALVESTON-BRAZORIA SERIOUS CLASSIFICATION REASONABLE FURTHER PROGRESS STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-079-SIP-NR

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Production of HGB Reasonable Further Progress On-Road Mobile Emissions Inventories

Prepared by the Texas A&M Transportation Institute

May 2019

PRODUCTION OF HGB REASONALBE FURTHER PROGRESS ON-ROAD MOBILE EMISSIONS INVENTORIES

TECHNICAL REPORT

FINAL

Prepared for the
Texas Commission on Environmental Quality
Air Quality Planning and Implementation Division

Prepared by the
Transportation Modeling Program
Texas A&M Transportation Institute
TTI Study No.: 609631
Study Title: Air Quality Technical Support
(Grant Activities: 582-18-81247-07)

May 2019

TEXAS A&M TRANSPORTATION INSTITUTE
The Texas A&M University System
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EXECUTIVE SUMMARY

The Texas Commission on Environmental Quality (TCEQ) sponsored work by the Texas A&M Transportation Institute (TTI) to develop and produce on-road emissions inventory data needed in support of the TCEQ's Houston-Galveston-Brazoria (HGB) 2008-eight-hour ozone nonattainment area reasonable further progress (RFP) state implementation plan (SIP) revision. This work by TTI produced ozone season, summer weekday on-road mobile source RFP scenario emissions inventories and individual control strategy reduction estimates needed for the HGB eight-county area consisting of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties.

The HGB RFP analysis requires five years - base, milestone, milestone contingency, attainment, and attainment contingency years (i.e., 2011, 2017, 2018, 2020, and 2021, respectively) - and includes the 12 RFP inventory scenarios, delineated in Table A. Individual control strategy reduction estimates of Volatile Organic Compounds (VOC) and Oxides of Nitrogen (NOx) were also required for 2017, 2018, 2020, and 2021. TTI produced inventory estimates of six gaseous pollutants and particulate matter (PM) pollutants in both 2.5 and 10 micron size categories ($PM_{2.5}$ and PM_{10}).

Table A. HGB RFP Inventory Scenarios.

No.	RFP Inventory	Activity Input[1]	Emissions Rates Input[2]
1	2011 Base Year	2011 (Base Year)	2011 Control Strategy
2	2011 Adjusted Base Year		2011 Pre-1990 Control
3	2017 Adjusted Base Year		2017 Pre-1990 Control
4	2020 Adjusted Base Year		2020 Pre-1990 Control
5	2017 Pre-1990 Control	2017 (Milestone Year)	2017 Pre-1990 Control
6	2017 Control Strategy		2017 Control Strategy
7	2018 Pre-1990 Control	2018 (Milestone Contingency Year)	2018 Pre-1990 Control
8	2018 Control Strategy		2018 Control Strategy
9	2020 Pre-1990 Control	2020 (Attainment Year)	2020 Pre-1990 Control
10	2020 Control Strategy		2020 Control Strategy
11	2021 Pre-1990 Control	2021 (Attainment Contingency Year)	2021 Pre-1990 Control
12	2021 Control Strategy		2021 Control Strategy

[1] For external inventory calculations: vehicle miles traveled (VMT) mix, link VMT/speeds, and off-network activity.

[2] "Pre-1990 Control" rates are for calendar year of evaluation fleet but exclude post-1990 Clean Air Act Amendment (CAAA) controls – no Inspection and Maintenance (I/M) program, no post-1990 Federal Motor Vehicle Control Program (FMVCP) effects, no reformulated gasoline (RFG) (uses pre-1992 conventional gasoline with 1992 summer Reid vapor pressure [RVP] limit promulgated prior to enactment of the 1990 CAAA), no Texas Low Emissions Diesel (TxLED). "Control Strategy" rates include effects of control strategies current for subject analysis year (i.e., both pre- and post-1990 FMVCP, RFG, I/M [depending on county], TxLED fuel).

TTI used the latest, official version of the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES) model (MOVES2014a), as required for SIP analyses, in combination with TTI's SIP-quality inventory development methodology for use with MOVES.[1] This is the detailed, disaggregate, travel demand model (TDM) link-based rates-per-activity inventory process. It produces MOVES-based emissions rate look-up tables for external emissions calculations performed at detailed, disaggregate, temporal, and spatial levels, using the latest (readily) available data, models, and procedures. The latest planning assumptions were used to assure that motor vehicle emissions budgets to be established by TCEQ in the SIP will be consistent with transportation conformity analysis requirements.

Hourly inventories were estimated by MOVES source use type (SUT) and fuel type (FT) combination (or vehicle type) and TDM roadway class. TDMs were post-processed to estimate hourly, directional, link (roadway segment)-level fleetwide vehicle miles traveled (VMT) and operational speeds, for use in combination with time-of-day VMT mix estimates (fractional VMT by vehicle type[2]), for the roadway-based emissions calculations. Using estimates of vehicle operating hours, vehicle populations, truck hotelling activity, and other data, TTI estimated hourly off-network activity factors for the parked vehicle-based emissions calculations. Off-network activity types are: source-hours-parked (SHP); starts; and source hours extended idling (SHI) and auxiliary power unit (APU) hours (emissions-producing components of combination long-haul truck hotelling hours). Particular off-network evaporative rates, in mass/SHP form not directly available from MOVES, were produced by a post-processing method and compiled with other rates produced directly by MOVES to yield look-up tables of all rates in the appropriate activity terms, as needed in the external emissions calculations. For applicable RFP scenarios, rates were further post-processed to factor in the Texas Low Emissions Diesel (TxLED) effects, which were unavailable in MOVES. The analysis used TTI's MOVES-based inventory development utilities recently updated for use with MOVES2014a.[3] EPA's *Technical Guidance*[4] is the primary technical reference for guidance on appropriate inputs and use of MOVES.

Table B and Table C summarize the inventory estimates and individual control strategy reduction estimates for the HGB eight-county area. A more detailed summary is provided in the following sections, along with the methods used and details of modeling input usage and development.

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[1] MOVES2014b incorporates significant improvements in calculating nonroad equipment emissions. It does not, however, significantly change the onroad criteria pollutant emissions results of MOVES2014a, and therefore is not considered a new model for SIP and transportation conformity purposes.

[2] The predominant fuel types of gasoline and diesel were estimated, with alternative fuels treated as de minimis.

[3] TTI's MOVES2014a-compatible inventory estimation utilities are detailed in: *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL User's Guide,* TTI, August 2016.

[4] *MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for Sate Implementation Plans and Transportation Conformity*, EPA, November 2015.

Table B. HGB Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_x	CO_2
Adjusted Base Year[1]	2011	145,136,623	34.51	239.63	3,194.89	536.68	81,891.57
	2017	145,136,623	34.51	242.85	3,198.95	536.32	77,260.99
	2020	145,136,623	34.51	242.46	3,194.11	536.11	77,249.85
Pre-1990 Controls[2]	2017	173,069,175	38.19	292.24	3743.37	671.15	91,806.80
	2018	183,591,636	37.75	311.03	3,980.24	714.24	97,875.33
	2020	193,683,005	37.85	322.18	4,167.49	750.39	103,147.24
	2021	197,487,997	37.75	334.30	4,277.41	768.67	105,310.34
Base Year and Control Strategy[3]	2011	145,136,623	34.51	80.45	894.40	168.60	81,443.95
	2017	173,069,175	38.19	61.24	775.29	107.52	90,499.71
	2018	183,591,636	37.75	58.65	778.33	95.24	94,566.13
	2020	193,683,005	37.85	52.21	737.19	79.48	95,337.62
	2021	197,487,997	37.75	51.28	723.54	73.57	94,929.02

[1] Adjusted base year inventories: 2011 activity inputs (VMT mix, link VMT/speeds, and off-network activity) and analysis year pre-1990 control emissions rates.

[2] Pre-1990 controls inventories: analysis year activity inputs and analysis year pre-1990 control emissions rates. Rates are for analysis year fleet but exclude post-1990 CAAA controls – no I/M program, post-1990 FMVCP effects, RFG (uses pre-1992 conventional gasoline with 1992 summer RVP limit promulgated prior to enactment of the 1990 CAAA), or TxLED.

[3] Base Year and control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., both pre- and post-1990 FMVCP, Tier 3 RFG and Ultra Low Sulfur Diesel, I/M [depending on county], and TxLED).

Table C. HGB Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC				NO_x			
		2017	2018	2020	2021	2017	2018	2020	2021
Inventory	**Pre-90 Control**	292.24	311.03	322.18	334.30	671.15	714.24	750.39	768.67
	Control Strategy	61.24	58.65	52.21	51.28	107.52	95.24	79.48	73.57
Reductions	**Total**	230.99	252.38	269.97	283.02	563.63	619.00	670.91	695.10
	Tier 3 RFG and ULSD[1]	11.63	16.49	16.96	17.64	87.59	96.99	101.55	104.22
	FMVCP	210.62	227.59	245.62	258.25	465.05	512.76	561.84	584.14
	I/M	8.74	8.29	7.39	7.13	8.01	6.45	5.13	4.55
	TxLED	0.00	0.00	0.00	0.00	2.98	2.81	2.39	2.19

[1] RFG with Tier 3 sulfur and pre-1990 diesel replaced with Ultra Low Sulfur Diesel.

Note: Columns may not total due to rounding.

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PURPOSE

This analysis developed and produced on-road mobile link-based emissions inventories for the eight Houston-Galveston-Brazoria (HGB) ozone nonattainment counties for analysis years 2011, 2017, 2018, 2020, and 2021. These emissions inventories are needed to support the HGB-area reasonable further progress (RFP) state implementation plan (SIP) revision for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS).

BACKGROUND

The Texas Commission on Environmental Quality (TCEQ) works with local planning districts, the Texas Department of Transportation (TxDOT), and the Texas A&M Transportation Institute (TTI) to provide on-road mobile source emissions inventories of air pollutants. TxDOT typically funds transportation conformity determinations required under 40 Code of Federal Regulations Part 93. TCEQ funds mobile source inventory work in support of federal Clean Air Act (CAA) requirements, such as supporting attainment of the NAAQS and the study and control of hazardous air pollutants, including those from motor vehicles and/or motor vehicle fuels (as mandated under CAA sections 202 and 211).

TCEQ is planning to update the SIP, which will require an RFP analysis from the base year to an attainment year, as determined in the final implementation rule, to demonstrate continued progress toward attainment of the U.S. Environmental Protection Agency's (EPA) 2008 eight-hour ozone standard for the HGB eight-county nonattainment area. The eight-county area includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties. The HGB RFP emissions inventories were developed using the latest version of EPA's Motor Vehicle Emissions Simulator (MOVES), MOVES2014a, released December 2015, updated November 2016,[5] and will use the latest planning assumptions to assure the motor vehicle emissions budgets set by the SIP revision will be consistent with transportation conformity analysis requirements. To complete the HGB RFP SIP analysis, RFP inventories were required for a base year, RFP milestone year, milestone contingency year, attainment year, and attainment contingency year, as well as individual control measure reduction estimates, and contingency measure control reduction estimates.

TTI accomplished this work in five main parts:

- "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight-County HGB Ozone NAAQS Nonattainment Area,"
- "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2017 RFP Milestone Year,"
- "Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the 2018 RFP Milestone Contingency Year,"
- "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2020 Attainment Year," and

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[5] TTI used MOVES2014a (November 2016 release), which for SIP on-road mobile purposes is equivalent to the latest, official MOVES model version, MOVES2014b (August 2018). The model updates subsequent to MOVES2014a (November 2016 release) were focused mainly on non-road mobile improvements, and outputs that do not apply to on-road mobile emission rates used for SIP inventories and conformity analyses.

- "Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the 2021 RFP Attainment Contingency Year."

TTI provided data products to TCEQ in one electronic data submittal, described in Appendix A.

Development of On-Road Mobile Source RFP Emissions Inventories for the Eight-County HGB Ozone Nonattainment Area

For this part of the work, TTI developed 12 link-based on-road mobile emissions estimates for the eight HGB ozone nonattainment counties as defined in the following for five RFP analysis years: 2011, 2017, 2018, 2020, and 2021. For the 2011 RFP base year, two inventories were required: 1) an RFP base-year inventory; and 2) an RFP adjusted base-year inventory. For the 2017 RFP milestone year, three inventories were required: 1) an RFP adjusted base-year inventory based upon 2011 activity and pre-1990 controls; 2) an RFP inventory with pre-1990 controls only; and 3) an RFP inventory with pre- and post-1990 control strategies. For the 2018 RFP milestone contingency year, two inventories were required: 1) an RFP inventory with pre-1990 controls only; and 2) an RFP inventory with pre- and post-1990 control strategies. For the 2020 attainment year, three inventories were required: 1) an RFP adjusted base-year inventory based upon 2011 activity and pre-1990 controls; 2) an RFP inventory with pre-1990 controls only; and 3) an RFP inventory with pre- and post-1990 control strategies. For the 2021 RFP attainment contingency year, two inventories were required: 1) an RFP inventory with pre-1990 controls only; and 2) an RFP inventory with pre- and post-1990 control strategies.

Table 1 lists the RFP inventories with activity and emissions rate components.

Table 1. HGB RFP Inventory Scenarios.

No.	RFP Inventory	Activity Input[1]	Emissions Rates Input[2]
1	2011 Base Year	2011 (Base Year)	2011 Control Strategy
2	2011 Adjusted Base Year		2011 Pre-1990 Control
3	2017 Adjusted Base Year		2017 Pre-1990 Control
4	2020 Adjusted Base Year		2020 Pre-1990 Control
5	2017 Pre-1990 Control	2017 (Milestone Year)	2017 Pre-1990 Control
6	2017 Control Strategy		2017 Control Strategy
7	2018 Pre-1990 Control	2018 (Milestone Contingency Year)	2018 Pre-1990 Control
8	2018 Control Strategy		2018 Control Strategy
9	2020 Pre-1990 Control	2020 (Attainment Year)	2020 Pre-1990 Control
10	2020 Control Strategy		2020 Control Strategy
11	2021 Pre-1990 Control	2021 (Attainment Contingency Year)	2021 Pre-1990 Control
12	2021 Control Strategy		2021 Control Strategy

[1] For external inventory calculations: vehicle miles traveled (VMT) mix, link VMT/speeds, and off-network activity.
[2] "Pre-1990 Control" rates are for calendar year of evaluation fleet but exclude post-1990 Clean Air Act Amendment (CAAA) controls – no Inspection and Maintenance (I/M) program, no post-1990 Federal Motor Vehicle Control Program (FMVCP) effects, no reformulated gasoline (RFG) (uses pre-1992 conventional gasoline with 1992 summer Reid vapor pressure [RVP] limit promulgated prior to enactment of the 1990 CAAA), no Texas Low Emissions Diesel (TxLED). "Control Strategy" rates include effects of control strategies current for subject analysis year (i.e., both pre- and post-1990 FMVCP, RFG, I/M [depending on county], TxLED fuel).

For the HGB area RFP inventories to be consistent with previous EPA inventory development guidance, the most recent activity information, based upon current travel demand modeling, and the most recent version of the EPA's on-road emissions model, MOVES2014a, released in December 2015, updated November 2016, was used to complete this task. The RFP inventories were produced based on methods agreed upon in consultation with the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance. Individual control reduction calculations were consistent with the capabilities of MOVES.

TTI also adhered to the following:

- Used the most recent version of the EPA's on-road emissions model, MOVES2014a, released in December 2015, updated November 2016, as the emissions factor model for developing inventories for this task.[6]
- The geographic scope for the summer weekday emissions was the eight-county HGB ozone nonattainment area: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties.

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[6] TTI used MOVES2014a (November 2016 release), which for SIP on-road mobile purposes is equivalent to the latest, official MOVES model version, MOVES2014b (August 2018). The model updates subsequent to MOVES2014a (November 2016 release) were focused mainly on non-road mobile improvements, and outputs that do not apply to on-road mobile emission rates used for SIP inventories and conformity analyses.

- The inventories included the following criteria pollutants and ozone precursors: volatile organic compounds (VOC), carbon monoxide (CO), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), ammonia (NH_3), carbon dioxide (CO_2), particulate matter with an aerodynamic diameter equal to or less than 2.5 microns ($PM_{2.5}$), and particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM_{10}).
- Used summer work weekday as the day type for inventories. Adjusted average annual daily activity levels to account for both seasonal differences for summer months and weekday.
- Used 2011 climate inputs. Used temperature, humidity, barometric pressure, and other data, as agreed upon and provided by the TCEQ (TCEQ monitoring operations or national climatic data, for subject counties or meteorologically similar county groups).
- Used the most current vehicle miles traveled (VMT) mixes. The VMT mixes were consistent with the EPA MOVES source use types.
- Used regional registration data as input for locality-specific age distributions. For historical years, used registration data for each historical year. For future analysis years, used the most recent year vehicle registration distributions.
- A link-based, time-of-day emissions analysis methodology was used for all of the HGB counties. For VMT by summer work weekday (Monday through Friday), TTI used travel demand model network link-based VMT for all HGB counties.
- Used 2011 and most recently available data for the off-network activity development. Developed 2011 and future year off-network activity inputs based on current Texas on-road inventory development processes and documented the process for development in the pre-analysis plan.
- Used MOVES individual fuel parameter inputs consistent with Code of Federal Regulations (CFR) Title 40 – Protection of the Environment, Part 80 – Regulation of Fuels and Fuel Additives, and Section 27 – Controls and Prohibitions on Gasoline Volatility (40 CFR § 80.27), as appropriate for RFP control scenarios.
- Used EPA's reformulated gasoline compliance data and the TCEQ fuel property survey data, including Reid vapor pressure (RVP), to develop model inputs. TCEQ provided the 2011 and 2017 Summer Fuel Field Study Final Report and associated electronic files.
- Modeled the effects of all the federal motor vehicle control programs as appropriate for RFP control scenarios.
- Modeled the HGB reformulated gasoline (RFG) program as appropriate for RFP control scenarios.
- Modeled either federally regulated gasoline and diesel sulfur levels or latest available fuel survey data for RFP control scenarios as appropriate.
- Used control program parameters, including RVP and fuel settings, based upon the inventory type as defined by the RFP analysis control scenarios.
- Post-processed the diesel vehicle NO_x emissions factors to account for Texas Low Emission Diesel (TxLED) program, consistent with 30 Texas Administrative Code (TAC) Sections 114.312-114.319, for RFP control scenarios as appropriate. Used year-

specific TxLED adjustment factors developed using the benefit information described in the EPA Memorandum "Texas Low Emission Diesel Fuel Benefits," and the method as documented in previous Texas on-road inventory development reports. Inventory reports documenting the TxLED methodology were available upon request from the TCEQ Mobile Source Programs Team.

Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2017 RFP Milestone Year

To complete this part, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the 2017 HGB RFP milestone year. The entire MOVES2014a-based control strategy reduction was subdivided into individual control reductions using the MOVES2014a-based methodology agreed to by the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance listed in the References section. The methodology included individually applying successive control strategies and re-running the emissions factor model. Since MOVES2014a does not separate the reductions from the individual components of the Federal Motor Vehicle Control Program (FMVCP) such as Tier 1, Tier 2, and the 2007 heavy-duty diesel vehicle certification standard, the effect of the FMVCP was calculated as one control reduction. For the HGB area RFP control reduction estimates to be consistent with other SIP analyses, the emissions reduction estimates were developed using the most recent version of the EPA's on-road emissions model, MOVES2014a, released in December 2015, updated November 2016. The methodology and MOVES2014a inputs were consistent with the work described in the previous section entitled "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight-County HGB Ozone Nonattainment Area."

Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the 2018 RFP Milestone Contingency Year

For this part of the work, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the HGB RFP milestone contingency measure analysis year, 2018. The entire MOVES2014a control strategy reduction for 2018 was subdivided into individual control strategy reductions using the MOVES2014a methodology agreed to by the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance listed in the References section. The methodology included individually applying successive control strategies and re-running the emissions factor model. For the HGB area RFP contingency measure reduction estimates to be consistent with other SIP analyses, the emissions reduction estimates were developed using the most recent version of the EPA's on-road emissions model, MOVES2014a, released in December 2015, updated November 2016. The MOVES2014a inputs were consistent with the work described in the previous two sections, entitled "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight-County HGB Ozone Nonattainment Area," and "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2017 RFP Milestone Year."

Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2020 Attainment Year

To complete this part, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the HGB RFP attainment year, 2020. The entire MOVES2014a-based control strategy reduction was subdivided into individual control reductions using the MOVES2014a-based methodology agreed to by the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance listed in the References section. The methodology included individually applying successive control strategies and re-running the emissions factor model. Since MOVES2014a does not separate the reductions from the individual components of the FMVCP such as Tier 1, Tier 2, and the 2007 heavy-duty diesel vehicle certification standard, the effect of the FMVCP was calculated as one control reduction. For the HGB area RFP control reduction estimates to be consistent with other SIP analyses, the emissions reduction estimates were developed using the most recent version of the EPA's on-road emissions model, MOVES2014a, released in December 2015, updated November 2016. The methodology and MOVES2014a inputs were consistent with the work described in the previous three sections entitled: "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight-County HGB Ozone Nonattainment Area," "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2017 RFP Milestone Year," and "Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the 2018 RFP Milestone Contingency Year."

Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the 2021 RFP Attainment Contingency Year

For this part of the work, TTI developed emissions reduction estimates for each on-road mobile source control strategy for the HGB RFP attainment contingency measure analysis year, 2021. The entire MOVES2014a control strategy reduction for 2021 was subdivided into individual control strategy reductions using the MOVES2014a methodology agreed to by the TCEQ Project Manager. The methods were consistent with the EPA's RFP guidance listed in the References section. The methodology included turning on successive control strategies and re-running the emissions factor model. For the HGB area RFP contingency measure reduction estimates to be consistent with other SIP analyses, the emissions reduction estimates were developed using the most recent version of the EPA's on-road emissions model, MOVES2014a, released in December 2015, updated November 2016. The MOVES2014a inputs were consistent with the work described in the previous four sections, entitled: "Development of On-Road Mobile Source RFP Emissions Inventories for the Eight-County HGB Ozone Nonattainment Area," "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2017 RFP Milestone Year," "Development of On-Road Mobile Source RFP Contingency Reduction Estimates for the 2018 RFP Milestone Contingency Year," and "Quantification of Individual On-Road Mobile Source RFP Control Reductions for the 2020 Attainment Year."

Deliverables

The deliverable is a Technical Report (a narrative in memorandum format that explains the tasks, the approaches used, and the findings) provided to the Project Manager as a loose-bound original suitable for copying, and in both Microsoft® Word and Adobe® Acrobat Portable Document Format (PDF) files, delivered in conjunction with supporting electronic files. The report includes documentation of all pertinent activities related to completion of the work. All data were submitted in the specified summary levels and electronic format.

Appendix A describes all the electronic data sets TTI submitted to TCEQ associated with this work, which includes but is not limited to:

- A document listing all the files being submitted and documenting file naming conventions;

- All pertinent data relating to task activities (for MOVES emissions rates-related data this includes: county and scenario MOVES inputs, MySQL scripts used to load county and scenario MOVES inputs into MOVES2014a county database files, MOVES2014a county database files, and MOVES run specification files);
- The standard set of activity and inventory summary files (includes tab-delimited format based upon the MOVES source use type (SUT) with hourly and 24-hour emissions, speed, VMT and off-network activity summaries by vehicle type and by facility type for each county); and
- The inventory summaries in a format compatible with TCEQ's Texas Air Emissions Repository (TexAER), based on the most recent version of the EPA's National Emission Inventory Format, the Consolidated Emissions Reporting Schema (CERS) written in Extensible Markup Language (XML).

TTI maintains a record of all electronic files developed or used in conjunction with the completion of this project. All pertinent data relating to project activities were submitted to TCEQ in the specified electronic format, in conjunction with supporting electronic document files, and copies of the report.

ACKNOWLEDGMENTS

Dennis Perkinson, Ph.D., Madhusudhan Venugopal, P.E., Chaoyi Gu, P.E., and Martin Boardman, all with TTI, contributed to the development of the MOVES link-based emissions estimates. Dr. Perkinson produced the VMT mixes used to divide fleet VMT activity into MOVES SUT by fuel type categories, county VMT control totals, seasonal and hourly VMT factors. Chris VanSlyke of the Houston-Galveston Area Council (H-GAC) provided the HGB regional travel model data sets and the Highway Performance Monitoring System (HPMS) adjustment factor. Venugopal produced vehicle population estimates needed for particular off-network activity estimates. Gu processed roadway based activity (VMT and speeds) and off-network vehicle activity estimates needed for the emissions calculations. Boardman developed the MOVES-based emissions rates with adjustments for TxLED fuel. Venugopal was responsible for the emissions inventory set-ups and execution and post-processing to produce the various inventory formats and summaries. Kristi Holstead, of TTI, was responsible for editing, design, and production of this Technical Report. Each member of the assigned TTI staff contributed to the quality assurance of the inventory data and process. Dr. Perkinson is the principal investigator for this project. This work was performed by TTI under contract to TCEQ. Aaron Slevin is the TCEQ project technical manager.

The report is organized in the following sections: Summary of Results, Overview of Methodology, Development of Vehicle Type VMT Mix, Estimation of VMT, Estimation of Link Speeds, Estimation of Off-Network Activity, Estimation of Emissions Rates, Emissions Calculations, Quality Assurance, and References.

SUMMARY OF RESULTS

Table 2 summarizes the RFP inventories (VMT and speed, and VOC, CO, NOx, and CO2 emissions) for the HGB region. The emissions reductions estimates from the incremental inclusion of control measures in the modeling are summarized for VOC and NOx in Table 3.

Table 2. HGB Summer Weekday On-Road Mobile Source RFP Emissions Inventories (Tons).

Inventory Type	Year	VMT	Speed	VOC	CO	NO_x	CO_2
Adjusted Base Year[1]	2011	145,136,623	34.51	239.63	3,194.89	536.68	81,891.57
	2017	145,136,623	34.51	242.85	3,198.95	536.32	77,260.99
	2020	145,136,623	34.51	242.46	3,194.11	536.11	77,249.85
Pre-1990 Controls[2]	2017	173,069,175	38.19	292.24	3743.37	671.15	91,806.80
	2018	183,591,636	37.75	311.03	3,980.24	714.24	97,875.33
	2020	193,683,005	37.85	322.18	4,167.49	750.39	103,147.24
	2021	197,487,997	37.75	334.30	4,277.41	768.67	105,310.34
Base Year and Control Strategy[3]	2011	145,136,623	34.51	80.45	894.40	168.60	81,443.95
	2017	173,069,175	38.19	61.24	775.29	107.52	90,499.71
	2018	183,591,636	37.75	58.65	778.33	95.24	94,566.13
	2020	193,683,005	37.85	52.21	737.19	79.48	95,337.62
	2021	197,487,997	37.75	51.28	723.54	73.57	94,929.02

[1] Adjusted base year inventories: 2011 activity inputs (VMT mix, link VMT/speeds, and off-network activity) and analysis year pre-1990 control emissions rates.

[2] Pre-1990 controls inventories: analysis year activity inputs and analysis year pre-1990 control emissions rates. Rates are for analysis year fleet but exclude post-1990 CAAA controls – no I/M program, post-1990 FMVCP effects, RFG (uses pre-1992 conventional gasoline with 1992 summer RVP limit promulgated prior to enactment of the 1990 CAAA), or TxLED.

[3] Base Year and control strategy inventories: analysis year activity inputs and analysis year control strategy emissions rates. Rates include effects of control strategies for analysis year (i.e., both pre- and post-1990 FMVCP, Tier 3 RFG and Ultra Low Sulfur Diesel, I/M [depending on county], and TxLED).

Table 3. HGB Summer Weekday RFP Control Scenario Inventories and Reductions (Tons).

Emissions Analysis		VOC				NO_x			
		2017	2018	2020	2021	2017	2018	2020	2021
Inventory	Pre-90 Control	292.24	311.03	322.18	334.30	671.15	714.24	750.39	768.67
	Control Strategy	61.24	58.65	52.21	51.28	107.52	95.24	79.48	73.57
Reductions	Total	230.99	252.38	269.97	283.02	563.63	619.00	670.91	695.10
	Tier 3 RFG and ULSD[1]	11.63	16.49	16.96	17.64	87.59	96.99	101.55	104.22
	FMVCP	210.62	227.59	245.62	258.25	465.05	512.76	561.84	584.14
	I/M	8.74	8.29	7.39	7.13	8.01	6.45	5.13	4.55
	TxLED	0.00	0.00	0.00	0.00	2.98	2.81	2.39	2.19

[1] RFG with Tier 3 sulfur and pre-1990 diesel replaced with Ultra Low Sulfur Diesel.
Note: Columns may not total due to rounding.

RFP inventory and individual control measure emissions reductions estimates with more detail (e.g., by county, SUT/fuel type) may be found in the electronic data submittal (see description in Appendix A).

OVERVIEW OF METHODOLOGY

TTI used its detailed travel demand model (TDM) link-based, rates-per-activity inventory methodology to produce MOVES-based, on-road vehicle, historical and future case inventories.

This TDM link-based, on-road mobile inventory method produces hourly seasonal, day-type (e.g., summer weekday) estimates by vehicle type (Table 4), pollutant (Table 5), and process (Table 6) for each county. For the roadway-based component of the analysis, emission rates (e.g., grams/mile [g/mi]) produced using MOVES are combined externally with each TDM network link (or roadway segment) VMT estimate to calculate the roadway-based inventories.

For the off-network component of the inventories, the TTI inventory development process requires off-network activity measure estimates for starts, source hours parked (SHP), source hours extended idling (SHI), and auxiliary power unit (APU) hours. Emission rates are produced in these terms for the off-network process calculations. MOVES2010b and earlier versions of MOVES provided the off-network start, evaporative, and extended idling rates only in "per vehicle" units, not applicable to the TTI activity-based inventory process; TTI post-processing procedures and utilities were used to produce the MOVES off-network rates in all the needed activity units. The previous version of MOVES (MOVES2014) added several new types of emissions rates (i.e., off-network process rates in terms of mass per unit of activity). All the activity-based rates required in the TTI inventory process are now directly available from MOVES, except for the SHP-based rates; these are produced using TTI inventory utilities.

TTI previously developed a set of external inventory development utilities for use with MOVES that is currently compatible with MOVES2014a. See Appendix B for more information on TTI's MOVES-based inventory utilities.[7]

Table 4. MOVES SUT/Fuel Types (Vehicle Types).

SUT ID	SUT Description	SUT Abbreviation[1]
11	Motorcycle	MC
21	Passenger Car	PC
31	Passenger Truck	PT
32	Light Commercial Truck	LCT
41	Intercity Bus	IBus
42	Transit Bus	TBus
43	School Bus	SBus
51	Refuse Truck	RT
52	Single Unit Short-Haul Truck	SUShT
53	Single Unit Long-Haul Truck	SULhT
54	Motor Home	MH
61	Combination Short-Haul Truck	CShT
62	Combination Long-Haul Truck	CLhT

[1] The SUT/fuel type, or vehicle type, labels are the combined SUT abbreviation and fuel type names separated by an underscore (e.g., MC_Gas, RT_Diesel, and SBus_Gas are motorcycles, diesel-powered refuse trucks, and gasoline-powered school buses, respectively).

The methodology estimates emissions for an estimated regional fleet mix composed of the predominant gasoline-powered and diesel-powered vehicles. Alternatively fueled vehicles were treated as *de minimis*.

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[7] The TTI's MOVES2014a-compatible inventory estimation utilities are detailed in: *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL User's Guide,* TTI, August 2016.

Table 5. MOVES Pollutants Inventoried.

Pollutant ID	Pollutant Name
2	Carbon Monoxide (CO)
3	Oxides of Nitrogen (NO_x)
30	Ammonia (NH_3)
31	Sulfur Dioxide (SO_2)
87	Volatile Organic Compounds (VOC)
90	Atmospheric CO_2
100	Primary Exhaust PM_{10} – Total
106	Primary PM_{10} –Brakewear Particulate
107	Primary PM_{10} – Tirewear Particulate
110	Primary Exhaust $PM_{2.5}$ – Total
111	Organic Carbon (OC)
112	Elemental Carbon (EC)
115	Sulfate Particulate
116	Primary $PM_{2.5}$ – Brakewear Particulate
117	Primary $PM_{2.5}$ – Tirewear Particulate
118	Composite – Non-Elemental Carbon (ECPM)

Table 6 shows the MOVES on-road emissions rates with associated processes and activity factors used.

Table 6. Emissions Rates by MOVES Emissions Process and Activity Factor.

Process (Process ID)	Activity[1]	Emissions Rates[2]
Running Exhaust (1)	VMT	mass/mile (mass/mi)
Crankcase Running Exhaust (15)	VMT	mass/mi
Brake Wear (9)	VMT	mass/mi
Tire Wear (10)	VMT	mass/mi
Start Exhaust (2)	starts	mass/start
Crankcase Start Exhaust (16)	starts	mass/start
Extended Idle Exhaust (90)	SHI	mass/shi
Crankcase Extended Idle Exhaust (17)	SHI	mass/shi
Auxiliary Power Exhaust (91)	APU Hours	mass/APU hour
Evaporative Permeation (11) Evaporative Fuel Vapor Venting (12) Evaporative Fuel Leaks (13)	VMT, SHP	mass/mi, mass/shp[2]

[1] VMT, SHP, vehicle starts, and hotelling activity (SHI and APU hours) are the basic activity factors. SHI and APU hours are for combination long-haul trucks only.

[2] All mass per activity rates shown are available in MOVES rate mode table output, except for mass/shp, which is produced by post-processing using the TTI RatesCalc utility.

Major Inventory Components

The county inventory estimation process requires development of the following major inventory components. All are inputs to the emissions calculation utility, except vehicle populations, which are an intermediate input needed for calculating estimates of SHP and vehicle starts activity.

- District, four-period, time-of-day, vehicle type VMT mix;
- County, hourly, on-road fleet link VMT and average speeds;
- County vehicle type populations;
- County, hourly vehicle type SHP;
- County, hourly vehicle type starts;
- County, hourly combination long-haul truck SHI and APU hours;
- County, hourly vehicle type MOVES-based on-road rates: mass/mile, mass/SHP, mass/start, mass/SHI, and mass/APU hour; and
- On-road source classification codes (SCCs) from MOVES.

The TTI utilities used to develop or process these inventory components are outlined and described in Appendix B, which also includes an inventory production process flow diagram.

VMT Mix

The VMT mix designates the vehicle types included in the analysis and specifies the fraction of on-road fleet VMT attributable to each vehicle type by day type (i.e., average weekday) and by MOVES road type.

The VMT mixes were estimated based on TTI's 24-hour average VMT mix method, expanded to produce the four-period, time-of-day estimates.[8] The procedure sets Texas vehicle registration category aggregations for MOVES SUT categories to be used in the VMT mix estimates, as well as for developing other fleet parameter inputs needed in the process (e.g., vehicle age distributions). The VMT mix procedure produced a set of four-period, time-of-day average vehicle type VMT allocations by MOVES road type and by day type, estimated for each TxDOT district for use with the counties associated with each district. The data sources used were recent, multi-year TxDOT vehicle classification counts, year-end TxDOT/Texas Department of Motor Vehicles (TxDMV) registration data, and MOVES default data.

On-Road Fleet Link-VMT and Speeds

Period and day-type-specific fleet VMT and average operational speed inputs to the roadway-based calculations (product of "per mile" rates and VMT) were required.

TTI used data sets extracted from the latest, four-period, time-of-day, directional, regional HGB travel models (data sets provided by the H-GAC), seasonal day-type adjustments, HPMS VMT-consistency adjustments, and hourly allocation factors to estimate the hourly, directional, link-VMT and associated average fleet speed inputs to the inventory calculations. The seasonal period, day type, and hourly distributions used were based on factors developed with TxDOT automatic traffic recorder (ATR) data from the Houston area. The hourly average operational fleet speeds were estimated corresponding to the link VMT estimates using the Houston speed model, which estimates operational speeds based on a link's estimated free-flow speed and congestion-related speed reduction.

Vehicle Population and Off-Network Vehicle Activity Estimates

The non-roadway-based inventory estimates (e.g., from vehicle starts, parked vehicle evaporative processes, hotelling activity) were calculated as the product of the amount of associated activity and the mass per unit of activity (rate per activity terms as shown in Table 6). To estimate the SHP and vehicle starts activity, vehicle population estimates were needed. Hotelling activity estimates (composed largely of the emissions-producing SHI and diesel APU hours) were based on county-specific actual estimates.[9]

Vehicle Type Populations: TTI based the vehicle population estimates on vehicle registration data, vehicle population factors developed from the VMT mix, and, additionally for future years, VMT growth estimates. For a historical year, the vehicle population estimates are based solely on mid-year TxDOT (or TxDMV) county registrations data and regional, all roads-weekday

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[8] *MOVES Source Use Type and VMT Mix for Conformity Analysis, TTI, August 2017*.

[9] Base estimates of hotelling hours used in this analysis are 2017 winter weekday estimates, developed by TTI during the truck idling study that produced county 24-hour hotelling estimate totals for all Texas counties, sponsored by TCEQ starting in 2017.

VMT mix-based vehicle type population factors for the analysis year. For future years, vehicle type populations were estimated as a function of base (e.g., latest available, mid-year) registrations, grown to a future value (growth as a function of base and future VMT), and all roads-weekday VMT mix-based vehicle type population factors for the analysis year.

The SHP was estimated as a function of total hours (hours a vehicle exists) minus its hours operating on roads (source hours operating [SHO]). For a historical year, the vehicle type SHP estimates are based on VMT mix, link VMT and speeds, and the vehicle population estimates. The VMT mix is applied to the link VMT to produce vehicle-type-specific VMT estimates. Link VMT is divided by the associated speed to produce SHO estimates, which are aggregated by vehicle type and subtracted from associated source hours resulting in SHP estimates. For a future year, the vehicle type SHP was estimated in the same manner as for historical years, except using the future year link VMT and speeds, VMT mix, and vehicle population estimates. This was performed by county and hour.

Starts: Engine starts were based on the MOVES national default starts per vehicle, and the local, county vehicle type population estimates. MOVES default weekday starts per vehicle were used. The starts were calculated as the product of starts/vehicle from MOVES, and the county vehicle type population estimates. This was performed by county and hour.

SHI and APU Hours: The SHI and APU hours, two of four activities comprising the diesel combination long-haul truck hotelling hours, were estimated for each county and analysis year using TTI's current procedure and new, base, activity estimates from the TCEQ's 2017 truck idling study. TTI used the winter weekday, 24-hour, 2017, base county level hotelling estimates from the truck idling study in combination with scaling factors estimated from 2017 base year and future (and 2011 historical) analysis year link VMT and VMT mix (for each county and year) to produce 2011, 2017, 2018, 2020, and 2021 analysis year, county, hourly hotelling activity estimates. Hotelling hourly factors (estimated by inverting hourly VMT factors) were then applied to allocate the 24-hour hotelling hours estimates for each county to each hour of the day. Estimated SHI and APU hours fractions of hotelling hours based on an updated hotelling activity distribution from the truck idling study were used to separate SHI and APU hours activity from total hotelling hours, for each county and hour.

MOVES Emissions Factors

TTI produced the emission rates look-up table inputs to the TTI's EmsCalc inventory calculation utility in three basic steps. The first step was to set up and execute the MOVES emissions rate mode runs. Next step was to perform the initial post-processing, which calculates rates in the form needed that are not directly available from MOVES. The last was performing the final post-processing to make needed adjustments and screen out non-applicable pollutants.

Local input parameters were developed and used to produce rates reflective of the local scenario conditions (e.g., weather and fleet characteristics, fuel properties, vehicle inspection and maintenance [I/M] program). MOVES county scale, rates mode modeling scenarios produced rates for the MOVES weekday day type by pollutant, process, speed (for roadway-based processes), hour, road type, and average SUT/fuel type. Two rates post-processing steps were performed to produce the final rates in the form needed. The first step produced the mass-per-SHP off-network evaporative rates not available from MOVES. The final rates post-processing step extracted the rates needed in the inventory calculations (i.e., screened out any unneeded pollutants/processes remaining from the previous step), and made required adjustments (i.e., for estimated TxLED effects on diesel vehicle NO_x rates, for all eight counties, for applicable RFP scenarios).

County-level, MOVES weekday hourly emissions factors were developed for two RFP control scenarios: 1) pre-1990 controls, and 2) control strategy (or "current controls"). For the estimation of emissions reductions by individual control measure an additional set of MOVES runs was performed, for a representative county (i.e., Harris County), for which control measures were incrementally added to the pre-1990 scenario in this sequence: RFG, post-1990 FMVCP, and I/M Program. Actual, local, activity estimates for each county were then externally combined with the associated rates in the EmsCalc utility inventory calculations, as needed to produce the inventories for each particular RFP scenario and for the individual control measure emissions reductions estimation procedure.

Inventory Calculations

Using the EmsCalc utility, inventories for each RFP control scenario were calculated for each county, and "incremental control" inventories were calculated for Harris as the representative county. The major inputs, in summary, were: TxDOT district-level, day type, time-of-day, VMT mix by MOVES road type; county, hourly on-road fleet link VMT and speed estimates for each activity scenario; county, hourly, off-network activity estimates by vehicle type for each activity scenario of SHP, starts, SHI, and APU hours; and county-level look-up tables of hourly MOVES weekday rates by road type, speed bin, vehicle type (SUT/fuel type), and process.

For the VMT-based calculations, county-to-TxDOT district, TDM road type/area type-to-MOVES road type, and hour-of-day to time-of-day period designations were used to match the appropriate VMT mixes with the link VMT. The VMT mixes by MOVES road type were multiplied by the link fleet VMT to distribute each link's VMT to the different vehicle types. Emissions rates for each link's average speed were interpolated (see procedure in Appendix B) from the appropriate set of look-up table rates and corresponding index speeds (i.e., the average bin speeds of 2.5, 5.0, 10.0, 15.0, … 75.0 mph), bounding the link's average speed. For link speeds below or above the minimum and maximum average bin speeds of 2.5 and 75 mph, the rates for those bounding speeds were used. The estimated vehicle type and MOVES road type link-speed-specific rates for each process were then multiplied by the associated VMT to produce the link-based estimates. This process was performed for each hour, by county for each RFP inventory scenario, and for the representative county for individual control measure emissions estimation procedure.

For the off-network calculations, which are county level, the vehicle type, county-level rates were multiplied by the associated county total activity estimate (starts, SHP, SHI, APU hours), as determined by the pollutant process. This process was performed for each hour, by county for each RFP inventory scenario, and for the representative county for individual control measure emissions estimation procedure.

The on-road mobile inventory utilities produce two types of tab-delimited summary output files and optionally a set of 24 link-emissions files (not included for this analysis). The standard on-road tab-delimited output file includes hourly and 24-hour activity and emissions results summarized by vehicle type and road type. The SCC tab-delimited output feature produces 24-hour activity and emissions data in a form (aggregated and coded) consistent with the EPA's

2014 National Emissions Inventory (NEI) inventory, as needed for uploading specified inventory data to TCEQ's TexAER. Appendix A contains more information on the output definitions and specifications, including the inventory data formatted for compatibility with TexAER.

TTI developed and maintains a series of computer utilities to calculate and summarize detailed on-road mobile source emissions inventories in various formats, such as those used in this analysis. Appendix B describes these applications.

Individual Control Strategy Emissions Reductions Estimation

Additional emissions modeling for milestone, attainment, and contingency years was performed to estimate emissions reductions by individual control strategy for all of the HGB counties. Individual control measure emissions reductions were first estimated for Harris County, as representative of all HGB counties. From the Harris County-based representative individual control reductions estimates, the fraction of total reductions (i.e., pre-1990 scenario emissions minus control strategy scenario emissions) was calculated for each individual control. These estimated representative incremental reduction fractions were used to break out individual control measure reduction estimates for all counties. The individual controls modeling sequence (beginning with the pre-1990 control base) was:

- Pre-1990 FMVCP (i.e., base from which sequential reductions were calculated);
- RFG (i.e., pre-1990 controls with RFG added);
- Post-1990 FMVCP (i.e., pre-1990 controls, RFG, post-1990 FMVCP);
- I/M Program, (i.e., pre-1990 controls, RFG, post-1990 FMVCP, I/M); and
- TxLED (i.e., pre-1990 controls, RFG, post-1990 FMVCP, I/M, and TxLED).

DEVELOPMENT OF VEHICLE TYPE VMT MIX

VMT mix is a major input to the MOVES link-based emissions estimation process. It is an estimate of the fraction of on-road fleet VMT attributable to each SUT by fuel type and is used to subdivide the total VMT estimates on each link into VMT by vehicle type. These hourly VMT estimates by vehicle type are combined with the appropriate emissions factors in the link-emissions calculations.

On-road mobile emissions are dependent upon the VMT assigned to each vehicle category. The VMT mix is used to distribute link VMT values to each vehicle category. Since the VMT mix can vary by time-of-day (and thus have an effect of the emissions totals), the TTI VMT mix procedure allows the option to develop VMT mix by time period. Time period VMT mix (by MOVES roadway type and vehicle type) consists of four time periods: morning rush hour (AM peak), mid-day, evening rush hour (PM peak), and overnight.

TxDOT district-level, time period, and Weekday (average Monday through Friday) VMT mix (for gasoline-powered and diesel-powered vehicles) is estimated by the four MOVES road type categories using the methodology characterizing VMT by vehicle type for a region (or district) as follows.[10]

1. MOVES – Data files of MOVES default values extracted from MOVES databases or pro forma runs.
2. TxDOT Classification Counts – Data files of standard TxDOT classification data assembled and used for determining the in-use road fleet mix.
3. TxDMV Registration Data – Data files of standard TxDMV vehicle registration summary data assembled and used for determining the in-use road fleet mix.
4. TxDOT ATR Data – Data files of TxDOT ATR data assembled and used to allocate VMT by season and day of week.
5. Single Unit Local vs. Total SUT_HDVyy – Procedure based on registration data to generate factors to separate Single Unit versus Combined Unit trucks by region. (SUT_HDVyy has multiple outputs based on vehicle category and fuel.)
6. Combination Local vs. Total SUT_HDXyy – Procedure based on registration data to generate short-haul and long-haul combination truck proportions by region.
7. Day of Week (DOW) Factors by Urban Area/TxDOT District – Seasonal day-of-week factors from TxDOT ATR data used to allocate VMT by season and day-of-week by urban area/TxDOT district.
8. Single Unit Short-Haul vs. Long-Haul SUT_SSHZ – Procedure to separate single unit short-haul versus single unit long-haul using factors generated at SUT_HDVyy and classification count data. Short-haul and long-haul are functionally defined as local and pass through.
9. Combination Short-Haul vs. Long-Haul SUT_CSHZ – Procedure to separate combined short-haul versus combined long-haul using factors generated at SUT_HDXyy and classification count data. Short-haul and long-haul are functionally defined as local and pass through.
10. PV and LDT Fuel MF_Fuelyy – Procedure to generate passenger vehicle and light truck fuel allocation by year based on MOVES national default values and local registration data.
11. Single Unit and Combination Truck Fuel SUT_HDVyy – Procedure to generate single unit and combined truck fuel allocation factors from registration data. (SUT_HDVyy has multiple outputs based on vehicle category and fuel.)

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[10] *MOVES Source Use Type and VMT Mix for Conformity Analysis* (TxDOT Air Quality / Conformity IAC-A - TTI Task 409480-0843: Maintain, Update and Enhance Traffic Activity Estimation and Forecasting Methods), Texas Department of Transportation, Austin, TX. October 2017.

12. SUT_yyddtt – Procedure to generate SUT proportions by year, day type, and time period, based on the previous steps.

13. MOVES SUTs – Output file of MOVES SUTs by region, analysis year, day type, and time period.

TxDOT district-level Weekday VMT mixes by MOVES road-type category are produced based on recent multi-year vehicle classification counts and appropriate end-of-year TxDOT vehicle registrations data. Using the same data sets and a similar procedure, aggregate (i.e., all road-type categories), TxDOT district-level weekday vehicle type VMT mixes (used in the vehicle population estimation) are also produced. To ensure general applicability and consistency across all study areas, all VMT mixes are developed in five-year increments beginning with the year 2005 and applied to the analysis years based on Table 7.

Table 7. VMT Mix Year/Analysis Year Correlations.

VMT Mix Year	Analysis Years
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032
2035	2033 through 2037

ESTIMATION OF VMT

The detailed, hourly, link-based emissions process requires VMT estimates by hour and direction for each link in the TDMs. This analysis also required that VMT be adjusted for HPMS consistency and to reflect estimated levels characteristic of a typical activity scenario (i.e., 2011, 2017, 2018, 2020 and 2021 summer weekday). The TRANSVMT utility (see Appendix B for a description of the utility), the latest available data sets from the HGB 2011, 2017, 2020 and 2021 TDMs (2018 was not available), and post-processing factors developed from several other data sources, were used to produce this hourly VMT by direction. The hourly and 24-hour VMT and VHT summaries by county and road type were provided electronically to TCEQ (see Appendix A for electronic data descriptions).

Data Sources

The latest available link data trips data, and zonal radii data sets extracted from the HGB 2011, 2017, 2020 and 2021 TDMs were used to estimate the directional link VMT and speeds by hour. Since intrazonal VMT are not accounted for in the TDMs, the intrazonal VMT was estimated using the TDM's trip matrix and zonal radii data sets. H-GAC provided the TDM data sets with some partial processing (February 2018).

Several other data sources were used to adjust the VMT for HPMS consistency and to estimate the summer weekday VMT. The first data source is HPMS VMT estimates, which are based on traffic count data collected according to a statistical sampling procedure specified by the Federal Highway Administration (FHWA) designed to estimate VMT. The county total HPMS Annual Average Daily Traffic (AADT) VMT was used to ensure the travel model VMT was consistent with the HPMS VMT estimates. (EPA and FHWA have endorsed HPMS as the appropriate source of VMT and require that VMT used to construct on-road mobile source emissions estimates be consistent with that reported through HPMS.)

The second data source is ATR vehicle counts, which are collected by TxDOT at selected locations throughout Texas on a continuous basis. These vehicle counts are available by season, month, and weekday, as well as on an annual average daily basis (i.e., AADT). The counts are very well suited for making seasonal, day-of-week, and time-of-day comparisons (e.g., seasonal adjustment and hourly allocation factors), even though there may be relatively few ATR data collection locations in any given area.

Multiple years (2008 through 2017) of data from the ATR stations were grouped for this analysis at different aggregation levels, depending upon the purpose. This data source was used to produce the day-type-specific adjustment factor, in which the data from the ATR stations within the Beaumont TxDOT District were combined for use with Chambers and Liberty counties and the ATR data within the Houston TxDOT District were combined for use with Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties. This data source was also used to produce the time-of-day (hourly) allocation factors, in which the data from the ATR stations within the eight-county region were combined.

VMT Adjustments

For each activity scenario, the TDM VMT was adjusted for HPMS consistency and for seasonality (i.e., summer weekday). For the 2011 and 2017 activity scenarios, which by definition are historical years (i.e., HPMS VMT data exists for those years), county-level VMT control totals were used to develop VMT adjustment factors. For the remaining activity scenario years (2018, 2020 and 2021), which are considered future years (i.e., HPMS VMT data does not exist), a regional HPMS factor and seasonal weekday factors were used. Since a current 2018 TDM did not exist, TTI also produced intermediate year growth factors using the bounding TDMs (i.e., 2017 and 2020) and applied these factors to designated (2017) TDM VMT. Hourly travel factors were also applied to distribute this adjusted VMT over each hour of the day.

Historical Year Activity Scenarios – VMT Control Totals and VMT Adjustments

To estimate the HPMS-consistent summer weekday VMT for the 2011 and 2017 historical year scenarios, county-level 2011 and 2017 summer weekday VMT control totals were used to develop county-level VMT adjustment factors. The VMT control totals are comprised of two key components: the analysis year county-level HPMS AADT VMT and the AADT-to-summer weekday adjustment factors.

The AADT-to-summer weekday adjustment factors were developed using aggregated ATR data for the years 2008 through 2017. Since the HGB area spans two TxDOT districts, two summer weekday adjustment factors were developed. One factor was developed for Liberty and Chambers counties (which are located in the Beaumont TxDOT District), and one factor was developed for Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties (which are located in the Houston TxDOT District). These regional factors were calculated by dividing the average day-of-week count by the AADT traffic count. Table 8 shows the HGB AADT-to-summer weekday factors used in developing the VMT control totals.

Table 8. HGB AADT-to-Summer Weekday Factors for Control Total Development.

TxDOT District	Weekday Adjustment Factor
Beaumont[1]	1.05241
Houston[2]	1.06949

[1] Only used for Liberty and Chambers counties.

[2] Only used for Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties.

The VMT control totals were then developed by multiplying the analysis year HPMS AADT VMT for each county by the appropriate summer weekday adjustment factor to produce eight VMT control totals (one for each county). To develop the county-level VMT adjustment factors, each county's respective control total was divided by the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from the analysis year TDM to produce eight county-level VMT adjustment factors. For each link in the TDM, the volume was multiplied by the corresponding VMT adjustment factor (based on the county where the link is located). The adjusted link volumes were then multiplied by the associated link lengths to produce the analysis year link-level HPMS consistent, summer weekday VMT estimates.

Table 9 and Table 10 show the weekday VMT control totals, the total TDM VMT, and the VMT adjustment factors produced for 2011 and 2017, respectively.

Table 9. HGB 2011 Weekday VMT Control Totals and VMT Adjustment Factors.

County	VMT Control Total	TDM VMT	VMT Adjustment Factor
Harris	103,744,830.000	114,372,862.702	0.907075573
Brazoria	6,141,888.000	7,403,815.326	0.829557158
Fort Bend	10,091,299.000	11,409,641.683	0.884453630
Waller	2,074,919.000	2,359,716.446	0.879308615
Montgomery	12,231,484.000	12,388,035.249	0.987362706
Liberty	2,295,353.000	2,873,444.723	0.798815784
Chambers	2,707,264.000	3,101,741.026	0.872820773
Galveston	5,849,586.000	6,262,992.407	0.933992191

Table 10. HGB 2017 Weekday VMT Control Totals and VMT Adjustment Factors.

County	VMT Control Total	TDM VMT	VMT Adjustment Factor
Harris	120,879,211.000	132,190,260.223	0.914433566
Brazoria	8,760,083.000	9,089,341.353	0.963775334
Fort Bend	13,044,677.000	15,136,754.431	0.861788243
Waller	2,498,992.000	2,180,968.377	1.145817622
Montgomery	15,223,852.000	17,532,761.414	0.868308856
Liberty	2,440,464.000	2,926,075.345	0.834040041
Chambers	2,937,556.000	3,631,831.068	0.808836079
Galveston	7,284,340.000	6,761,544.438	1.077318957

Future Year Activity Scenarios – HPMS Adjustment Factor

For the future year activity scenarios, an HPMS adjustment factor was used to adjust the total VMT (TDM assignment VMT plus intrazonal VMT estimate) from each TDM for HPMS consistency. The HPMS factor used in this analysis (0.938371) was based on the H-GAC's 2016 TDM validation and was provided directly by H-GAC.

Future Year Activity Scenarios – Seasonal Adjustment Factors

For the future year activity scenarios, seasonal adjustment factors were used to adjust the TDM and estimated intrazonal VMT to summer weekday VMT. The seasonal adjustment factors were developed using aggregated ATR data for the years 2008 through 2017. Since the HGB area spans two TxDOT districts, two ozone season summer weekday adjustment factors were developed. One factor was developed for Liberty and Chambers counties (which are located in the Beaumont TxDOT District), and one factor was developed for Harris, Galveston, Fort Bend, Brazoria, Waller, and Montgomery counties (which are located in the Houston TxDOT District). These factors were calculated by dividing the average day-of-week (weekday) count by the annual non-summer weekday traffic (ANSWT) traffic count. Table 11 shows the seasonal adjustment factors by TxDOT district.

Table 11. HGB Weekday Seasonal Adjustment Factors for Future Year Activity Scenarios.

TxDOT District	Weekday Seasonal Adjustment Factor
Beaumont[1]	1.01050
Houston[2]	1.00532

[1] Only used for Liberty and Chambers counties.

[2] Only used for Harris, Galveston, Fort Bend, Brazoria, Montgomery, and Waller counties.

Future Year Activity Scenarios – Intermediate Year Adjustment Factors

For the 2018 future analysis year scenario, a TDM did not exist. Intermediate year adjustment factors were used to estimate future analysis year VMT from an existing TDM. These adjustment factors were developed using the bounding year TDMs (i.e., 2017 and 2020) and applied to the 2017 TDM. The intermediate year adjustment factors were based on the annually compounded growth rates between bounding year TDMs, as shown in Table 12. Since the 2018 analysis year is one year after the designated (2017) TDM, the county annual growth rates are equal to the county intermediate year adjustment factors.

Table 12. Annually Compounded Growth Rates (Intermediate Year Adjustment Factors).

VMT and Growth Rate[1]	2017 TDM VMT[1]	2020 TDM VMT[1]	Growth Rate[2]
Harris	132,190,260.223	142,336,864.774	1.024957787
Brazoria	9,089,341.353	9,892,105.504	1.028613236
Fort Bend	15,136,754.431	17,109,272.693	1.041676646
Waller	2,180,968.377	2,295,937.945	1.017271613
Montgomery	17,532,761.414	19,241,272.935	1.031480825
Liberty	2,926,075.345	3,061,674.828	1.015214596
Chambers	3,631,831.068	4,018,202.699	1.034273507
Galveston	6,761,544.438	7,319,375.834	1.026776800

[1] VMT is unadjusted TDM VMT plus intrazonal VMT.

[2] Since the 2018 intermediate year is one year after the designated (2017) TDM, these county annual growth rates are equal to the intermediate year adjustment factors.

Future Year Activity Scenarios – VMT Summary

For each future year activity scenario (i.e., 2018, 2020 and 2021 summer weekday), the final HPMS-consistent, VMT is comprised of two parts: the link-level VMT and the estimated intrazonal VMT. The 2017 TDM link and intrazonal VMT were used for 2018. The volume for each link was multiplied by the HPMS factor, the seasonal adjustment factor, the intermediate year adjustment factor (for 2018 only), and the link's respective length to estimate the link-level VMT (hourly factors were applied to distribute the resulting VMT over each hour of the day, discussed in a later section). This set of adjustment factors (as well as the hourly factors mentioned previously) were also applied to the estimated intrazonal VMT. Table 13 shows the TDM and summer weekday VMT summaries.

Table 13. HGB 2018, 2020 and 2021 VMT Summary.

County	2018		2020		2021	
	TDM[1]	Weekday	TDM[1]	Weekday	TDM[1]	Weekday
Harris	132,190,260.223	127,815,739	142,336,864.774	134,275,351	144,910,927.894	136,703,627
Brazoria	9,089,341.353	8,819,895	9,892,105.504	9,331,848	10,049,371.919	9,480,207
Fort Bend	15,136,754.431	14,874,576	17,109,272.693	16,140,257	17,608,968.587	16,611,652
Waller	2,180,968.377	2,092,981	2,295,937.945	2,165,903	2,350,723.317	2,217,586
Montgomery	17,532,761.414	17,060,446	19,241,272.935	18,151,508	19,748,249.860	18,629,771
Liberty	2,926,075.345	2,816,789	3,061,674.828	2,903,153	3,138,745.107	2,976,233
Chambers	3,631,831.068	3,561,820	4,018,202.699	3,810,156	4,080,287.881	3,869,026
Galveston	6,761,544.438	6,549,390	7,319,375.834	6,904,829	7,420,149.025	6,999,895

[1] Includes intrazonal VMT.

Hourly Travel Factors

Hourly travel factors were used to distribute the TDM and intrazonal VMT to each hour of the day. These hourly travel factors were developed using multi-year (2008 through 2017) aggregated ATR station data for the eight-county HGB region. To maintain VMT proportions within each of the four assignment time periods, the hourly fractions were normalized within each time period to produce the time period hourly travel factors. Each factor (i.e., 24, or one for each hour of the day) was then multiplied by the link volume (in addition to the other VMT adjustment factors). These adjusted link volumes were then multiplied by their respective link lengths to estimate the link level, summer weekday VMT estimates for each activity scenario year. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly-adjusted VMT. Table 14 shows the weekday time period hourly travel factors.

Table 14. Weekday Time Period Hourly Travel Factors.

Assignment	Hour	Base Factor	Time Period Factor[1]
AM Peak	6:00 a.m. to 7:00 a.m.	0.062272	0.330715
	7:00 a.m. to 8:00 a.m.	0.068020	0.361242
	8:00 a.m. to 9:00 a.m.	0.058003	0.308043
Mid-Day	9:00 a.m. to 10:00 a.m.	0.051793	0.160814
	10:00 a.m. to 11:00 a.m.	0.050526	0.156880
	11:00 a.m. to 12:00 p.m.	0.052466	0.162903
	12:00 p.m. to 1:00 p.m.	0.054335	0.168707
	1:00 p.m. to 2:00 p.m.	0.055120	0.171144
	2:00 p.m. to 3:00 p.m.	0.057828	0.179552
PM Peak	3:00 p.m. to 4:00 p.m.	0.063315	0.241788
	4:00 p.m. to 5:00 p.m.	0.068045	0.259851
	5:00 p.m. to 6:00 p.m.	0.071227	0.272001
	6:00 p.m. to 7:00 p.m.	0.059275	0.226360
Overnight	7:00 p.m. to 8:00 p.m.	0.045842	0.201260
	8:00 p.m. to 9:00 p.m.	0.035585	0.156229
	9:00 p.m. to 10:00 p.m.	0.031037	0.136262
	10:00 p.m. to 11:00 p.m.	0.024223	0.106346
	11:00 p.m. to 12:00 a.m.	0.016393	0.071970
	12:00 a.m. to 1:00 a.m.	0.009035	0.039666
	1:00 a.m. to 2:00 a.m.	0.005964	0.026184
	2:00 a.m. to 3:00 a.m.	0.005571	0.024458
	3:00 a.m. to 4:00 a.m.	0.005903	0.025916
	4:00 a.m. to 5:00 a.m.	0.012327	0.054119
	5:00 a.m. to 6:00 a.m.	0.035895	0.157590

[1] Used in the VMT calculation process.

ESTIMATION OF LINK SPEEDS

The operational speeds for each link, excluding centroid connectors and the special intrazonal links, were calculated using the Houston speed model. The Houston speed model calculates these speeds using the travel model speed, speed factors (consisting of a free-flow speed factor and level of service [LOS] E speed factor) and a volume-to-capacity (V/C) ratio-based speed reduction factor (SRF) for each link.

The speed factors were used to convert the link-level travel model (input) speed to a free-flow speed and a LOS E speed (i.e., application of these factors results in two speeds). The free-flow speed factors (grouped by functional class and area type) were calculated by dividing the distance-weighted free-flow speed by the distance-weighted input speed for each functional class/area type combination. The distance-weighted free-flow speeds were calculated using output from the detailed speed model used by H-GAC in the travel model development process (as provided by H-GAC) with link volumes set to 0 (i.e., V/C = 0). The LOS E speed factors were calculated in a similar manner (distance-weighted LOS E speed divided by distance-weighted input speed) using the detailed speed model output with link volumes set equal to capacity (i.e., V/C = 1). Appendix E shows the speed factors and the network functional class and functional group relationship.

The link-specific V/C ratio is calculated as the time period (hourly) volume divided by the time period capacity. The V/C ratio is expressed as:

$$\text{v/c ratio} = Vh / Ch$$

Where:

Vh = the hourly link volume (travel model × HPMS factor × seasonal adjustment factor × hourly time period factor; Weekend profile factor is included for Saturday and Sunday); and

Ch = the hourly link capacity (travel model capacity × hourly capacity factor). Appendix E shows the hourly capacity factors.

After the V/C ratio was calculated, the link-specific SRF was determined using the V/C ratio, the link-specific SRF area type, the link-specific SRF functional class, and the SRFs. The SRFs are for V/C ratios of 0 to 1 in 0.05 increments (i.e., 0, 0.05, 0.10, ... , 0.95, 1.0). Appendix E shows these SRFs. The link-specific SRF was calculated using linear interpolation. For V/C ratios greater than 1.0, a SRF is not required.

The speed model (for V/C ratios from 0.00 to 1.00) is expressed as:

$$S_{V/C} = S_{0.0} - SRF_{V/C} \times (S_{0.0} - S_{1.0})$$

Where:

$S_{V/C}$ = estimated directional speed for the forecast V/C ratio on the link in the given direction;

$S_{0.0}$ = estimated free-flow speed for the V/C ratio equal to 0.0;

$S_{1.0}$ = estimated LOS E speed for the V/C ratio equal to 1.0; and

$SRF_{V/C}$ = SRF for the V/C ratio on the link. The V/C ratio can be 0.0 to 1.0.

For V/C ratios greater than 1.0 and less than 1.5, the following speed model extension was used:

$$S_{V/C} = S_{1.0} \times (1.15/(1.0 + (0.15 \times (v/c)^4)))$$

Where:

$S_{v/c}$ = estimated directional speed for the forecast V/C ratio on the link in the given direction;
$S_{1.0}$ = estimated LOS E speed for the V/C ratio equal to 1.0; and
v/c = the forecast V/C ratio on the link. The V/C ratio can be 1.0 to 1.5.

For V/C ratios greater than 1.5, the speed was calculated using the previous speed model extension, except the V/C ratio was set to 1.5.

These speed models were applied to all functional classes excluding the centroid connector and intrazonal functional classes. For these functional classes, capacity data were not used. The centroid connector travel model input speeds were used as the centroid connector operational speeds estimates. Operational speeds for the intrazonal functional class were estimated by zone as the average of the zone's centroid connector speeds.

The hourly and 24-hour speed (VMT/VHT) summaries by county and road type were provided electronically to TCEQ (see Appendix A for electronic data descriptions).

ESTIMATION OF OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates (i.e., mass per SHP, mass per start, and mass per SHI), county-level estimates of the SHP, starts, SHI, and APU hours are required by hour and vehicle type for each activity scenario (SHI and APU hours are for diesel combination long-haul trucks only). One of the main components of the SHP and starts off-network activity estimation is the activity scenario year county-level vehicle population. Summaries of the vehicle population and 24-hour SHP, starts, SHI, and APU hours off-network activity are included as Appendix F. Hourly SHP, starts, SHI, and APU hours activity estimates are included with the detailed inventory data provided (see inventory data file descriptions in Appendix A).

The county-level vehicle population estimates were developed using the VehPopulationBuild utility. The county-level SHP, starts, SHI, and APU hours of off-network activity were developed using the OffNetActCalc utility. Appendix B contains a description of the utilities.

Estimation of Vehicle Population

Vehicle population estimates are needed to estimate the SHP and starts off-network activity. The vehicle population estimates (included as Appendix F) were produced for each county and activity scenario year. The vehicle population estimates are a function of vehicle registration data (TxDMV registration data sets), population scaling factors (where applicable), and vehicle type VMT mix.

For estimating vehicle populations, a historical activity scenario year is defined as any year where actual TxDMV registration data and HPMS VMT data (used in developing population scaling factors) exists. Therefore, the 2011 activity scenario year was considered a historical year and the vehicle population estimates were based on the 2011 TxDMV registration data. Currently, the latest available vehicle registration data year is 2014. Thus, 2017 and later analysis years were considered future activity scenario years. For the future activity scenario years, the vehicle population estimates were based on the most recent year (2014) TxDMV registration data set for which HPMS VMT data also exists, and activity scenario year population scaling factors

The VMT mix used to estimate the vehicle population is the aggregate (i.e., all road-type categories) TxDOT district-level weekday VMT mix. The development of the VMT mix is described in more detail in the "Development of Vehicle Type VMT Mix" section and included as Appendix D.

Historical Vehicle Population Estimates

The county-level vehicle population estimates for the activity scenario year (2011) were calculated using the activity scenario year county-level, mid-year TxDMV vehicle registrations and the assigned aggregate VMT mix (see Table 7 and Appendix D). The vehicle population estimation process assumes that all of the non-long-haul SUT category populations for a county are represented in the county vehicle registrations data. This process also estimates the long-haul category populations as an expansion of the county registrations. There are three main steps in the vehicle population estimation process: registration data category aggregation, calculation of the vehicle type population factors, and estimation of the county-level vehicle population by vehicle type.

The first step in the vehicle estimation process is the registration data category aggregation. For each county, the activity scenario year vehicle registrations were aggregated into five categories. Table 15 shows these five categories.

Table 15. Registration Data Categories.

Registration Data Category	Vehicle Registration Aggregation
1	Motorcycles
2	Passenger Cars (PC)
3	Trucks <= 8.5 K gross vehicle weight rating (GVWR) (pounds)
4	Trucks > 8.5 and <= 19.5 K GVWR
5	Trucks > 19.5 K GVWR

The second step is calculating the vehicle type population factors. Using the assigned aggregate VMT mix, population factors were calculated for each vehicle type. For the non-long-haul SUT categories, the population factors were calculated by dividing the vehicle type VMT mix by the summed total of the VMT mix fractions in its associated vehicle registration data category. For example, the LCT_Diesel population factor using the VMT mix is LCT_Diesel/(PT_Gas + PT_Diesel + LCT_Gas + LCT_Diesel). For the long-haul SUTs, the vehicle type population factors were calculated by taking the ratio of the long-haul and short-haul VMT mix values. For example, the SULhT_Gas population factor using SUT mix fractions is SULhT_Gas/SUShT_Gas. Table 16 shows the vehicle registration aggregations and their associated MOVES SUT/fuel types.

Table 16. TxDMV Vehicle Registration Aggregations and Associated Vehicle Types for Estimating Vehicle Populations.

Vehicle Registration[1] Aggregation	Associated Vehicle Type[2]
Motorcycles	MC_Gas
Passenger Cars (PC)	PC_Gas; PC_Diesel
Trucks <= 8.5 K GVWR (pounds)	PT_Gas; PT_Diesel; LCT_Gas; LCT_Diesel
Trucks > 8.5 and <= 19.5 K GVWR	RT_Gas; RT_Diesel SUShT_Gas; SUShT_Diesel MH_Gas; MH_Diesel IBus_Diesel TBus_Gas; TBus_Diesel SBus_Gas; SBus_Diesel
Trucks > 19.5 K GVWR	CShT_Gas; CShT_Diesel
NA[1]	SULhT_Gas; SULhT_Diesel CLhT_Gas; CLhT_Diesel

[1] The four long-haul SUT/fuel type populations are estimated using a long-haul-to-short-haul weekday SUT VMT mix ratio applied to the short-haul SUT population estimate.

[2] The mid-year TxDMV county registrations data extracts were used (i.e., the three-file data set consisting of: 1 - light-duty cars, trucks, and motorcycles; 2 - heavy-duty diesel trucks; and 3 - heavy-duty gasoline trucks) for estimating the vehicle populations.

The third step is the estimation of the county-level vehicle type population. The non-long-haul vehicle type populations were estimated by applying their vehicle type population factors to the appropriate registration data category. For the CLhT_Gas type, the vehicle population was set to 0. For the remaining three long-haul SUT/fuel types (SULhT_Gas, SULhT_Diesel, and CLhT_Diesel), the vehicle populations were calculated as the product of the corresponding short-haul category vehicle population and the associated long-haul population factor (e.g., SULhT_Gas vehicle population = SUShT_Gas vehicle population x [SULhT_Gas SUT mix fraction/ SUShT_Gas SUT mix fraction]).

Future Vehicle Population Estimates

The process for estimating the county-level population estimates for the future activity scenario years is very similar to the historical vehicle population estimates except that instead of using the activity scenario year registration data sets, the most recent (2014) county-level TxDMV registration data sets for which HPMS data exists were used. Using these registration data sets and the assigned aggregate VMT mix, the county-level base 2014 vehicle population estimates were calculated. Future year county-level vehicle population scaling factors were used to scale the county-level base 2014 vehicle population estimates to the activity scenario year. These future year county-level vehicle population scaling factors were calculated as the ratio of the county-level weekday VMT for the activity scenario year to the county-level weekday VMT for the year of the most recent (2014) TxDMV registration data (i.e., vehicle population increases linearly with VMT).

Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level estimates of SHP by hour and vehicle type for each activity scenario. For each hour, the county-level vehicle type SHP was calculated by taking the difference between the vehicle type total available hours minus the vehicle type SHO. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type population. The SHO was calculated using the link VMT and speeds and the TxDOT district-level vehicle type VMT mixes by MOVES road-type category (see the "Development of Vehicle Type VMT Mix" section for more details). Appendix F includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and vehicle type for each activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

Vehicle Type Total Available Hours

The vehicle type total available hours is typically calculated as the vehicle type population times the number of hours in the time period. Since this calculation was performed at the hourly level, the vehicle type total available hours for each activity scenario was set equal to the vehicle type vehicle population for the activity scenario year.

Vehicle Type SHO

To calculate SHO for a given link, the VMT was allocated to each vehicle type using the TxDOT district-level vehicle type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link vehicle type SHO. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 7 and Appendix C). This SHO calculation was performed for each link in a given hour, aggregating the SHO to one value per vehicle type per hour.

Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level estimates of starts by hour and vehicle type for each activity scenario. For each activity scenario, the vehicle type hourly default starts per vehicle were multiplied by the activity scenario county-level vehicle type vehicle population to estimate the county-level vehicle type starts by hour. Appendix F includes the 24-hour summaries of the county-level vehicle type starts by hour for the activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

For the hourly default starts per vehicle, the MOVES defaults were used. The MOVES activity output was used to estimate the hourly starts per vehicle for a MOVES weekday run by dividing the MOVES start output by the MOVES vehicle population output. These MOVES national default starts per vehicle do not vary by year, only by MOVES day type. For the activity scenario day type of Weekday, the MOVES national default weekday starts per vehicle were used.

Estimation of SHI and APU Hours

The remaining activity measures needed to estimate the off-network emissions using the mass per activity emissions rates are the hourly, county-level heavy-duty diesel truck (SUT 62, fuel type 2 [CLhT_Diesel]) emissions-producing hotelling activities (i.e., truck main engine idling and diesel APU use). During hotelling, the truck's main engine is assumed to be in idling mode or its diesel auxiliary power unit is in use, or it is using electric power or no power. For each activity scenario, hotelling hours were first estimated followed by estimation of the SHI and diesel APU hours components of hotelling hours. The discussion and associated procedures are only applicable to CLhT_Diesel vehicles.

The hotelling activity estimates were based on information from a TCEQ extended idling study, which produced 2017 winter weekday extended idling estimates for each Texas county. Hotelling scaling factors (by activity scenario) were applied to the base 2017 winter weekday hotelling values from the study to estimate the 24-hour hotelling. Hotelling hourly factors were then applied to allocate the 24-hour hotelling to each hour of the day. To ensure valid hourly hotelling values were used in the emissions estimation, the hourly hotelling hours were compared to the CLhT_Diesel hourly SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHI and APU hours factors were then applied to the hotelling hours to produce the hourly SHI and APU hours of activity. This procedure was performed for each activity scenario. Appendix F includes the 24-hour summaries of the county-level estimates of hotelling hours, SHI, and APU hours for each activity scenario (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

Hotelling Scaling Factors

To estimate the county-level 24-hour hotelling by activity scenario, county-level hotelling scaling factors were developed for each activity scenario. These scaling factors were produced using the county-level 2017 winter weekday link-level VMT and speeds, the TxDOT district-level base weekday vehicle type VMT mix (by MOVES road type), the county-level activity scenario link-level VMT and speeds, and the TxDOT district-level activity scenario vehicle type VMT mix (by MOVES road type). The 2017 winter weekday link-level VMT and speeds were developed similarly to the 2017 summer weekday link-level VMT and speed data except using a 2017 winter weekday VMT control total. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 7 and Appendix C). For the base weekday vehicle type VMT mix, the 2015 weekday vehicle type VMT mix was used.

For each link in the 2017 winter weekday link-level VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday vehicle type VMT mix. This VMT allocation was performed for each link and hour in the 2017 winter weekday link-level VMT and speeds, with the individual link VMT aggregated by hour to produce the CLhT_Diesel hourly and 24-hour 2017 winter weekday VMT. Using a similar allocation process, the activity scenario CLhT_Diesel hourly and 24-hour VMT were calculated using the activity scenario link-level VMT and speeds and the inventory vehicle type VMT mix. The county-level 24-hour hotelling scaling factors by activity scenario were calculated by dividing the activity scenario CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2017 winter weekday VMT.

Hotelling Hourly Factors

Hotelling hourly factors for each activity scenario were used to allocate county-level, 24-hour, hotelling hours to each hour of the day. These hotelling hourly factors were calculated as the inverse of the activity scenario hourly VHT fractions. The hourly VHT fractions were first calculated using the hourly VHT from the SHP estimation process (VHT = SHO). The inverses of these hourly VHT fractions were calculated and then normalized across all hours to produce the county-level, hotelling hours hourly distribution. This procedure was performed for each activity scenario.

Hotelling by Hour Estimation

The initial activity scenario hotelling by hour was calculated by multiplying the 24-hour 2017 winter weekday hotelling hours by the activity scenario hotelling scaling factor and by the activity scenario hotelling hourly factors. A comparison was then made between hourly hotelling and hourly SHP for the scenario. For each hour where the activity scenario initial hotelling hours were greater than the SHP, the final hotelling hours estimate was set equal to the SHP, otherwise the initial hotelling hours estimate was set as the final value. All calculations (scaling factors, hotelling hourly factors, and hotelling by hour) were performed by county for each activity scenario.

SHI and APU Hours Estimation

The hourly, county-level, hotelling estimates for each activity scenario were then factored to produce the SHI and APU hours activity components using aggregate extended idle mode and aggregate APU mode fractions. For each hour, the activity scenario hotelling hours was multiplied by the SHI fraction to calculate the hourly SHI and by the APU fraction to calculate the hourly APU hours.

The aggregate SHI and the APU fractions were estimated using model year travel fractions (based on source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the updated MOVES hotelling distributions[11] shown in Table 17. The associated travel fractions were applied to the appropriate extended idle and APU operating mode fractions (of the hotelling operating mode distribution) by model year and summed within each mode to estimate the aggregate (across model years) individual SHI and APU fractions. (The sum of the resulting SHI and APU fractions, when subtracted from 1.0, leaves the portion of hotelling hours in which trucks were using electric power or using no power.)

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[11] Population and Activity of On-road Vehicles in MOVES201X (page 87 of unpublished report), https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=328870

Table 17. Hotelling Activity Distributions by Model Year.

First Model Year	Last Model Year	Operating Mode Fraction by ID and Name			
		200	201	203	204
		ExtendIdling	Diesel Aux	Battery AC	APU Off
1960	2009	0.80	0	0	0.20
2010	2020	0.73	0.07	0	0.20
2021	2023	0.48	0.24	0.08	0.20
2024	2026	0.40	0.32	0.08	0.20
2027	2050	0.36	0.32	0.12	0.20

ESTIMATION OF EMISSIONS RATES

TTI developed the emissions rates needed for the on-road mobile source emissions inventories according to TTI's detailed MOVES rates-per-activity, county-level, link-based, method. On-road mobile emissions rates data from the EPA's "latest" emissions factor model, MOVES2014a,[12] together with TTI rates post-processing utilities, RatesCalc and RatesAdj, were used to produce rates in the form needed for input to the TTI external inventory calculation utility, EmsCalc.

The emissions rates were developed based on TTI's *TTI Emissions Inventory Utilities User's Guide* [13] and the EPA's MOVES inventory development *Technical Guidance*[14] and *User's Guide.*[15] The TTI MOVES data post-processing utilities used to produce the databases of rates look-up tables are also described, along with other TTI inventory process utilities, in Appendix B of this Technical Report.

The general process involved setting up and executing MOVES emissions rates mode runs to produce the emissions and activity data needed for the development of on-road mobile source, county-level emissions rates. For the initial post-processing step, TTI's on-road rates look-up table post-processor, RatesCalc, was run to produce rates look-up tables from the MOVES data. The TTI RatesAdj utility was then run to produce the final rates look-up tables by dropping pollutants not needed and making adjustments where required. Using this process, on-road rates

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[12] Software (November 2016 release) and database (MOVESDB20161117) from http://www.epa.gov/otaq/models/moves/index.htm. EPA's November 2016 MOVES2014a update is not the actual latest, but is essentially for practical purposes, the latest on-road release – i.e., emission rate results for SIP on-road pollutants from MOVES2014a (November 2016) compared to results replicated with MOVES2014b (August 2018) are equivalent.

[13] TTI's MOVES2014a-compatible inventory estimation utilities are detailed in this document: *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014aUTL User's Guide,* TTI, August 2016.

[14] *MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for Sate Implementation Plans and Transportation Conformity*, EPA, November 2015.

[15] *MOVES2014a User Guide,* EPA, November 2015.

look-up tables were produced from each MOVES run in the form needed for input to the EmsCalc utility external inventory calculations.

For the external inventory calculations, the method requires that all rates be in terms of mass per unit of activity, as opposed to the off-network rates of mass per vehicle, which is the only output option available for off-network "parked vehicle" evaporative emissions output by MOVES. Table 18 summarizes the form of rates produced for the external inventory calculations (presented in a previous section but provided here again for convenience).

Table 18. Emissions Rates by MOVES Emissions Process and Activity Factor.

Process (Process ID)	Activity[1]	Emissions Rates[2]
Running Exhaust (1)	VMT	mass/mile (mass/mi)
Crankcase Running Exhaust (15)	VMT	mass/mi
Brake Wear (9)	VMT	mass/mi
Tire Wear (10)	VMT	mass/mi
Start Exhaust (2)	Starts	mass/start
Crankcase Start Exhaust (16)	Starts	mass/start
Extended Idle Exhaust (90)	SHI	mass/shi
Crankcase Extended Idle Exhaust (17)	SHI	mass/shi
Auxiliary Power Exhaust (91)	APU Hours	mass/APU hour
Evaporative Permeation (11) Evaporative Fuel Vapor Venting (12) Evaporative Fuel Leaks (13)	VMT, SHP	mass/mi, mass/shp[3]

[1] VMT, SHP, vehicle starts, and hotelling activity (SHI and APU hours) are the basic activity factors. SHI and APU hours are for combination long-haul trucks only.

[2] All mass per activity rates shown are available in MOVES rate mode table output, except for mass/shp, which is produced using the TTI RatesCalc utility.

The RFP inventory analysis required sets of emissions factors for the two main RFP control scenarios: pre-1990 controls, and control strategy. Since MOVES does not model TxLED fuel, emissions rates were post-processed to include TxLED effects in the control strategy emissions rates.

The difference between pre-1990 controls and control strategy emissions are emissions reductions due to the post-1990 CAA controls. To estimate emissions reductions from individual control measures, an additional set of MOVES runs was performed. A single county (Harris) was selected, and additional scenarios were set up by adding sequentially to the pre-1990 controls scenario: RFG, post-1990 FMVCP, I/M, and TxLED. The rates from these runs were used in a procedure discussed later for estimating the individual control program emissions reductions for 2017, 2018, 2020, and 2021.

The five control scenarios (listed by label used in the modeling input/output files and databases) were:

- "CS0" – Pre-1990 control scenario;
- "CS1" – CS0 + RFG;
- "CS2" – CS1 + post-1990 FMVCP;
- "CS3" – CS2 + I/M Program; and
- "CSC" – CS3 +TxLED fuel (i.e., control strategy scenario).

The main purpose of this overall discussion is three-fold. First, the MOVES-based emissions rate look-up table development process is explained. Second, specifics are provided on emission rates modeling for the two main RFP control scenarios - Pre-1990 controls (CS0) and control strategy (CSC) - the first and last bullets of the previously listed control scenarios. TTI produced all emissions rates consistent with the methods and procedures presented for these two main RFP control scenarios. Third and last, the control scenario rates development for individual control measure impacts estimation (i.e., CS1, CS2, and CS3) is detailed.

MOVES Inputs, Outputs, and Post-Processing

The MOVES model is equipped with default modeling values for the range of conditions that affect emissions factors. MOVES defaults may be replaced by alternate input data sets that better reflect local scenario conditions. Local data, where available and consistent with the methodology, replaced MOVES default data by using MOVES Run Specification input files (RunSpecs or MRS) and MOVES county databases (CDBs). (The MRS files, CDBs, and MOVES default database provide the input data tailored for each local scenario model run.)

Local data were developed to reflect county June through August period weather conditions, HGB region summer fuel properties, county vehicle age distributions, and the local I/M program (details are provided later). For the activity input data to MOVES, the MOVES defaults were in general used, which is basic to the emissions rates method (i.e., inventory scenario rates produced via post-processing are externally multiplied by the actual local VMT and off-network activity estimates, detailed in the previous sections, to calculate emissions external to MOVES).

There was one RunSpec and one CDB required per county per MOVES run. Each RunSpec was designed to produce a separate, corresponding MOVES output database (i.e., one output database per run). For the two main RFP scenarios, there were 80 runs, requiring 80 MRS input files and 80 CDBs, and correspondingly producing 80 MOVES output databases (i.e., eight each CS0 and CSC scenario runs for the five years – 2011, 2017, 2018, 2020, and 2021). For the post-processing corresponding to each MOVES run, RatesCalc first processed the MOVES data into one interim "ratescalc" output database. The RatesAdj utility processed the RatesCalc output (filtered and adjusted rates as needed) loading the resulting final rates into one database (for each MOVES run), for subsequent input to TTI's EmsCalc inventory calculation utility. The final rates include TxLED effects adjustments.

MOVES set-ups and runs were executed and the results were post-processed to produce county-level, summer weekday, activity-based emissions rates of the desired pollutants and processes. The rates for each RFP control scenario were estimated by speed (for miles-based rates), process, hour, MOVES road type, SUT, and fuel type.

Summary of Control Programs Modeled by RFP Control Scenario

Table 19 shows the control measures modeled in each of the RFP control scenarios, pre-1990 controls (CS0) and control strategy (CSC).

Table 19. Control Measure Modeling by RFP Control Scenario.

Individual Control Measures[1]	Method	RFP Control Scenario	
		Pre-1990 Controls (CS0)	Control Strategy (CSC)
Pre-1990 CAA FMVCP	MOVES inputs	√	√
1992 Federal Controls on Gasoline Volatility	MOVES inputs	√	
RFG	MOVES inputs		√
Post-1990 CAA FMVCP Tier 1 National Low Emission Vehicle Program Tier 2 Tier 3 Heavy-Duty 2004 Diesel 2005 Gasoline 2007 Gasoline and Diesel Highway Motorcycle 2006 Light- and Medium-Duty 2010 Cold Weather Light- and Heavy-Duty Greenhouse Gas (GHG)	MOVES inputs		√
I/M Program	MOVES inputs		√
TxLED Fuel	Post-process diesel vehicle NOx rates		√

[1] For the pre-1990 scenario, MOVES diesel and gasoline property inputs reflected pre-1990 diesel sulfur and pre-1992 conventional gasoline with 1992 summer Reid vapor pressure [RVP] limit promulgated prior to enactment of the 1990 CAAA. For the control strategy scenario, MOVES gasoline and diesel inputs reflected Ultra Low Sulfur Diesel, RFG for 2017 consistent with the actual, summer 2017 Houston RFG survey data, and for 2018 and later years, the same as 2017 RFG inputs except with sulfur set to the Tier 3 sulfur (10 ppm) standard; Post-1990 FMVCP all together, per MOVES limitation; I/M for Harris, Brazoria, Fort Bend, Galveston, and Montgomery counties; and TxLED effects adjustment to diesel vehicle NO_x emissions for all counties.

MOVES Emissions Factor Aggregation Levels

The MOVES model produces results at different aggregation levels that are selected in the MRS. The detailed, hourly, link-based inventory method required MOVES weekday day-type rates at the following MOVES output detail level:

- Up to 13 source types (i.e., vehicle types);
- Up to five fuel types;
- Up to five road types (four actual MOVES road categories and "off-network");
- Each of the 24 hours in a day;
- 16 speed bins (only included in miles-based rate tables);
- Up to 156 pollutants; and
- Up to 14 on-road processes.

The vehicle fleet was modeled as powered only by the predominant on-road fuels of gasoline and diesel (alternate fuels were considered *de minimis*). The five road type categories in MOVES are Off-Network (not actually a road type, this category is for parked vehicle activity), Rural Restricted Access, Rural Unrestricted Access, Urban Restricted Access, and Urban Unrestricted Access.[16] The rates for each of the actual four MOVES road types are indexed by the 16 MOVES speed bin average speeds: 2.5, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, and 75 mph.

MOVES Run Specification Input Files

The MRS is a file (in XML format) that defines the place, time, road categories, vehicle and fuel types, pollutants and emissions processes, and the overall scale and level of output detail for the modeling scenario. TTI created an MRS for one county and scenario using the MOVES graphical user interface (GUI), converted this MRS to a template, and used it as a base from which to build all the MRSs needed.

Table 20 describes the MRS selections used to produce MOVES output needed for post-processing the emissions rates for the two main RFP control scenarios, with further details on the selections provided after the table.

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[16] The MOVES "separate ramps" feature is not available for MOVES emissions rates mode.

Table 20. RFP Control Scenario MRS Selections by MOVES GUI Panel.

<table>
<tr><th>Navigation Panel</th><th>Detail Panel</th><th colspan="3">Selection</th></tr>
<tr><td>Scale[1]</td><td>Model; Domain/Scale;
Calculation Type</td><td colspan="3">On-Road; County;
Emissions Rates</td></tr>
<tr><td>Time Spans[1]</td><td>Time Aggregation Level;
Years – Months – Days – Hours</td><td colspan="3">Hour;
<YEAR>[1] - July – Weekday - All</td></tr>
<tr><td>Geographic Bounds[1]</td><td>Region;
Selections;
Domain Input Database</td><td colspan="3">Zone and Link;
<COUNTY>;[1]
<COUNTY INPUT DATABASE (CDB) NAME>[1]</td></tr>
<tr><td rowspan="14">On-Road Vehicle Equipment</td><td rowspan="14">SUT/Fuel Combinations</td><td>SUT</td><td>Gasoline</td><td>Diesel</td></tr>
<tr><td>Motorcycle</td><td>X</td><td>-</td></tr>
<tr><td>Passenger Car</td><td>X</td><td>X</td></tr>
<tr><td>Passenger Truck</td><td>X</td><td>X</td></tr>
<tr><td>Light Commercial Truck</td><td>X</td><td>X</td></tr>
<tr><td>Intercity Bus</td><td>-</td><td>X</td></tr>
<tr><td>Transit Bus</td><td>-</td><td>X</td></tr>
<tr><td>School Bus</td><td>X</td><td>X</td></tr>
<tr><td>Refuse Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Long-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Motor Home</td><td>X</td><td>X</td></tr>
<tr><td>Combination Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Combination Long-Haul Truck</td><td>-</td><td>X</td></tr>
<tr><td>Road Type</td><td>Selected Road Types</td><td colspan="3">Off-Network –
Rural Restricted Access – Rural Unrestricted Access –
Urban Restricted Access – Urban Unrestricted Access</td></tr>
<tr><td>Pollutants[2] and Processes</td><td>VOC; CO; NO_x; Atmospheric CO_2; SO_2; NH_3; $PM_{2.5}$: OC, EC, SO_4, NonECPM, Total Exhaust, Brakewear, and Tirewear;
PM_{10}: Total Exhaust, Brakewear, and Tirewear</td><td colspan="3">Dependent on pollutant:
Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Fuel Vapor Venting, Fuel Leaks; Refueling Displacement Vapor Loss, Refueling Spillage Loss, Brakewear, Tirewear</td></tr>
<tr><td>Manage Input Data Sets</td><td>Additional Input Database Selections</td><td colspan="3">None</td></tr>
<tr><td>Strategies</td><td>Rate-of-Progress</td><td colspan="3">***Pre-1990 Control***: “No Clean Air Act Amendments” – ON
Control Strategy: “No Clean Air Act Amendments” – OFF</td></tr>
<tr><td>General Output[1]</td><td>Output Database;[1]
Units;
Activity</td><td colspan="3">***<MOVES OUTPUT DATABASE NAME>***;[1]
Pounds, KiloJoules, Miles;
Hotelling Hours, Population, Starts (not adjustable, pre-selected)</td></tr>
<tr><td>Output Emissions Detail</td><td>Always;
For All Vehicles/Equipment;
On Road</td><td colspan="3">Time: Hour – Location: Link – Pollutant;
Fuel Type, Emissions Process;
Road Type, Source Use Type</td></tr>
<tr><td>Advanced Performance Measures</td><td>Aggregation and Data Handling</td><td colspan="3">Only the “clear BaseRateOutput after rate calculations” box was checked</td></tr>
</table>

[1] Only one county and year per run. Database names are distinct by control scenario, county Federal Information Processing Standards (FIPS) code, and year.

[2] OC and EC are organic and elemental carbon. Chained pollutants require other pollutant selections not listed in the table (e.g., VOC requires Total Gaseous Hydrocarbons and Non-Methane Hydrocarbons: CO_2 requires TEC).

Scale, Time Spans, and Geographic Bounds

The MOVES Domain/Scale “County” was selected as is required for SIP inventory estimates. The MOVES Calculation Type “Emissions Rates” was selected for MOVES to produce the emissions rates with speed bin indexing, as needed for the link-based inventory estimation process.

The Time Spans parameters were specified to provide the most detail available, which is the hourly aggregation level, for all hours of the day, for the selected year, month, and day type. One analysis year (2011, 2017, 2018, 2020, or 2021) was selected, and one “Months” (July) and one “Days” (Weekdays) selection was made.

Under Geographic Bounds for the County Domain Scale, only one county may be selected. The local CDB containing the calendar year scenario-specific input data for the county was specified as the County Domain Input Database, and under Region, “Zone & Link” was selected as required for the emissions rates calculation type. With these required set-ups, one county, one year, one day type, 24 hourly periods, and 16 (speed bin) average speeds were modeled per run.

On-Road Vehicle Equipment and Road Type

The local VMT mixes developed for the study define the SUT/fuel type combinations included in the MOVES runs. The VMT mixes specify the vehicle fleet as the 22 gasoline and diesel SUTs designated as “on-road vehicle equipment” selections in Table 20. These SUT/fuel type combinations were chosen in all the MOVES RunSpecs. The MOVES default fuel engine fractions were also replaced (via the MOVES Alternative Vehicle Fuels and Technologies [AVFT] table, discussed later) with local input data consistent with the SUT/fuel type combinations selected in Table 20.

All five MOVES road type categories were selected (the “provide separate ramps output” box is not active when using emissions rates mode).

Pollutants and Processes

In addition to the required pollutants within the scope of the inventory, MOVES requires that additional pollutants be selected for “chained” pollutants (i.e., pollutants that are calculated as a function of another MOVES pollutant). Of the pollutants listed for the inventory, the following additional pollutants were selected, as required by the model, due to chaining: non-methane hydrocarbons and total gaseous hydrocarbons (for VOC); total energy consumption (TEC) (for CO_2); and Composite – NonECPM, H_2O (aerosol), and sulfate for Primary Exhaust $PM_{2.5}$ - Total. All of the associated on-road processes available by the selected pollutants were included, including the two refueling emissions processes (although refueling emissions, in the area source category, were not calculated).

Manage Input Data Sets and Strategies

The Manage Input Datasets feature allows alternate inputs other than those included in the CDB. No additional inputs were included via the Manage Input Datasets panel.

The Strategies, Rate-of-Progress feature was used for the pre-1990 control emissions rates modeling scenario. The check-box *Compute Rate-of-Progress "No Clean Air Act Amendments" Emissions* was selected, which models a "No Clean Air Act Amendments" scenario by assigning 1993 model year emissions rates to all post-1993 vehicles.

Output

The output units were pounds, kilojoules, and miles. The activity categories were pre-set by MOVES rates mode (and not adjustable) for inclusion in the output database. The selected output detail level was by hour, link (in MOVES rates mode "link" is the combination of county, road type, and speed bin), pollutant, process, road type, SUT, and fuel type.

Appendix A lists the electronic data files provided in support of this analysis, which includes the MRSs used.

MOVES County Input Databases

The locality-specific input data for the county scale runs were entered through the CDB.

TTI developed procedures to accommodate building and checking CDBs for large scale emissions inventory estimation projects. The basic procedure was to write a MySQL script to produce one county scenario CDB and convert it to a template from which all of the CDB scripts were built. The scripts were then run in batch mode to produce all CDBs for the analysis.

Data for populating the CDBs were first prepared in the form of text files and/or MySQL databases (e.g., for local fuels, weather data), and some values provided directly in the CDB builder MySQL script. Any default data used was selected from the MOVES default database, MOVESDB20161117 (e.g., for default activity data). After running the scripts to produce the CDBs, a CDB checker utility written by TTI was run to verify all CDB tables were built and populated as intended. Table 21 provides an outline and brief description of the CDBs, followed by discussion of the development of the local data and the defaults contained therein. Unless otherwise stated, the CDB table data applies to all counties, years and RFP scenarios.

Table 21. CDB Input Tables.

MOVES Input Table	Data Category	Notes
year	Time	Designates analysis year as a base year (base year means that local activity inputs are supplied rather than forecast by the model).
state	Geography	Identifies the state (Texas).
county	Geography/ Meteorology	Specifies county, altitude, and barometric pressure (base year 2011 summer period data were provided by TCEQ).
zonemonthhour	Meteorology	Hourly temperature and relative humidity (2011 summer period county data were provided by TCEQ).
roadtype[1]	Activity	Lists the MOVES road types and associated ramp activity fractions. Road type ramp fractions were set to 0.
hpmsvtypeyear[2]	Activity	Used MOVES default national annual VMT by HPMS vehicle type.
roadtypedistribution[2]		Used MOVES default road type VMT fractions.
monthvmtfraction[2]		Used MOVES default month VMT fractions.
dayvmtfraction[2]		Used MOVES default day VMT fractions.
hourvmtfraction[2]		Used MOVES default hour VMT fractions.
avgspeeddistribution[2]		Used MOVES default average speed distributions.
sourcetypeyear[2]	Fleet	Used MOVES default national SUT populations.
sourcetypeage-distribution	Fleet	Local SUT age fractions estimated using TxDMV mid-year vehicle registration data and MOVES defaults, as needed. Used TxDMV 2011 and (for future analysis years) latest available (2014) data.
avft	Fleet	Local SUT fuel fractions estimated using TxDMV vehicle registration data, consistent with the data used in the sourcetypeagedistributions, and defaults where needed (normalized for gasoline and diesel for consistency with the local VMT mix).
zone	Activity	Start, idle, and SHP zone allocation factors. County = zone and all factors were set to 1.0 (required for county scale analyses).
zoneroadtype	Activity	SHO zone/roadtype allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
fuelsupply	Fuel	Control scenario-specific. The fuel supply, or market share, reflecting one RFG and one diesel fuel formulation.
fuelformulation	Fuel	Control scenario-specific gasoline and diesel formulations. Pre-1990 control scenario – 7.8 psi RVP conventional gasoline and typical pre-1993 regulation diesel sulfur level. Control strategy scenario – RFG (based on latest available survey data with Tier 3-consistent sulfur-level setting for future years), diesel sulfur consistent with federal ultra low sulfur diesel standard and local diesel survey sample data.
imcoverage	I/M	Control scenario-specific. Pre-1990 control scenario – No I/M modeled. Control strategy scenario – Local I/M parameters based on Houston I/M program design, prior modeling set-ups, and appropriate MOVES I/M parameters, for five HGB I/M counties.
countyyear	Stage II	N/A.
hotellingactivity-distribution	Activity	Used newly expanded distribution including the original two hotelling modes extended idling and APU use, plus two non-vehicle emissions producing modes of electric power and all power off.

[1] In MOVES rates mode, "ramp road type" rates are not available.

[2] Use of a default set of activity and population inputs for all MOVES runs is basic to the inventory method, e.g., MOVES default activity is normalized in the calculated rates for applicable processes, and actual local activity estimates are used in the external inventory calculations.

Year, State, and County Inputs to MOVES

The year, state, and county tables are populated with data identifying the year, state, and county of the run.

The yearID field of the "year" table was populated with the analysis year value, and the year was set as a base year (to specify that certain user-input fleet and activity data were to be used, rather than forecast by MOVES during the model runs). As part of designating the appropriate fuel supply for the modeling scenario, the fuelyearID in the year table was also set to the analysis year.

StateID "48" (Texas) was inserted in the state table. In addition to identifying the county of analysis, the county table contains barometric pressure and altitude information (discussed further with other meteorological inputs). The county data were selected from a prepared local "meteorology" database containing tables of weather data records (i.e., "county" and "zonemonthhour" tables) for the analysis.

Roadtype Inputs to MOVES

Currently, the MOVES model contains "ramp" emissions rates, but not an (activated) individual road type for separate ramps output (when using MOVES rates mode). In the roadtype table, MOVES provides a field "rampFraction" for including a fraction of estimated ramp activity as a fraction of SHO on each of the MOVES road types. For this analysis, the MOVES default roadtype table data were used, except the ramp fractions were set to zero (i.e., 100 percent of activity on each MOVES road type was based on the road type drive cycles assigned to that road type by MOVES, exclusive of ramp activity). (MOVES unrestricted access emission rates were used in lieu of ramp emission rates in the external emissions calculations, for particular TDM network links coded as ramps.)

Activity and Vehicle Population Inputs to MOVES

The activity and vehicle population input parameters under the methodology use the MOVES defaults. The tables are: hpmsvtypeyear, roadtypedistribution, monthvmtfraction, dayvmtfraction, hourvmtfraction, avgspeeddistribution, and sourcetypeyear. Data for all of these tables were selected and inserted from the MOVES default database.

The zone and zoneroadtype tables contain zonal sub-allocation activity factors. For county scale analyses, county is equal to zone; therefore these allocation factors were set to 1.0.

Age Distributions and Fuel Engine Fractions Inputs to MOVES

The locality-specific inputs of vehicle age and fuel type fractions by model year, under the SIP county-level inventory procedures, consist of county-level age distributions and statewide gasoline and diesel fractions (fuel engine fractions in MOVES). The age distributions and fuel engine fractions inputs were calculated and written to text files in preparation for loading the data into the appropriate CDB input tables - the sourcetypeagedistribution table for age distributions, and the AVFT table for fuel engine fractions. The MOVESfleetInputBuild utility was used to produce local sourcetypeagedistribution and AVFT inputs to MOVES in the required formats (see utility description in Appendix B), and MySQL scripts were used to populate the CDB input tables.

The age distributions and fuel engine fractions were based on TxDMV mid-year county registrations data and MOVES model defaults (normalized for gasoline/diesel), where needed. The fuel engine fractions were developed consistent with the local VMT mix estimate (i.e., the local fuel engine fractions estimates reflect no compressed natural gas [CNG] vehicles, no E-85 fuel type, and no gasoline transit buses, consistent with the local VMT mix). Locality-specific SUT age distributions were produced based on the TxDMV county vehicle registration category aggregations, consistent with the vehicle registration category aggregations of the VMT mix. Appendix G includes the age distributions and fuel engine fractions summaries.

Table 22 summarizes the data sources and aggregation levels used to estimate the local sourcetypeagedistribution and AVFT inputs to MOVES.

Table 22. Age Distributions and Fuel/Engine Fractions - Data Sources and Aggregations.

SUT Name	SUT ID	TxDMV Category[1] Aggregations for Age Distributions and Fuel/Engine Fractions	Geographic Aggregation for Age Distributions	Geographic Aggregation for Fuel/Engine Fractions[2]
Motorcycle	11	Motorcycles	County	NA – 100% gasoline, no Fuel/Engine Fractions
Passenger Car	21	Passenger Cars	County	MOVES default[2]
Passenger Truck	31	Total Trucks<=8500	County	MOVES default[2]
Light Commercial Truck	32	Total Trucks<=8500	County	MOVES default[2]
Single-Unit Short-Haul Truck	52	>8500+ >10000+ >14000+>16000	HGB Region	Texas Statewide
Single-Unit Long-Haul Truck	53	>8500+ >10000+ >14000+>16000	Texas Statewide	Texas Statewide
Refuse Truck	51	MOVES default (for year consistent with year of local data used)		
Motor Home	54			
Intercity Bus	41			
Transit Bus[2]	42			
School Bus	43			
Combination Short-Haul Truck	61	>19500+ >26000+ >33000+ >60000	HGB Region	Texas Statewide
Combination Long-Haul Truck	62	>19500+ >26000+ >33000+ >60000	Texas Statewide	NA – 100 % diesel, no Fuel/Engine Fractions

[1] TxDMV mid-year 2011 and 2014 (latest available used for later years) county vehicle registrations data (i.e., three-file data set: composite fuel light-duty categories; heavy-duty gasoline by eight weight categories; and heavy-duty diesel by eight weight categories) were used for developing local inputs (weights are GVWR in units of lbs.). The MOVES2014a model default age distributions are from the MOVESDB20161117 database.

[2] Consistent with the local vehicle type VMT mix, MOVES fuel engine fractions for light-duty categories were revised to exclude E-85, and for transit buses were revised to exclude CNG and gasoline components. MOVES default fuel engine fractions were taken from the MOVESDB20161117 sample vehicle population table.

Local Meteorological (County and Zonemonthhour Table) Inputs to MOVES

The meteorological inputs were input via the "county" (barometric pressure) and "zonemonthhour" (temperature and relative humidity) tables. These input data (originally developed and applied in the TCEQ's 2011 HGB periodic emissions inventory analysis[17]) were developed as June 1 through August 31, 2011 hourly temperature and relative humidity, and 24-hour barometric pressure averages, using the hourly data from numerous weather stations within the HGB area. Altitude, also an input of the county table, was set to "low" for all counties. Table 23 summarizes the temperatures, relative humidity, and barometric pressure input values.

Table 23. Meteorological Inputs to MOVES.

Hour	Temperature (Degrees Fahrenheit)	Relative Humidity (Percent)	Barometric Pressure (Inches of Mercury)
1	81.78	77.92	29.9544
2	81.05	80.26	
3	80.42	82.41	
4	79.88	83.82	
5	79.38	85.06	
6	78.92	86.09	
7	78.66	86.78	
8	79.91	84.25	
9	82.99	76.56	
10	85.64	67.93	
11	88.01	59.29	
12	90.11	52.73	
13	91.82	48.13	
14	92.94	45.45	
15	93.60	43.78	
16	93.82	43.29	
17	93.55	43.99	
18	92.67	45.94	
19	91.15	49.19	
20	88.90	54.47	
21	86.34	61.24	
22	84.64	66.62	
23	83.45	71.05	
24	82.54	74.73	

Source: Provided by TCEQ. HGB area weather station data averages for the 2011 June through August period developed originally for the 2011 AERR inventories, TTI, August 2012.

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[17] *2011 On-Road Mobile Source Actual Annual and Weekday Emissions Inventories: Houston Area,* TTI, August 2012.

Fuels Inputs to MOVES

The local, summer season, fuels inputs to MOVES were supplied in the CDB fuelsupply and fuelformulation tables. The fuel supply for each county, year, and RFP scenario consisted of one gasoline and one diesel formulation. Each gasoline and diesel formulation market share in the fuel supply was therefore 1.0. These fuel types are consistent with the local SUT/fuel type VMT mix and AVFT estimates. TTI prepared both RFP pre-1990 and control strategy scenario inputs.[18]

TTI developed the control strategy fuels inputs based on local, retail outlet survey data, and where appropriate, expected future year values. For the federal Renewable Fuel Standard (RFS) expected future year effects, renewable fuel volumes (e.g., ethanol, biodiesel) reflected in the latest available local fuel surveys were used.[19]

For the pre-1990 controls scenario, TTI used an appropriate MOVES default gasoline formulation. The pre-1990 controls diesel formulation used was developed by TTI for previous analyses based on National Institute for Petroleum and Energy Research (NIPER)-developed information on pre-regulation diesel sulfur content.

The MOVES2014a fuelformulation table fields and units include:

- RVP (pounds per square inch [psi]);
- sulfurLevel (parts per million [ppm]);
- ETOHVolume (volume percent);
- MTBEVolume (volume percent);
- ETBEVolume (volume percent);
- TAMEVolume (volume percent);
- aromaticContent (volume percent);
- olefinContent (volume percent);
- benzeneContent (volume percent);
- e200 (vapor percent at 200 degrees Fahrenheit);
- e300 (vapor percent at 300 degrees Fahrenheit);
- T50 (degrees Fahrenheit at 50 percent vapor); and

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[18] At the time of emission rates development, latest available fuel surveys were 2017. Thus, analysis years through 2017 were treated as historical, using actual data. 2018 and later analysis years were treated as future years, using latest available survey-based inputs, with some defaults also (e.g., Tier 3 sulfur), as future year expected values.

[19] Constraints in the fuel market to accommodate federally mandated, annually increasing RFS renewable fuel (RF) volume targets (e.g., ethanol, biodiesel) have required EPA to propose reductions in total renewable fuels below statutory volumes. With observed and potential variability in annual RF volumes relative to targets, the latest available observed RF volumes in the local survey-based estimates were considered reasonable for future expected levels. Ethanol and biodiesel blends were based on the latest available Texas summer fuel surveys, which indicates statewide saturation of E10 gasoline and no biodiesel.

- T90 (degrees Fahrenheit at 90 percent vapor).

Although not listed previously, the fields BioDieselEsterVolume, CetaneIndex, and PAHContent are also included in the fuelformulation table but were not used.

Data Sources – For pre-1990 controls, a MOVES default was used for gasoline, and conventional diesel sulfur content was based on information from NIPER U.S. refiner survey summary information on the typical post-1979/pre-1993 regulation No. 2 diesel.

For the control strategy scenarios, the EPA Office of Transportation and Air Quality (OTAQ) provided TTI with the summer 2011 and summer 2017 retail outlet RFG survey data summaries for the HGB RFG area (sample data by fuel grade: regular [RU], mid-grade [MU], and premium [PU]), collected by the RFG Survey Association.[20] TCEQ provided the summer 2011 and summer 2017 Texas statewide fuel survey data summaries, for which the information on local diesel fuel were used (each includes diesel and three gasoline grade samples from each of 92 locations across Texas).[21]

Development of Gasoline Fuel Formulations Inputs – For the pre-1990 controls scenario, an appropriate gasoline fuel formulation (ID 1007) was taken directly from the MOVES default database and given a unique fuel formulation ID. The particular selection was made by using a combination of fuel region, fuel year and month (July 1990), and verifying appropriate average fuel property values (e.g., non-oxygenated gasoline, 7.8 psi RVP limit, a typical pre-regulation gasoline sulfur level).

For the control strategy scenarios, the standard procedure was used which involves calculating average fuel properties by fuel grade and calculation of the overall averages as a weighting of the fuel grade results using relative sales volumes. The relative sales volumes were estimated using annual average sales volumes per day through retail outlet statistics for Texas.[22] For the future years formulation, the latest available (2017) survey-based averages were used as expected future year values, except for average sulfur content, which was replaced with the MOVES default value (consistent with the Tier 3 average annual standard).

Development of Diesel Fuel Formulation Inputs – For the pre-1990 controls scenario, the diesel sulfur content estimate used was developed by TTI for prior SIP RFP analyses. This diesel sulfur level was based on NIPER U.S. refiner survey summary information, which placed the average sulfur value for the typical No. 2 diesel, within the post-1979/pre-1993 regulation period, in the 2500-3000 ppm range. The conservative, low-end-of-the-range value was used.

For the control strategy scenarios, TCEQ's most recent (2011 and 2017) summer fuel surveys were used. These surveys provide similar observations for diesel sulfur content based on individual samples from the 92 locations across the state. Average sulfur content was within the

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[20] For more information see: http://www.epa.gov/otaq/fuels/gasolinefuels/rfg/properf/perfmeth.htm.

[21] *Sampling and Laboratory Analysis of Retail Gasoline and Diesel Fuel for Selected Texas Cities – Summer 2011 (Revised) Final Report*, ERG, August 31, 2011, Revised March 2015; *2014 Summer Fuel Field Study (Revised) Final Report*, ERG, revised January 2015.

[22] Sales volumes by grade were from the Energy Information Administration's (EIA) *Petroleum Marketing Annuals*. 2011 sales (latest available).

range of 2 to 11 ppm, and the average was approximately 6 ppm. For each year TTI calculated the statewide average sulfur level for use with all counties. Recent on-road inventory analyses have used a standard future year “expected” average diesel sulfur level (11 ppm) consistent with the federal low sulfur diesel average annual sulfur standard (15 ppm). The 11 ppm expected value, which fits very well with the recent observed data, was used for the future year control strategy scenarios. (The effects of TxLED were incorporated by emissions factor post-processing, discussed later.)

Table 24 summarizes the gasoline and diesel fuel property inputs.

Table 24. HGB Summer Gasoline and Diesel Fuel Formulation Table Inputs to MOVES.

Field[1]	Units	Pre-1990 Controls[2]		2011[3]		2017[3]		2018 and later[4]	
fuelFormulationID	-	10001	32500	11724	30572	17724	30637	18724	30011
fuelSubtypeID	-	10	20	12	20	12	20	12	20
RVP	psi	7.80	0	7.06	0	7.01	0	7.01	0
sulfurLevel	ppm	429.96	2,500	29.52	5.72	19.49	6.37	10.00	11.00
ETOHVolume	vol.%	0.00	0	9.76	0	9.67	0	9.67	0
MTBEVolume	vol.%	0.00	0	0	0	0	0	0	0
ETBEVolume	vol.%	0.00	0	0	0	0	0	0	0
TAMEVolume	vol.%	0.00	0	0	0	0	0	0	0
aromaticContent	vol.%	26.4	0	14.75	0	15.62	0	15.62	0
olefinContent	vol.%	11.9	0	13.17	0	10.83	0	10.83	0
benzeneContent	vol.%	1.64	0	0.53	0	0.51	0	0.51	0
e200	vap.%	46.04	0	49.21	0	49.02	0	49.02	0
e300	vap.%	81.43	0	84.64	0	84.54	0	84.54	0
VolToWtPercentOxy	-		0	0.3653	0	0.3653	0	0.3653	0
BioDieseEsterVolume	vol.%	/N	/N	/N	/N	/N	/N	/N	/N
CetaneIndex	-	/N	/N	/N	/N	/N	/N	/N	/N
PAHContent	vol.%	/N	/N	/N	/N	/N	/N	/N	/N
T50	deg. F	207.90	0	202.18	0	203.13	0	203.13	0
T90	deg. F	336.54	0	328.58	0	327.89	0	327.89	0

[1] MOVES fuelformulation table fields - fuelsubtypeID 10 is conventional gasoline, 12 is E10 gasoline with about 10 % by volume ethanol - in this case, local E10 RFG), and 20 is conventional diesel. Note the field value "/N" indicates a "null" value, which means the parameter does not matter or is not used, or was considered de minimis or not significant. SulfurLevel, for example, is the major MOVES diesel input parameter, whereas BioDieselEsterVolume in Texas is currently treated as de minimis in usage volumes or marketshare (most fuelformulation fields in MOVES for diesel are not used and were set to zero, although "null" would be appropriate as well).

[2] Pre-1990 controls - Gasoline: used select MOVES 1990 default formulation (default fuelformulationID 1007) and replaced the default ID with a unique, arbitrary value. Diesel: based on NIPER U.S. refiner survey summary information which placed average sulfur for the typical No. 2 diesel, within the post-1979/pre-1993 regulation period, in the 2500-3000 ppm range.

[3] 2011/2017 - Gasoline: used Texas sample data from EPA Houston summer RFG compliance surveys for each year, calculated average properties by grade then overall weighted composites using sales fractions by grade (based on Texas 2011 and 2016 [latest] annual reformulated gasoline volumes from EIA "Prime Supplier Sales Volumes for Petroleum Products" data). Diesel: Aggregated sulfur data from each TCEQ/ERG 2011 and 2017 statewide survey to the state level to calculate Texas average diesel sulfur content for each year.

[4] 2018 and later (future years) - Gasoline: RFG formulations are consistent with 2017 (based on the latest local survey data) except with average sulfur level set to the expected future year value (i.e., MOVES default -Tier 3 annual average standard). Diesel: set average sulfur level to the expected Texas future year value (i.e., within the federal ultra-low sulfur diesel average annual standard of 15 ppm and conservatively consistent with the local statewide survey data).

The actual fuelformation and fuelsupply input database tables used are included in the electronic data submittal as described in Appendix A.

Local I/M Inputs to MOVES

To model a local I/M program design, it must be defined using MOVES I/M coverage parameters by source type, entered in the MOVES imcoverage table. The appropriate internal MOVES I/M factors for modeling a local I/M program are designated in a model run by the local program input data in the imcoverage table.[23]

MOVES adjusts emissions (Hydrocarbons [HC], CO, and NO_x) at the source-type level to incorporate the benefits of the local I/M program design specified using the MOVES I/M coverage table parameters. TTI previously produced a comprehensive set of MOVES imcoverage records for Texas I/M counties to use in place of MOVES defaults.

The imcoverage parameters (by field header) are:

- polProcessID (pollutant and emissions process affected by the program);
- stateID (state subject to the I/M program);
- countyID (county Federal Information Processing Standards [FIPS]);
- yearID (year administered);
- sourceTypeID (source type affected);
- fuelTypeID (fuel type for the program);
- IMProgramID (arbitrary ID number specific to a local program);
- begModelYearID (first model year included);
- endModelYearID (last model year included);
- inspectFreq (inspection frequency for the program);
- testStandardsID (I/M test type);
- useIMyn (a Y/N [yes/no] switch that specifies whether or not to use the record); and
- complianceFactor (an adjustment factor reducing the I/M effects for compliance rate, waiver rates, regulatory class coverage adjustments, or other adjustments, if needed).

With earlier MOVES versions, there was a requirement to input any MOVES default I/M coverage records particular to the modeling scenario, along with the local user inputs, but flag the MOVES defaults for non-use. TTI only entered the local input parameters via the CDB imcoverage table, as entry of the defaults is no longer required.

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[23] In general, MOVES produces a local I/M program effect as an adjustment to the model’s internal reference I/M program effect (i.e., represented as the “standard I/M difference” in the pair of MOVES emissions rates [I/M – No I/M], which are specific to vehicle regulatory class categories of which the source types are composed). MOVES contains a large set of “I/M factors” by source type (in the MOVES imfactor table) computed specifically for adjusting the MOVES standard I/M difference to reflect the effects of local I/M program design alternatives.

Data Sources – TTI produced the local I/M coverage input parameters to represent Texas I/M program designs as specified in the Texas I/M SIP and Texas rules. The I/M program requires annual emissions testing of gasoline vehicles within a 2-through-24 year vehicle age coverage window (motorcycles, military tactical vehicles, diesel-powered vehicles, and antique vehicles are excluded). A gas cap integrity test is required on all these vehicles, and depending on the model year, gross vehicle weight (GVW) (threshold of 8,500 GVW separating light-duty and heavy-duty class), and I/M area, current vehicle emissions testing may use On-Board Diagnostics (OBD) tests, the Acceleration Simulation Mode (ASM-2) test, or the Two-Speed Idle (TSI) test.

Table 25 and associated notes describe MOVES imcoverage records developed by TTI for the years available in MOVES applicable to each HGB I/M county. For additional I/M program details, see the current I/M SIP and/or pertinent Texas Administrative Code.[24]

Local I/M Coverage Input Data Development Approach – Following is the general approach used to build the Texas imcoverage tables:

- Identified MOVES I/M test standards applicable to Texas I/M counties in consultation with TCEQ (see Table 25, column 4);
- Queried the MOVES database to determine the extent to which MOVES provides I/M effects corresponding to Texas I/M Programs (i.e., test frequency, fuel type, and test types). From the result, listed the SUTs, test standards, pollutant and emissions process combinations with I/M effects in MOVES (i.e., with non-zero MOVES I/M factors and corresponding base emissions rates with non-zero standard I/M differences);
- Categorized counties and years in groups under the pertinent MOVES test standards; and
- Assigned MOVES I/M Program IDs such that: 1) all MOVES default I/M Program IDs were excluded; and 2) for each year ID, each I/M Program ID represented a unique combination of test standard, test frequency, begin model year, and end model year.

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[24] *Revision to the State Implementation Plan Mobile Source Strategies, Inspection and Maintenance State Implementation Plan Revision*, TCEQ, adopted February 12, 2014.

Table 25. MOVES I/M Coverage Inputs for Annual Inspections of Gasoline Vehicles for HGB I/M Counties (Harris, Brazoria, Fort Bend, Galveston, Montgomery).

Year ID[1]	Begin Model Year ID[1]	End Model Year ID[1]	Test Standards ID[2]	Source TypeID[3]
2014	1990	1995	23 (A2525/5015 Phase)	21 (PC – Passenger Car), 31 (PT – Passenger Truck), 32 (LCT – Light Commercial Truck)
			41 (Evp Cap)	
	1996	2012	51 (Exh OBD)	
			45 (Evp Cap, OBD)	
2020, 2026, 2032	*X*	*Y*	51 (Exh OBD)	
	X	*Y*	45 (Evp Cap, OBD)	

[1] begmodelyearID (*X*) and endmodelyearID (*Y*) define the range of model years covered – where represented by "*X*" and "*Y*," respectively, are calculated as YearID – 24, and YearID – 2.

[2] The processes/pollutants affected are start and running exhaust HC, CO, NO_x, and tank vapor venting HC.

[3] Source type compliance factor field input values (PC – 93.12 percent; PT – 91.26 percent; LCT – 85.67 percent) were calculated per Section 4.10.6, *MOVES Technical Guidance*, EPA, November 2015, using Texas modeling protocol compliance and waiver rates of 96 percent and 3 percent, and regulatory class adjustments per *MOVES Technical Guidance*, Appendix A. The regulatory class adjustments provide a conservative result in that small portions of PT and LCT, attributable to regulatory class 40 (Class 2b Trucks with 2 Axles/4 Tires [8,500 lbs. < GVWR <= 10,000 lbs.], or "LHD <= 10k"), exclude a potential evaporative gas cap effect available in MOVES for LHD<= 10k.

Hotelling Activity Distribution Inputs to MOVES

To model emissions from long-haul truck hotelling activity with MOVES, a distribution of hotelling activity modes by model year may be input via the hotellingactivitydistribution table, otherwise the MOVES default is used. For previous inventory analyses, TTI used the MOVES default, currently comprised solely of the two emissions-producing hotelling activity modes, extended idling and diesel APU operation. For this analysis, TTI used the updated, more realistic hotelling activity distributions adopted in TCEQ's 2017 truck idling study, comprised of four modes, extended idling and APU use modes, and the non-vehicle-emissions-producing electric power use and power off modes. The updated hotellingactivitydistribution table inputs were previously shown in Table 21.

The MOVES input files (MRSs and CDBs) were provided as a part of the electronic data submittal (Appendix A) of this Technical Note.

Checks and Runs

After completing the input data preparation, the CDBs were checked to verify that all 21 tables were in the appropriate CDBs and the tables were populated with data as intended. The MOVES RunSpecs were executed in batches using the MOVES commandline tool. After completion, TTI verified that the MOVES runs were error free (i.e., checked all run log text files for errors and warnings). The MOVES runs summaries are included as Appendix H.

Post-Processing Runs

Each MOVES output database was post-processed using the TTI's MOVES emissions rates post-processing utilities for on-road mobile emissions rates, RatesCalc and RatesAdj. Post-processing for each MOVES run was performed in two steps – RatesCalc first produced and interim "ratescalcs" rate database, followed by an "ratesadj" database containing the final on-road rate tables for subsequent input to the EmsCalc inventory calculation utility. The following post-processing procedures were performed on each MOVES output database.

- Interim Rate Databases: Using RatesCalc, the mass/SHP off-network evaporative process rates were calculated using data from the CDB, the MOVES default database, and the MOVES rateperprofile and ratepervehicle emissions rate output. The utility also copied the mass/mile, mass/start, and mass/hour rates along with the units into emissions rate tables. This utility does not perform any unit conversions and excludes total energy and refueling processes. The utility created the look-up tables ttirateperdistance, ttirateperstart, ttirateperhour (for SHI and APU hours), and ttiratepershp in a "ratescalcs" interim output database for each scenario.
- Final Rate Databases: Using RatesAdj, TTI produced the final on-road mobile emissions rates for input to the EmsCalc emissions calculator. RatesAdj extracted emissions rates from the RatesCalc rate tables for only those pollutants needed in the emissions calculations. For the RFP control strategy scenario runs, this step applied TxLED adjustments (see factors developed by TTI in Table 26) to the diesel vehicle NO_x emissions rates for all HGB counties. (TxLED was not included for the Pre-1990 Controls scenario modeling.) TTI produced these average diesel SUT NO_x adjustments using 4.8 percent and 6.2 percent reductions for 2002 and later, and 2001 and earlier model years, respectively.[25] The extracted and adjusted rate tables were placed in "outRatesAdj" databases (one each per run) for subsequent input to the on-road mobile source emissions calculator, EmsCalc.[26]

See the utility descriptions in Appendix B for more information.

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[25] Reductions as detailed in the EPA Office of Transportation and Air Quality Memorandum, RE: Texas Low Emission Diesel [LED] Fuel Benefits, September 27, 2001.

[26] The TxLED counties list may be found at: http://www.tceq.texas.gov/airquality/mobilesource/txled/txled-affected-counties. For full details on the TCEQ TxLED factor development procedure, see "mvs14-statewide-txled-analysis-06-12-17-18.zip" found at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/.

Table 26. TxLED Adjustment Factors Summary.

Diesel Fuel Source Use Type	Reduction					Adjustment				
	2011	2017	2018	2020	2021	2011	2017	2018	2020	2021
Passenger Car	5.88%	5.17%	4.99%	4.92%	4.92%	0.9412	0.9483	0.9501	0.9508	0.9508
Passenger Truck	5.35%	5.08%	5.04%	5.01%	4.97%	0.9465	0.9492	0.9496	0.9499	0.9503
Light Commercial Truck	5.69%	5.35%	5.32%	5.21%	5.20%	0.9431	0.9465	0.9468	0.9479	0.9480
Intercity Bus	5.84%	5.69%	5.65%	5.61%	5.56%	0.9416	0.9431	0.9435	0.9439	0.9444
Transit Bus	5.80%	5.66%	5.60%	5.51%	5.47%	0.9420	0.9434	0.9440	0.9449	0.9453
School Bus	5.80%	5.67%	5.63%	5.57%	5.52%	0.9420	0.9433	0.9437	0.9443	0.9448
Refuse Truck	5.64%	5.38%	5.30%	5.24%	5.13%	0.9436	0.9462	0.9470	0.9476	0.9487
Single Unit Short-Haul Truck	5.06%	4.89%	4.88%	4.85%	4.84%	0.9494	0.9511	0.9512	0.9515	0.9516
Single Unit Long-Haul Truck	5.05%	4.90%	4.89%	4.86%	4.85%	0.9495	0.9510	0.9511	0.9514	0.9515
Motor Home	5.59%	5.38%	5.36%	5.29%	5.26%	0.9441	0.9462	0.9464	0.9471	0.9474
Combination Short-Haul Truck	5.49%	5.19%	5.16%	5.11%	5.05%	0.9451	0.9481	0.9484	0.9489	0.9495
Combination Long-Haul Truck	5.59%	5.26%	5.21%	5.12%	5.05%	0.9441	0.9474	0.9479	0.9488	0.9495

Source: TTI, September 2017. TTI used the TxLED factor procedure from TCEQ (available in "mvs14-statewide-txled-analysis-06-12-17-18.zip" available at: ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/) in combination with 2011 data and the latest available data (i.e., statewide age distributions based on mid-year 2014 TxDMV vehicle registrations for future years).

The resulting hourly on-road rates were input to the EmsCalc utility to calculate the on-road mobile source inventories for each county RFP inventory scenario. All emissions factor modeling inputs and the final rates used in the inventories were provided electronically as described in Appendix A.

Emissions Rates for Estimation of Individual Control Reductions

In a manner consistent with the development of the CS0 and CSC scenario emissions rates, TTI produced emissions rates for the CS1, CS2, and CS3 incremental control scenarios needed for estimating the individual control measure emissions reductions.

Table 27 summarizes the run sequence. Note that existing MOVES and MOVES post-processor utility runs from the CS0 and CSC scenarios were used in combination with output from the extra runs needed, to produce the required five scenarios of Harris County emissions estimates. Existing runs and new runs are summarized together for the overall emissions rates development process, which includes development of MOVES setups (MRSs, CDBs), RatesCalc set-ups, and RatesAdj set-ups. (EmsCalc runs to calculate the emissions estimates are discussed in the next section).

Table 27. Harris County Emissions Factor Modeling Control Scenarios and Sequence.

Scenario Label	Controls Increment	MOVES CDB	MRS	MOVES Runs	RatesCalc Runs	RatesAdj Runs
CS0	Pre-1990 Controls (base)	Existing "pre-1990 controls" scenario set-ups and runs				
CS1	CS0 + RFG and ULSD	Same as CS0 except for current fuels	Changes only in input/output labeling	√	√	√ (no TxLED)
CS2	CS1 + post-1990 FMVCP	Same as CS1 CDB	"No CAA" switched off Input/output labels changed	√	√	√ (no TxLED)
CS3	CS2 + I/M	Existing set-ups and runs (i.e., CSC set-ups and runs prior to TxLED adjustments, or CSC scenario - TxLED)				√ (no TxLED)
CSC	CS3 + TxLED	Existing "control strategy" scenario set-ups and runs				

As shown in Table 27, of the five control scenarios, three (CS1, CS2, and CS3) required some modeling set-ups and runs. The CS1 and CS2 control scenarios required the full process stream of set-ups and runs, whereas the CS3 control scenario only required set-ups and runs beginning with the RatesAdj step (since CS3 is the same as CSC, except with no TxLED). Therefore, the CSC RatesCalc step output was input to a new "CS3" RatesAdj utility run with no TxLED adjustments applied to produce the CS3 scenario rate tables. This series of additional emissions factor modeling set-ups and runs was developed and executed for 2017, 2018. 2020 and 2021 analysis years.

The Harris County emissions factors for the CS1, CS2, and CS3 incremental control scenarios for each year were input with appropriate activity inputs into EmsCalc to produce the emissions estimates that, together with the existing CS0 and CSC scenario emissions, were used to quantify the individual control measure emissions reductions, discussed in a later section.

The emissions factor MOVES set-ups used (MRS files and CDBs) were provided as a part of the electronic data submittal (see Appendix A).

EMISSIONS CALCULATIONS

Using TTI's EmsCalc utility and the previously detailed inventory activity and emissions rate inputs, TTI calculated hourly on-road mobile emissions by HGB county for each RFP inventory scenario and the extra incremental control measure scenarios only for Harris County.

Under the TDM link-based inventory methodology, the on-road emissions calculation process falls into two vehicle activity categories: VMT-based emissions calculations and off-network emissions calculations. The VMT-based emissions calculations use the TDM link-based VMT and speeds to estimate emissions at the TDM roadway network link level. The off-network emissions calculations use off-network activity (SHP, starts, SHI and APU hours) to estimate emissions at the county level.

EmsCalc produced three output files per run. These outputs consist of a listing file (summarizing information regarding the execution of the utility), a standard tab-delimited emissions inventory summary, and a tab-delimited 24-hour emissions inventory summary by SCCs and pollutant codes consistent with EPA's 2017 NEI.

Hourly Link-Based Emissions Calculations

The hourly link-based emissions by county for each inventory scenario were calculated using EmsCalc and the following major inputs.

- Time period TxDOT district-level SUT/fuel type VMT mix – by MOVES roadway type;
- Time period designation – the four VMT mix time periods to hour-of-day associations;
- Roadway-based activity – link (and intrazonal link)-specific, hourly, directional, operational VMT and speed estimates as developed by the TRANSVMT utility to include: A node, B node, county number, TDM road type (functional class) code, link length, congested (operational) speed, VMT, and TDM area type code;
- TDM road type designations – TDM road type and area type codes to MOVES road type codes (and to VMT mix road type, and to rates road type codes) (see Table 28);
- Off-network activity – county, hourly SHP, starts, SHI, and APU hours by vehicle type;
- Pollutant/process/units list – for emissions to be calculated and output in tab-delimited emissions summary files;
- Roadway-based emissions factors – MOVES-based, county level by pollutant, process, hour, average speed, MOVES road type, SUT, and fuel type;
- Off-network (parked vehicle) emissions factors – MOVES-based, county level by pollutant, process, hour, SUT, and fuel type;
- SCCs – mapping for MOVES source type, fuel type, road type, and process codes to output SCCs; and
- MOVES pollutant codes to NEI pollutant codes – for SCC output.

The VMT-based emissions were calculated for each hour using the time-period TxDOT-level SUT/fuel type VMT mix, the link VMT and speeds estimates, the MOVES-based "on-network" emissions factors, and the link road type/area type-to-MOVES road type designations. For each link, the link was assigned a MOVES road type based on the link's road type and area type (see Table 28). The link VMT was distributed to each SUT/fuel type using the VMT mix from the appropriate time period based on the link's designated MOVES road type. The time period VMT mixes were applied by hour as follows: morning peak – 6 a.m. to 9 a.m.; mid-day – 9 a.m. to 3 p.m.; evening peak – 3 p.m. to 7 p.m.; and overnight – 7 p.m. to 6 a.m.

The emissions factors by hour for each SUT/fuel type were selected based on the designated hour of the link file, and the link's designated MOVES road type and the link speed. For link speeds falling between MOVES speed bin average speeds, emissions factors were interpolated from bounding speeds. For link speeds falling outside of the MOVES speed range (less than 2.5 mph and greater than 75 mph), the emissions factors for the associated bounding speeds were used. The mass/mi rates were multiplied by the link SUT/fuel type VMT producing the link-level emissions estimates. This was performed for each hour of the day.

Table 28. H-GAC TDM Road Type/Area Type to MOVES Road Type Designations.

TDM Road Type (Code - Name)[1]	TDM Area Type (Code - Name)[1]	MOVES Road Type (Code - Name)[1, 2]
3 - Toll Roads	5 – Rural	2 – Rural Restricted Access
10 - Rural Interstate	5 – Rural	
11 - Rural Other Freeway	5 – Rural	
4 - Ramps (Fwy/Toll/Frnt)	5 – Rural	3 – Rural Unrestricted Access
8 - Local (Centroid Connector)	5 – Rural	
12 - Rural Principal Arterial	5 – Rural	
13 - Rural Other Arterial	5 – Rural	
14 - Rural Major Collector	5 – Rural	
15 - Rural Collector	5 – Rural	
1 - Urban Interstate	1 – CBD; 2 – Urban; 3 – Urban Fringe	4 – Urban Restricted Access
2 - Urban Other Freeway	2 – Urban; 3 – Urban Fringe	
3 - Toll Roads	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	
10 - Rural Interstate	2 – Urban; 3 – Urban Fringe; 4 – Suburban	
11 - Rural Other Freeway	3 - Urban Fringe; 4 – Suburban	
4 - Ramps (Fwy/Toll/Frnt)	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	5 – Urban Unrestricted Access
5 - Urban Principal Arterial	1 – CBD; 2 – Urban; 3 – Urban Fringe	
6 - Urban Other Arterial	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	
7 - Urban Collector	1 – CBD; 2 – Urban; 3 – Urban Fringe	
8 - Local (Centroid Connector)	1 – CBD; 2 – Urban; 3 – Urban Fringe; 4 – Suburban	
12 - Rural Principal Arterial	3 – Urban Fringe; 4 – Suburban	
13 - Rural Other Arterial	3 – Urban Fringe; 4 – Suburban	
14 - Rural Major Collector	3 – Urban Fringe; 4 – Suburban	
15 - Rural Collector	3 – Urban Fringe; 4 – Suburban	
40 - Local (Intrazonal)	40 – Local (Intrazonal)	

[1] The TDM road type and area type code combinations are also correlated to VMT mix road type codes and emissions rate road type codes, which, for this analysis, are identical to the MOVES road type codes.

[2] The four period, time-of-day VMT mix to hour-of-day designations are: AM peak – three hours of 6 a.m. to 9 a.m.; mid-day – six hours of 9 a.m. to 3 p.m.; PM peak – four hours of 3 p.m. to 7 p.m.; and overnight – 11 hours of 7 p.m. to 6 a.m.

The off-network emissions were calculated at the county-level by multiplying the hourly MOVES-based SUT/fuel type off-network emissions factors by the appropriate county-level hourly SUT/fuel type off-network activity, which was determined by the pollutant process and associated emissions rate table.

Hourly Link-Based Emissions Output

The EmsCalc hourly link-based emissions output data sets consisted of three output files per run. These output files are:

- A listing file that summarizes the utility execution information, including the inputs and outputs used, a summary of the VMT mix, a summary of the off-network activity, a summary of the emissions factor dimensions (i.e., hour, MOVES road type, MOVES speed bin, SUT, fuel type, pollutant, process), and an hourly totals summary of the totals for VMT, VHT, speed, off-network activity, and emissions in pounds;
- A tab-delimited summary output file consisting of one header section followed by hourly and 24-hour totals data blocks of on-road activity and emissions (in units of pounds). Hourly and 24-hour total summaries are by road type and vehicle type of VMT, VHT, speed (VMT/VHT), pollutant totals, and pollutant process totals (with the "off-network" category listed as the last road type preceding the TOTALS row in each data block), and with starts, SHP, SHI, and APU activity rows last in the activity data block for each time period; and
- A tab-delimited summary SCC output file that contains the 24-hour totals of VMT and emissions (in units of pounds) using inventory data aggregations, SCCs, and pollutant codes consistent with the EPA's 2017 NEI.

The pollutants included are:

- VOC, CO, NO_x, NH_3, SO_2, CO_2, PM_{10} Total Exhaust, PM_{10} Brakewear, PM_{10} Tirewear, $PM_{2.5}$ Total Exhaust, $PM_{2.5}$ Brakewear, $PM_{2.5}$ Tirewear, OC, EC, and Composite Non-elemental Carbon.

See Appendix B for further details on the EmsCalc utility.

XML-Formatted 24-Hour Summaries for TexAER

TTI post-processed the EmsCalc 24-hour summer weekday 2011, 2017, 2018, 2020 and 2021 RFP control strategy scenario SCC-labeled inventory output, using the TTI's MOVESSCCXMLFormat utility, into the NEI Emission Inventory System (EIS) CERS XML format for inclusion in TCEQ's TexAER database.

The tab-delimited SCC-based inventory data files output by EmsCalc were produced for direct input to the XML format utility using inventory data aggregation and coding (SCCs and pollutant codes) consistent with EPA's latest (2017) NEI, as required for compatibility with TexAER. The current NEI SCC codes are aggregations of the more detailed MOVES SCC codes, providing the total emissions for each valid NEI pollutant by source type and fuel type (e.g., for on-road, by pollutant, the total of all roadway-based and off-network processes, excluding refueling).

The on-road emissions inventory XML summaries include VOC, CO, NO_x, SO_2, NH_3, CO_2, $PM_{2.5}$ and PM_{10} (PMs are aggregate of exhaust, tirewear, and brakewear). Each run produced a LST file, the XML file, and one tab-delimited SCC-labeled inventory summary per county included in the run. All eight HGB counties were included in each of the three (one per year) MOVESSCCXMLFormat runs. (Further details may be found in Appendix A.)

QUALITY ASSURANCE

Analyses and results were subjected to appropriate internal review and QA/QC procedures, including independent verification and reasonableness checks. All work was completed consistent with applicable elements of American Society for Quality, American National Standard ASQ/ANSI: E4:2014: *Quality Management Systems for Environmental Information and Technology Programs – Requirements with Guidance for Use,* February 2014, and the TCEQ Quality Management Plan.

The QAPP category and project type most closely matching the intended use of this analysis are QAPP Category II (for important, highly visible Agency projects involving areas such as supporting the development of environmental regulations or standards) and Modeling for NAAQS Compliance. Internal review and quality control measures consistent with the QA category and project type-specific requirements provided in Guidance for Quality Assurance Project Plans for Modeling, EPA QA/G-5M,[27] along with appropriate audits or assessments of data and reporting of findings, were employed. These include but are not limited to the elements outlined, per EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5),[28] in the following description.

A. Project Management

The project management was as listed previously in the Acknowledgments section.

The definition and background of the problem addressed by this project, the project/task description, and project documents and records produced are as described previously in the Purpose and Background sections. No special training or certifications were required. The TTI project manager assured that the appropriate project personnel had and used the most current, approved version of the QAPP.

After receiving the Notice to Commence (NTC) from TCEQ, the TTI project manager provided a detailed pre-analysis plan to the TCEQ project manager for review and concurrence. Upon concurrence of the pre-analysis plan, the TTI project manager distributed the pre-analysis plan to the TTI inventory developers for use in both the inventory development and QA review process. TTI maintains records of the project QA checks as a part of the project archive, for at least five years.

The objective was to produce the emissions inventory product of the quality suited to its purpose as specified (i.e., inventories needed to support RFP analyses), in accordance with the appropriate guidance and methods documents as referenced, as detailed in the pre-analysis plan, and in consultation with the TCEQ project manager.

Basic criteria were used to assure that the acceptable quality of the product was met – product developers verified that the process and product as specified, to include:

- The product met the purpose of the emissions analysis (i.e., for use in support of RFP SIP analyses);

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[27] PDF available at: https://www.epa.gov/sites/production/files/2015-06/documents/g5m-final.pdf.

[28] PDF available at: https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf.

- The full extent of the modeling domain (i.e., analysis years, geographic coverage, seasonal periods, alternate scenarios, days, sources, pollutants) was included;
- Agreed methods, models, tools, and data were used (i.e., as listed in the Grant Activities Description, and as listed in the more detailed pre-analysis plan);
- The required output data sets were produced in the appropriate formats in accordance with the pre-analysis plan;
- Any deficiencies found during development and end-product quality checks (as discussed in QAPP Part D) were corrected; and
- Aggregate emissions estimate results were comparable with available, similarly produced emissions estimates.

B. Measurement and Data Acquisition

Note that no sampling of data was involved in the emissions inventory development, thus only existing data (non-direct measurements) were used for this project.

The data needed for project implementation were in the categories needed for development of emissions rate model inputs and adjustment factors, and for development of the activity inputs for external emissions calculations. These emissions factor model inputs and activity inputs were developed using data sources as outlined previously and/or methods and procedures as detailed in the references listed, and as provided in the pre-analysis plan.

All data used either as direct input or to produce inputs (e.g., to the MOVES model or to TTI's emissions inventory development utilities used, which were listed in the pre-analysis plan) were reviewed by TTI for suitability before use. The data sets for the project were provided by TxDOT, a Metropolitan Planning Organization (MPO) or Council of Governments (COG), TCEQ, and/or the EPA, and in most cases were QA'd by the providing agency. The pre-analysis plan lists the data to be used for the project. The data needed may include: HPMS data (from TxDOT's Roadway Inventory Functional Classification Record [RIFCREC] report); regional travel demand model data; speed model data; vehicle registration data; ATR data; vehicle classification count data; meteorological data; fuels data; MOVES emissions model data; extended idling activity data; and vehicle I/M program design data.

Any significant problems found during data review, verification, and/or validation (see QA criteria and methods discussed in Section D) were corrected, and the QA procedure was repeated until satisfied. No significant problems were found.

Data Management: TTI emissions inventory data developers work as a closely coordinated team. The assigned staff used the same electronic project folder structure on their individual workstations. As various scripts, inputs, and outputs were developed in the emissions inventory development process, data were shared within the team for crosschecking via an intra-net, flash drive, or external hard drive. To perform the MOVES model runs, a computer cluster (multiple computer) configuration or individual workstation configuration was used. After input data were QA'd, depending on the size of the data set, the data sets were backed up and stored in compressed files. These activities were performed throughout the process until the final products were produced.

For MOVES model runs to produce emissions factor look-up tables for the emissions inventories, all run files (MOVES model inputs and batch files) were produced on an individual workstation. After the MOVES input data and batch files (i.e., Run Files) were QA'd they were either executed on an individual workstation, or they were copied (via external hard drive) to the cluster's Master computer and executed. Upon execution, completion, and error checking, the MOVES output databases were (for cluster runs first copied to an individual workstation) archived and processed further in preparation for input to the emissions calculations utility.

After the final product was completed, all the project data archives were compiled on a set of optical data discs (CD-ROM or DVD, depending on size), or on an external drive for very large project data sets. A complete archive of the project data is kept by TTI (the computer models and emissions inventory development utilities used in the process are included). An electronic data submittal package (containing the project deliverables as listed in Appendix A) was produced along with data description (on CD-ROM, DVDs, or external hard drive, depending on needed storage space) and delivered to TCEQ.

C. Assessment and Oversight

The following assessments were performed.

- Verified that the overall scope was met (consistent with the intended purpose, for specified temporal resolution and geographic coverage, for specified sources, pollutants, and emissions processes).
- Checked that input data preparation, and model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files) were prepared according to the plan.
- Checked that correct output data were produced (includes interim output [output that becomes input to a subsequent step in the inventory development process], as well as the final product). Records were kept of the checks performed.

In the case that any inconsistencies or deficiencies were found, the issue was directly communicated to the responsible staff for corrections (or the outside agency staff involved, if provided from outside of TTI, if needed). After a correction was made, the QA checks were performed again to ensure that the additional work resulted in the intended quality assured result, and the correction was noted in the QA record (process was performed until QA check was satisfied).

Any major problem was reported to the project manager and communicated to the project team as needed, as well as when the various data elements in the process passed QA checks and were ready for further processing according to the project pre-analysis plan. The project manager ensured that all of the QA checks performed were compiled, and maintained in the project archives.

In addition, technical systems audits were performed as appropriate. Audits of data quality at the requisite 25 percent level were performed for any data collected or produced as part of this study. QA findings were reported in both the draft and the final reports.

D. Data Validation and Usability

Erroneous or improper inputs at any point during the emissions inventory development process may produce resulting emissions estimates that are inaccurate and may not be suitable for their intended purpose. Adherence to the inventory process flow with performance of the integrated QA checks at each step of the process was of the utmost importance to ensure that the results met the project objectives.

The criteria for passing quality checks and the checks typically performed on each major inventory input component (i.e., input estimates of source activity, activity distributions, and emissions factors; as well as the resulting emissions estimates) are summarized in the following. These QA guidelines were used to ensure the development of emissions inventory estimates that were as accurate as possible and met the requirements of TCEQ's intended use.

TTI verified that the overall scope of the emissions analysis has been met as prescribed in the pre-analysis plan, to include:

- Purpose of the emissions analysis (i.e., needed for RFP SIP analysis);
- Extent of the modeling domain (e.g., analysis years, geographic coverage, seasonal periods, alternate scenarios, days, sources, pollutants);
- Methods, models, and data used (e.g., default versus local input data sources); and
- Procedures and tools used and all required emissions output data sets were produced.

TTI performed checks on input data preparation, model or utility execution instructions (e.g., run specifications, scripts, job control files [JCFs], command files), and output, as appropriate to the component.

- Input data preparation checks:
    - Verified the basis of input data sets against the pre-analysis plan: Actual historical or latest available data, validated model, expected values or regulated limits, regulatory program design, model defaults, surrogates, professional judgment; checked aggregation levels.
    - Data development: Depending on the procedure and particular input data set, calculations were verified (e.g., re-calculated independently and compared with originally prepared values – when spot-checking a series of results, included extremes and intermediate values).
    - Completeness: Verified that input data sets were within the required dimensions, and all required fields were populated and properly coded or labeled.
    - Format: Verified that formats were within required specifications (e.g., field positions, data types and formats, and file formats) if any.
    - Reasonability checks: (discussed in the next section).
    - Ensured that any inputs provided from external sources were quality assured, as listed previously.

- Checked the model or utility execution instructions:
  - Verified that the correct number of utility or model run specifications were prepared for each application (e.g., by year, county, season, day type).
  - Verified that each utility or model run script included the correct modeling specifications for the application per applicable user guide (e.g., commands, input values, input and output file paths, output options).
- Checked for the successful completion of model and utility executions:
  - Verified that the correct number of each type of output file was produced by the particular model or utility.
  - Checked for any unusual output file sizes.
  - Searched output for warnings and errors (e.g., utility listing files or model execution logs that contain error and warning records).
  - Checked the summary information provided in output listing files for any unusual results.

TTI performed further checks for consistency, completeness, and reasonability of data output from model or utility applications.

- Verified that the data distributions and allocation factors produced or used sum to 1.0, as appropriate (e.g., hourly travel factors within a time period, proportion of travel by vehicle categories on a particular roadway category).
- Verified that the required data fields were present, populated, and properly coded or labeled; verified that data and file formats were within specifications.
- Verified that any activity, emissions rate, or emissions adjustments were performed as intended (e.g., seasonal activity factor, emissions control program adjustment).
- For data sets prepared with temporal or geographic variation, compared and noted whether directional differences were as expected (e.g., activity distributions between weekends/weekdays, vehicle mix, or average speeds between road types or time periods).
- Checked for consistency between data sets (e.g., compared detailed spatially and temporally disaggregated activity estimates [e.g., link VMT] to original aggregate totals, activity total summaries between utility applications [e.g., link-VMT producer and emissions calculator], and input hourly distributions versus hourly summaries from the link activity output data).
- Calculated county, 24-hour, aggregate emissions rates (from aggregate VMT and emissions output) and compared the rates between counties examining the results for outliers while assessing the reasonability of any relative and directional differences (e.g., qualify based on activity distributions by road type and speed, mix of vehicles by road type, meteorological variation, control program coverage). Compared the results to results from previous emissions analyses where available.
- Calculated county, 24-hour aggregate rates by vehicle class and compared between vehicle classes. Examined the results for consistent patterns.

Any additional data products required for the emissions analysis were subjected to the appropriate QA checks previously listed. Any issues found needing resolution were corrected, and appropriate QA checks were performed until satisfied, ensuring the project results met TCEQ requirements, i.e., as outlined in the GAD, QAPP, and pre-analysis plan.

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APPENDIX A:
HGB RFP ON-ROAD INVENTORIES ELECTRONIC DATA SUBMITTAL

HGB RFP MOVES2014a-Based, County-Level, On-Road Emissions Inventories and Control Measure Emissions Reductions Estimates – Electronic Data Submittal

This appendix describes the electronic data package TTI submitted (Spring 2019) to TCEQ per Proposal for Grant Activities No. 582-18-81247-07.

Data File Labels Key

The MOVES rates-per-activity, TDM link-based method externally combined emissions rates and activity factors to produce ozone season weekday county inventories.[29] The 12 HGB Area RFP inventories (by county, 96 provided), in terms of activity and emissions rates, are:

Table 29. HGB Area RFP Inventory Scenarios - Descriptions and Data Labels.

Sequence No. (Label)	RFP Inventory	Activity Input[1]	Emissions Rates Input[2]
1 (2011 CSC)	2011 Control Strategy (Base Year)	2011	2011 Control Strategy (CSC)
2 (2011 ABY)	2011 Adjusted Base Year		2011 Pre-1990 Control (CS0)
3 (2017 ABY)	2017 Adjusted Base Year		2017 (CS0)
4 (2020 ABY)	2020 Adjusted Base Year		2020 (CS0)
5 (2017 CS0)	2017 Pre-1990 Control	2017	2017 (CS0)
6 (2017 CSC)	2017 Control Strategy		2017 (CSC)
7 (2018 CS0)	2018 Pre-1990 Control	2018	2018 (CS0)
8 (2018 CSC)	2018 Control Strategy		2018 (CSC)
9 (2020 CS0)	2020 Pre-1990 Control	2020	2020 (CS0)
10 (2020 CSC)	2020 Control Strategy		2020 (CSC)
11 (2021 CS0)	2021 Pre-1990 Control	2021	2021 (CS0)
12 (2021 CSC)	2021 Control Strategy		2021 (CSC)

[1] For external inventory calculations: vehicle miles traveled (VMT) mix, link VMT/speeds, and off-network activity.

[2] "Pre-1990 Control" rates are for calendar year of evaluation fleet but exclude post-1990 Clean Air Act Amendment (CAAA) controls – no Inspection and Maintenance (I/M) program, no post-1990 Federal Motor Vehicle Control Program (FMVCP) effects, no reformulated gasoline (RFG) (uses pre-1992 conventional gasoline with 1992 summer Reid vapor pressure [RVP] limit promulgated prior to enactment of the 1990 CAAA), no Texas Low Emissions Diesel (TxLED). "Control Strategy" rates include effects of control strategies current for subject analysis year (i.e., both pre- and post-1990 FMVCP, RFG, I/M [depending on county], TxLED fuel).

The following representative county (Harris) inventory control scenarios (CS1, CS2, and CS3) were produced for estimating HGB RFP individual control reductions (2017 and 2020) and contingency reductions (2018 and 2021):

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[29] Inventories: VOC, CO, NO_x, SO_2, NH_3, $PM_{2.5}$, PM_{10}, and CO_2. PM includes total exhaust, brakewear and tirewear. In addition to total exhaust, $PM_{2.5}$ exhaust subcomponents included are elemental and organic carbon, sulfate, and composite non-elemental carbon PM.

Table 30. Representative County Incremental Controls Inventories - Descriptions and Data Labels.

Sequence No. (Label)	Incremental Control Inventory[1]	Activity	Emissions Rates[1]
13 (2017 CS1)	2017 CS0 plus Post-1990 Federal Fuels	2017	2017 CS1
14 (2017 CS2)	2017 CS1 plus Post-1990 FMVCP		2017 CS2
15 (2017 CS3)	2017 CS2 plus I/M Program		2017 CS3
16 (2018 CS1)	2018 CS0 plus Post-1990 Federal Fuels	2018	2018 CS1
17 (2018 CS2)	2018 CS1 plus Post-1990 FMVCP		2018 CS2
18 (2018 CS3)	2018 CS2 plus I/M Program		2018 CS3
19 (2020 CS1)	2020 CS0 plus Post-1990 Federal Fuels	2020	2020 CS1
20 (2020 CS2)	2020 CS1 plus Post-1990 FMVCP		2020 CS2
21 (2020 CS3)	2020 CS2 plus I/M Program		2020 CS3
22 (2021 CS1)	2021 CS0 plus Post-1990 Federal Fuels	2021	2021 CS1
23 (2021 CS2)	2021 CS1 plus Post-1990 FMVCP		2021 CS2
24 (2021 CS3)	2021 CS2 plus I/M Program		2021 CS3

[1] CS0 is pre-1990 controls. CS1 is pre-1990 controls (CS0) except with post-1990 federal fuels (Tier 3 RFG and Ultra Low Sulfur Diesel); CS2 is pre-1990 controls plus post-1990 federal fuels plus post-1990 FMVCP; CS3 is pre-1990 controls plus post-1990 federal fuels plus post-1990 FMVCP with I/M program added.

Electronic Media

The electronic data submittal described in the following was provided on one DVD, entitled:[30]

> "*HGB RFP MOVES2014a-Based On-Road Mobile Source Inventories – TTI FY2019.*"

Emissions Inventory Data Files:

- RFP inventory and individual control reductions summaries (spreadsheet files).
- Inventory output files – EmsCalc utility TAB-delimited, hourly and 24-hour inventory report summary files and other associated output files (LSTs and SCC output).
- Inventory extracts –seven different aggregations from EmsCalc standard output.
- XML-formatted inventory summaries (control strategy scenario) for TexAER.

Emissions Factor Data Files:

- MOVES inputs - MRS files, CDBs, data files and MySQL scripts for building CDBs.
- Final, MOVES-based, TTI RatesAdj utility, rate-per-activity emissions factor databases (inputs to external emissions calculations), and TxLED adjustment factor files used.

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[30] "***CCCC***" in data descriptions denotes HGB county FIPS codes, which are: Brazoria - 48039, Chambers - 48071, Fort Bend - 48157, Galveston - 48167, Harris - 48201, Liberty - 48291, Montgomery - 48339, and Waller - 48473. Databases provided are MySQL databases, which consist of a folder containing one "db.opt" file and one or more database tables, where each table is composed of three files of the type: *.frm, *.MYD, and *.MYI.

Emissions Inventory Data Files

RFP Inventory Summary Tables and Individual Control Reductions Tables – The HGB area county RFP inventory summary tables and individual control measure reduction summary tables (and calculations) were provided in the following spreadsheet files:

- hgbrfp18_12RFP_inventories_summaries.xlsx (standard county summary tables).
- HGBrfp18_24TabFileTots_summaries.xlsx (additional pivot summary tables).
- HGBRFP18_<year>_Reductions_Calc.xlsx (four files –2017, 2018, 2020 and 2021).

"HGBrfp18_xls_summaries.zip" contains the six files.

RFP Inventory and Incremental Control Inventory Scenario EmsCalc Output – The EmsCalc output files provided (three types per run) are listed by filename prefix and described below:

Table 31.RFP Inventory and Incremental Control Inventory Scenario EmsCalc Output.

Year (*YYYY*)	**Control Scenario (*SSSS*)**	**RFP Inventory Scenario EmsCalc Output File Prefixes** (Where ***CCCC*** is each HGB Area county FIPS code)
2011	ABY, CSC	HGBRFP18_MVS14A_***CCCC***_***YYYY***SWK_***SSSS***_*
2017, 2020	ABY, CS0, CSC	
2018, 2021	CS0, CSC	
		Incremental Controls EmsCalc Output File Prefixes
2017, 2018, 2020, 2021	CS1, CS2, CS3	HGBRFP18_MVS14A_48201_***YYYY***SWK_***SSSS***_*

EmsCalc inventory output file-types (3) for each above listed run (108 runs produced 324 output files) were provided in "hgbrfp18_emscalc.zip:"

- "*ems.TAB:" a tab-delimited file of hourly and 24-hour activity and emissions summaries (pounds): by roadway and vehicle type (SUT/Fuel Type) for roadway processes – VMT, VHT, average speed (VMT/VHT), and associated pollutant/process emissions; by vehicle type for off-network processes – SHP, SHI and APU Hours, starts, and associated pollutant/process emissions (excluding refueling);

- "*sccoutput_ems.TAB:" a tab-delimited file of 24-hour activity and emissions summaries (pounds) using aggregations, SCCs, and pollutant codes consistent with EPA's 2014 NEI (for subsequent conversion to XML form uploadable to TexAER); and

- "*ems.LST:" a file listing run times; run script; file locations, data descriptions; data codes keys; tab output data label descriptions; and data summaries including hourly and 24-hour activity, pollutant/process emissions totals, and average speed (VMT/VHT).

Inventory Extracts – Seven inventory aggregations extracted from EmsCalc standard output were provided by year for each RFP inventory and extra incremental control scenario inventory. Output filenames are similar to EmsCalc output, except with no county codes and with an identifier for each aggregation type. One LST file was output for each inventory scenario along with the seven tab-delimited inventory aggregation files:

- HGBRFP18_MVS14A_<year>SWK_<type>_EMS_tabtots.LST
- HGBRFP18_MVS14A_<year>SWK_<type>_EMS_***????***.TAB

Where the aggregation types "????" are:

- "tabtots" (24-hr totals);
- "tabtots_Hr" (hourly totals);
- "tabtots_HrST" (hourly, SUT/fuel type totals);
- "tabtots_RdType" (hourly, road type totals);
- "tabtots_ST" (24-hr SUT/fuel type totals);
- "tabtots_RdTypeST" (hourly, road type, SUT/fuel type totals); and
- "tabtots_24hourRdTypeST" (24 hour, road type, SUT/fuel type totals).

"HGBrfp18_tabtotals.zip" contains the extracts output (192 files).

XML-Formatted 24-Hour Inventory Summaries for the TexAER – Using TTI's MOVESsccXMLFormat utility, TTI post-processed the 24-hour CSC scenario emissions inventory SCC-labeled output from EmsCalc to a form consistent with 2017 NEI EIS CERS XML specifications, for inclusion in the TexAER. The XML summaries use 10-digit SCCs providing the inventory data at the source type and fuel type level. Only VMT activity is reported. Using gasoline passenger cars, for example, the SCCs are:

- On-road processes excluding refueling – 2201210080:
    - 22 – mobile sources;
    - 01 – highway vehicles, gasoline (MOVES fueltypeID);
    - 21 – passenger car (MOVES SourcetypeID);
    - 00 – all road types; and
    - 80 – all on-network and off-network processes (except refueling).

The pollutants included are: VOC, CO, NO_x, SO_2, NH_3, $PM_{2.5}$ and PM_{10} (aggregate of exhaust, tirewear, brakewear), and CO_2. Each run produced a LST file, the XML file, and one tab-delimited SCC-labeled summary per county. The files are named:

- MOVESsccXMLformat_hgbRFP18_mvs14a_***YYYY***swk_CSC.LST;
- MOVESsccXMLformat_hgbRFP18_mvs14a_***YYYY***swk_CSC.XML; and
- MOVESsccXMLformat_hgbRFP18_mvs14a_***YYYY***swk_CSC_***CCCC***_summary.TAB.

"HGBrfp18_ XMLformat.zip" contains XML format utility output (50 files).

MOVES Emissions Rates Data Files

The following lists the emissions rate development files and final emissions rates provided. These consist of the MOVES run specification files; MOVES CDB files; MySQL scripts and data files used to produce the CDBs; and additionally the final, MOVES-based emissions rates produced with TTI's RatesAdj utility for input to the external inventory calculations.

Table 32. MOVES Input Files (CDBs and MRSs), MySQL CDB Scripts, and Final Rates Developed.

Control Scenario (***SSSS***)[1]	Year (***YYYY***)	CDB MySQL Script Files; CDBs; MRS Files; Final RatesAdj Rate Tables[2] (Where ***CCCC*** is FIPS county code for each of the eight HGB counties)
CS0, CSC[3]	2011, 2017, 2018, 2020, 2021	mvs14a_hgbrfp18_***YYYY***swkd_***SSSS***_***CCCC***_er_cdb_in.SQL mvs14a_hgbrfp18_***YYYY***swkd_***SSSS***_***CCCC***_er_cdb_in mvs14a_hgbrfp18_***YYYY***swkd_***SSSS***_***CCCC***_er.mrs mvs14a_hgbrfp18_***YYYY***swkd_***SSSS***_***CCCC***_er _outRatesAdj
CS1	2017, 2018, 2020, 2021	mvs14a_hgbrfp18_***YYYY***swkd _CS1_48201_er_cdb_in.SQL mvs14a_hgbrfp18_***YYYY***swkd _CS1_48201_er_cdb_in mvs14a_hgbrfp18_***YYYY***swkd _CS1_48201_er.mrs mvs14a_hgbrfp18_***YYYY***swkd _CS1_48201_er_outRatesAdj
CS2	2017, 2018, 2020, 2021	(used 48201 CS1 CDB -- only change from CS1 is in MRS file) mvs14a_hgbrfp18_***YYYY***swkd _CS2_48201_er.mrs mvs14a_hgbrfp18_***YYYY***swkd _CS2_48201_er_outRatesAdj
CS3	2017, 2018, 2020, 2021	(used MOVES output from 48201 CSC run) mvs14a_hgbrfp18_***YYYY***swkd _CS3_48201_er_outRatesAdj
The files were provided in the following zip files: • hgbRFP18_CDBscripts.zip (84 files); • hgbRFP18_CDBs.zip (84 CDBs, 5,376 files); • hgbRFP18_MRSs.zip (88 files); • hgbRFP18_RatesAdjDBs.zip (92 final rates databases, 1,472 files); and • mvs14a_txled_adjfactors.zip (5 files).[4]		

[1] CS0 is pre-1990 controls; CS1 = CS0 + post-1990 federal fuels; CS2 = CS1 + post-1990 FMVCP; CS3 = CS2 + I/M; CSC = CS3 + TxLED.

[2] Emissions rates (MySQL databases) input to the emissions inventory calculations (EmsCalc utility).

[3] Only the CSC (control strategy) scenario RatesAdj output was adjusted for TxLED effects.

[4] Contains TxLED NOx adjustment factor input files to RatesAdj for the CSC scenario rates, by year.

RatesAdj output (emissions rate look-up table) databases include a "ratesadjrun" table (run log) and four rate tables: "ttirateperdistance" for roadway-based processes; "ttirateperhour," "ttiratepershp," and "ttirateperstart" for off-network processes. Each rates table contains its namesake rates field: ratePerDistance, ratePerHour, ratePerSHP, or ratePerStart. Rates are in terms of pounds per unit of activity. Common fields are: pollutantID, processID, hourID, sourceTypeID, fuelTypeID, and Units_Per_Activity. The ttirateperdistance table also includes the avgSpeedBinID and roadTypeID fields.

County, Scenario MOVES Input Data Loaded in CDBs – Rates mode CDBs input to the MOVES rates mode runs for the rates-per-activity method external emissions inventory calculations were populated with a combination of local data and MOVES default data from the MOVES database (movesdb20161117 available from EPA's MOVES website). The following local input data used were provided (80 files in "hgbrfp18_localMOVESdata.zip"):

- meteorological inputs -- "hgb_metinputs_summer2011aerr" (MySQL database with MOVES "county" and "zonemonthhour" tables – and a readme file) (eight files);
- fuels inputs -- "hgb_fuelsinputs_summer_rfppre1990cs_mvs14a," and "hgb_2011_17_18_20_21_rfg_dsl_fuels_mvs14a_fffs_201801" (MySQL databases [2] with MOVES "fuelformulation" and "fuelsupply" tables for Houston– one database for pre-1990 scenario and one for the current control scenarios; "readme" files describing fuels input data development and sources; data spreadsheets, text files, and MySQL scripts for building the databases) (26 files);
- age distributions -- "mvs14a_movesdb20151028_HGB***CCCC_XXXX***j_SUTage.tab" and "*.LST," where ***XXXX*** is 2011 and 2014 vehicle registration data years and ***CCCC*** is FIPS county code (tab-delimited, county "sourcetypeagedistribution" text files and associated "*.LST" text files from the MOVESfleetbuilder utility runs, plus a readme file) (33 files);[31]
- fuel fractions -- "mvs14a_movesdb20151028_TX_***XXXX***j_SUTage.tab," "mvs14_movesdb20151028_TX_***XXXX***j_SUTavft.tab," and "*.LST," where ***XXXX*** is 2011 and 2014 registration data years (statewide "sourcetypeagedistribution" and "avft" tab-delimited files and "*.LSTs" from each MOVESfleetbuilder utility run) (six files);
- I/M coverage -- "_tx1990_19992050_mvs14a_imcoverage_213132" (imcoverage database table used and a readme file) (five files);
- Hotelling activity distribution -- "mvs14a_moves201X_hotellingactivitydistribution.tab" (hotellingactivitydistribution input data tab-delimited text file used to populate the associated CDB tables and a readme file) (two files); and
- "MOVESDB20161117" (the MOVES default database, although not provided in this submittal, was also used in building the CDBs).

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[31] Although TTI used MOVESdb20161117 for this analysis, the sourcetypeagedistribution and avft text files prepared by TTI were from a prior analysis that used MOVESdb20151028 data. These MOVES defaults used, however, are still the latest default data. TTI has verified default sourcetypeagedistribution table data between MOVESdb20161117 and MOVESdb20151028 databases are the same (as well as are the age distribution data released with MOVES2014b [August 2018]).

APPENDIX B:
EMISSIONS ESTIMATION UTILITIES FOR MOVES-BASED EMISSIONS INVENTORIES

TTI EMISSIONS ESTIMATION UTILITIES FOR MOVES2014A-BASED EMISSIONS INVENTORIES

The following is a summary of utilities developed by TTI (written in the Visual Basic programming language) for producing detailed, link-based, hourly, and 24-hour emissions estimates for on-road mobile sources using the latest version of EPA's MOVES model (MOVES2014a). These utilities produce inputs used with the MOVES model, make special adjustments to the emissions factors (when required), and multiply them with travel model link-based or Highway Performance Monitoring System (HPMS)-based (virtual link) activity estimates to produce emissions at user-specified temporal and spatial scales.

The main utilities for calculating hourly and 24-hour emissions using MOVES are TRANSVMT, VirtualLinkVMT, VehPopulationBuild, OffNetActCalc, MOVESactivityInputBuild, MOVESfleetInputBuild, RatesCalc, RatesAdj, and EmsCalc. The TRANSVMT and VirtualLinkVMT prepare the link VMT and speeds activity input. The VehPopulationBuild utility builds the vehicle population used to calculate the off-network activity. The OffNetActCalc utility builds the SHP, starts, SHI, and APU hours required to estimate emissions using the rate-per-activity emissions rates produced by the RatesCalc or RatesAdj utilities. The MOVESactivityInputBuild and MOVESfleetInputBuild utilities build inputs used in MOVES. The RatesCalc utility assembles the emissions rates from the MOVES output in terms of rate-per-activity, including rate-per-SHP for the evaporative emissions processes. The RatesAdj utility makes special adjustments to the emissions rates when required. The EmsCalc utility calculates emissions by hourly time periods, producing a tab-delimited summary file (including 24-hour totals), hourly link emissions output files (optional), and an optional tab-delimited summary file by MOVES source classification code (SCC).

A process flow diagram follows the utility descriptions.

TRANSVMT

The TRANSVMT utility post-processes travel demand models (TDMs) to produce hourly, on-road vehicle, seasonal and day-of-week specific, directional link VMT, and speed estimates. The TRANSVMT utility processes a TDM traffic assignment by multiplying the link volumes by the appropriate HPMS, seasonal, or other VMT factors. Hourly factors are then used to distribute the link VMT to each hour in the day. A speed model is used to estimate the operational time-of-day link speeds for each direction. Since intrazonal links are not included in the TDM, special intrazonal links are created, and the VMT and speeds for these special links are estimated using the intrazonal trips from the trip matrix and the zonal radii. The link VMT and speeds produced by TRANSVMT are subsequently input to the EmsCalc utility for applying the MOVES-based emissions factors (as well as with other utilities to develop off-network activity estimates).

VirtualLinkVMT

The VirtualLinkVMT utility post-processes county HPMS average annual daily traffic (AADT) VMT, centerline miles, and lane miles by functional classification and area type (from the Texas Department of Transportation's [TxDOT's] annual Roadway Inventory Functional Classification Record [RIFCREC]) to produce hourly, on-road vehicle fleet, seasonal and day-of-week specific actual or projected VMT, and directional operational speed estimates. These estimated VMT and speeds are produced for up to 42 directional HPMS functional classification/area type combinations, or "links." The VirtualLinkVMT utility was developed for use in areas that do not have TDM networks, as well as for inventory applications for which network link-based detail is not required. The main inputs to VirtualLinkVMT are:

- County HPMS data sets, which include AADT VMT, centerline miles, and lane miles by HPMS area type and functional class;
- County-level VMT control totals;
- Hourly VMT distributions; and
- Speed model inputs to include volume/delay equation parameters adapted for HPMS, and free-flow speeds and lane capacities by HPMS functional classification and area type.

VirtualLinkVMT initially scales the county HPMS AADT VMT at the link level to the appropriate VMT (e.g., uses a county-level VMT control total-to-AADT ratio to produce seasonal, day-of-week specific VMT). Hourly factors and directional split factors are applied to the adjusted VMT on each link to estimate the hourly, directional VMT (and volumes) by HPMS link. Congested speed models, each for the high- and low-capacity links, are used to estimate the hourly operational speeds by direction for each link. The operational speeds are based on volume/capacity (v/c)-derived directional delay (minutes/mile) applied to the estimated free-flow speeds for each link. The virtual-link VMT and speeds produced using the VirtualLinkVMT utility are an input to the emissions calculation utility, EmsCalc (as well as with other utilities to develop off-network activity estimates).

VehPopulationBuild
The VehPopulationBuild utility builds the sourcetypeyear data files in a format consistent with the MOVES input database table and the SUT/fuel type population input file (can be used with the EmsCalc utility to estimate emissions or the OffNetActCalc utility to estimate starts and SHP) using the VMT mix and the Texas Department of Motor Vehicles (TxDMV) registration data sets. The TxDMV registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- County ID file, which specifies the county for which the output will be calculated;
- Age registration data file, which lists 31 years of registration data for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, Gas >60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000, and Diesel Totals diesel truck categories;
- VMT mix by TxDOT district, MOVES SUT, and MOVES fuel type;
- TxDOT district name file, which specifies the VMT mix TxDOT district;

- MOVES default database;
- Population factor file (optional); and
- Year ID file (optional, only used if population factors are used), which specifies the year for calculating the output.

For the desired county (from the county ID file), the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, and Gas >60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, and Diesel >60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array. The age registration data array and the diesel/gas registration data array are combined to form the registration category data array (seven categories for 31 years of data and the total) using the combinations in Table 33.

Table 33. Registration Categories.

Registration Category	Vehicle Category	Data Location
1	Passenger Vehicle	Age registration data array
2	Motorcycles	
3	Total Trucks <=8500	
4	Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000	Diesel/gas registration data array
5	Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000	
6	Gas >8500, Gas >10000, Gas >14000, Gas >16000	
7	Gas >19500, Gas >26000, Gas >33000, Gas >60000	

The registration category data array is used to fill the SUT population array (by SUT and fuel type) for all vehicles except long-haul trucks. Each SUT/fuel type combination is assigned the total registrations from one or more of the registration categories in the registration category data array. Table 34 shows the SUTs and their associated registration category in the registration category data array.

Table 34. SUT/Registration Category Correlation.

SUT	Registration Category
11	2
21	1
31, 32	3
41, 42, 43, 51, 52, 54	4 + 6
61	5 + 7

SUT population factors are calculated by SUT/fuel type using the data from the VMT mix input for all SUTs except motorcycles (SUT 11) and the long-haul trucks (SUTs 53 and 62) and saved in the SUT population factors array. For SUT 21, the fuel type VMT mix is divided by the total VMT mix for SUT 21. For SUT 31, the fuel type VMT mix is divided by the total VMT mix for SUTs 31 and 32. The same process applies to SUT 32. For SUT 41, the fuel type VMT mix is divided by the total VMT mix for SUTs 41, 42, 43, 51, 52, and 54. The same process applies to SUTs 42, 43, 51, 52, and 54. For SUT 61, the fuel type VMT mix is divided by the total VMT mix for SUT 61.

For SUT 11, the SUT population factor for fuel type 1 (gasoline) is set 1 with all other factors set to 0. For SUT 53, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 53 by the fuel type VMT mix for SUT 52. For SUT 62, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 62 by the fuel type VMT mix for SUT 61, therefore creating a ratio of long-haul and short-haul trucks.

The SUT population factors and the population factor (if desired) are applied to the SUT population array for all SUTs except SUT 53 and 62. For SUT 53, the SUT population factors for SUT 53 are applied to the SUT population array for SUT 52. For SUT 62, the SUT population factors for SUT 62 are applied to the SUT population array for SUT 61.

Using the appropriate MySQL code, a new sourcetypeyear database table is created. The data in the SUT population array is aggregated by fuel type and used to fill the sourcetypeyear database table, along with the yearID, salesGrowthFactor, and migrationrate. For the yearID, the year of the registration data is used, unless a population factor is used, in which case the year from the year ID input is used. The salesGrowthFactor and migrationrate for each SUT is set 1. A text format of this database table is written by the utility as well. The SUT/fuel type population input file is written using the SUT population array.

OffNetActCalc

The OffNetActCalc calculates the analysis scenario (i.e., year, season, day type) SHP, starts, SHI, and APU hours by hour, SUT, and fuel type used to estimate emissions using the EmsCalc utility. The SHI and APU hours are only calculated for SUT 62, fuel type 2 (CLhT_Diesel). The SHP is calculated using either the TDM or the virtual-link-based link VMT and speeds (same as used in the distance-based emissions estimation), the 24-hour or time period VMT mix (by roadway type and SUT/fuel type), and the SUT/fuel type population (from the

VehiclePopulationBuild utility). The starts activity is calculated using the SUT/fuel type population and the starts per vehicle (typically the MOVES default). The SHI and APU hours are a function of hotelling hours. This utility has two options for calculating the hotelling hours. Using the first option, the analysis scenario 24-hour hotelling hours is calculated using a user-supplied extended idle factor to the source hours operating (SHO). However, this method of estimating the hotelling hours as a direct function of the SHO does not consider the availability of locations where extended idling may occur. The second option (and suggested method) uses base data (24-hour hotelling, link VMT and speeds, and VMT mix), the analysis scenario data used to calculate the SHP, and the analysis scenario SHP to calculate the analysis scenario 24-hour hotelling hours.

For the analysis scenario first hourly VMT and speeds input, the utility applies the appropriate VMT mix (either the 24-hour VMT mix or the appropriate time period VMT mix as assigned by the user) to each link that has the desired county code; thus distributing the link VMT to each SUT/fuel type, which is added to the hourly SUT/fuel type VMT. The link VMT by SUT/fuel type is divided by the link speed to calculate the link VHT (or SHO) by SUT/fuel type, which is added to the SUT fuel/type VHT. This calculation process is repeated for each analysis scenario VMT and speeds input; therefore producing the analysis scenario hourly values for VMT by SUT/fuel type and for VHT by SUT/fuel type.

The analysis scenario hourly SUT/fuel type speed, total hours (or source hours), and SHP are then calculated. For each hour and SUT/fuel type, the hourly SUT/fuel type VMT is divided by the hourly SUT/fuel type VHT to calculate the hourly SUT/fuel type speed. The hourly SUT/fuel type total hours are set equal to the SUT/fuel type population. The hourly SUT/fuel type SHP is calculated by subtracting the hourly SUT/fuel type VHT (or SHO) from the hourly SUT/fuel type total hours. If the calculated SHP is negative (i.e., SHO is greater than the total hours), the SHP is set to 0.

To calculate the analysis scenario 24-hour hotelling hours under option 1 (as a direct function of SHO), the utility multiplies the CLhT_Diesel analysis scenario 24-hour SHO by the user-supplied extended idle factor, which represents the amount of extended idle time that must occur per SHO. For option 2 (as a function of base hotelling data), the utility calculates the base 24-hour CLhT_Diesel VMT using the base VMT and speeds inputs and the base VMT mix with the same procedure used in the analysis scenario SHP calculations. The 24-hour analysis scenario CLhT_Diesel VMT is then divided by the 24-hour base CLhT_Diesel VMT to create a scaling factor, which is then applied to the base 24-hour hotelling hours to calculate the analysis scenario 24-hour hotelling hours.

The utility then calculates the analysis scenario hourly hotelling hours. The analysis scenario hourly CLhT_Diesel SHO (from the SHP calculation process) is converted to hourly VHT fractions. The hourly hotelling fractions are calculated as the inverse of the hourly VHT fractions. The hourly hotelling fractions are then applied to the analysis scenario 24-hour hotelling hours to calculate the hourly hotelling hours. For each hour, the hourly hotelling hours are then compared to the hourly CLhT_Diesel SHP. For those hours where the hotelling hours are greater than the SHP, hotelling hours are set to the SHP for that hour.

The utility then calculates the SHI fraction and the APU fraction using the source type age distribution (same distribution used in the MOVES runs), the relative mileage accumulation rates, and the hotelling activity distribution. Travel fractions for SUT 62 (CLhT) by ageID (0 through 30) are calculated by multiplying the age distribution by the appropriate relative mileage accumulation rate, which is then converted into a distribution by dividing the individual travel fraction (ageID 0 through 30) by the sum of the travel fractions. These travel fractions are then applied to the appropriate operating mode fractions from the hotelling activity distribution (operating mode 200) and summed to calculate the SHI fraction. Using a similar process, the APU fraction is calculated using the operating mode fractions for operating mode 201. For each hour the analysis scenario hotelling hours are multiplied by the SHI fraction to calculate the analysis scenario SHI activity and by the APU fraction to calculate the analysis scenario APU hours.

MOVESactivityInputBuild

The MOVESactivityInputBuild utility builds the roadtypedistribution, hourvmtfraction, avgspeeddistribution, roadtype, hpmsvtypeday, sourcetypedayvmt, year, state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction data files in a format consistent with the MOVES input database tables using the link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility, the VMT mix, and the MOVES defaults. The utility also has the option of building the sourcetypeage (adjusted to reflect the 24-hour VMT mix), starts, and hotellinghours data files in a format consistent with the MVOES input database tables using the output from the OffNetActCalc utility, along with inputs from the MOVES runs and the MOVES defaults. The primary inputs to this utility are:

- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility;
- County ID file which specifies the county number in the link-based hourly VMT and speeds for which the output will be calculated;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types (same as used with the EmsCalc utility);
- 24-hour or time period VMT mix by roadway type, MOVES source type, and MOVES fuel type (same as used with the EmsCalc utility);
- Day ID, which specifies the MOVES day ID for calculating the output;
- Year ID, which specifies the year for calculating the output;
- Link/Ramp designations, which designates each link roadway type/area type combination to either ramp or non-ramp;
- MOVES default database;
- Month ID, which specifies the month for calculating the output;
- sourcetypeyear, SUT age, and sourcetypeage inputs from the MOVES runs (optional, only if sourcetypeage table output is to be created);
- Starts output from the OffNetActCalc utility (optional, only if starts table output is to be created); and

- Hotelling, extended idle, and APU hours output from the OffNetActCalc utility (optional, only if hotelling table output is to be created).

For each link in the link-based hourly VMT and speeds in which the county number matches the desired county ID, the link VMT is saved in a VMT summary array based on hour, link functional class, and link area type. The link VHT (link VMT/link speed) is saved in a VHT summary array based on hour, link functional class, link area type, and MOVES average speed bin ID (determined using the MOVES average speed bins and the link speed). The link VHT is also saved in a road type VHT array based on link functional class and link area type, and, if the link is specified as ramp by the link/ramp designations specified by the user, the VHT is additionally saved in the ramp segment of the road type VHT array.

A MOVES roadway type array by MOVES roadway type (roadTypeID codes 2 through 5) is also created using the data in the VMT summary array and VMT roadway type designations. For the link road types designated a MOVES road type of 6 or 8, the VMT is added to MOVES road type 2 in the MOVES roadway type array. For the link road types designated a MOVES road type of 7 or 9, the VMT is added to MOVES road type 4 in the MOVES roadway type array. An hourly VMT array (by MOVES SUT, MOVES roadway type, and hour) is formed using the data in the VMT summary array, the VMT roadway type designations, and the VMT mix. If the time period VMT mix is used, each hour is assigned a time period by the user. Otherwise, the same 24-hour VMT mix is used for all hours. An average speed distribution array (by MOVES SUT, MOVES roadway type, hour, and MOVES speed bin) is created using the VHT summary array and the VMT mix. Using the appropriate MySQL code, the MOVES roadtypedistribution, hourvmtfraction, and avgspeeddistribution default values are extracted and saved for later use.

The VMT in the MOVES roadway type array is used to produce the roadway type distribution array by MOVES SUT and MOVES roadway type. This VMT is converted to a distribution by MOVES SUT (i.e., the total for a SUT over the five MOVES roadway types should equal 1), with the distribution value for MOVES roadway type 0 (Off-Network) equal to 0. The utility writes the tab-delimited roadtypedistribution table output (optional).

The VMT in the hourly VMT array is added to the hourly VMT fraction array (by SUT, MOVES roadway type, and hour) and for those roadway types where the VMT for all hours is greater than 0, this VMT is converted to an hourly distribution. For those roadway types where the VMT is equal to 0, a value of 1 is placed in the first hour, followed by 0 in the remaining hours. The utility writes the tab-delimited hourvmtfraction table output (optional). For those SUTs where the VMT mix is greater than 0, the hourly VMT fraction array is used. Otherwise, the MOVES hourvmtfraction default values are used.

The VHT in the average speed distribution array is converted to a distribution by SUT, MOVES roadway type, hour/day (combination of hour and the day ID specified by the user), and MOVES average speed bin. The utility writes the tab-delimited avgspeeddistribution table output (optional). For those SUTs where the VMT mix is greater than 0, the average speed distribution array is used. Otherwise, the MOVES avgspeeddistribution default values are used.

The VHT in the road type VHT array is converted to a proportion of ramp VHT by dividing the ramp segment of the road type VHT array by the total VHT for the road type in the road type

VHT. The utility writes the tab-delimited roadtype table output (optional). If the ramp fraction for roadTypeID 2 is greater than 0, then roadTypeID 6 (with rampFraction equal to 0) and roadTypeID 8 (with rampFraction equal to 1) are also added to the roadtype database table. If the ramp fraction for roadTypeID 4 is greater than 0, then roadTypeID 7 (with rampFraction equal to 0) and roadTypeID 9 (with rampFraction equal to 1) are also added to the roadtype database table.

The VMT in the hourly VMT array is aggregated to create the 24-hour HPMS vehicle type VMT array. Each SUT is assigned an HPMS vehicle type (SUT 11 is HPMS vehicle type 10; SUTs 21, 31 and 32 are HPMS vehicle type 25; SUTs 41, 42, and 43 are HPMS vehicle type 40; SUTs 51, 52, 53, and 54 are HPMS vehicle type 50; and SUTs 61 and 62 are HPMS vehicle type 60). The utility writes the tab-delimited hpmsvtypeday table output (optional).

The VMT in the hourly VMT array is also aggregated by SUT to create the 24-hour SUT VMT array. Using this VMT data, the utility writes the tab-delimited sourcetypedayvmt output table (optional) in a format consistent with the MOVES input.

Using the appropriate MySQL code, the fuel year ID is extracted from the MOVES default year database table for the user-supplied year ID. The tab-delimited year table output is written (optional) using the user-supplied year ID and the extracted fuel year ID. The “isbaseYear” data is written as well (automatically set to “Y”).

The utility also produces two tab-delimited summary output files. A tab-delimited VMT summary is output by hour, link road type, and link area type for the user-specified county. A tab-delimited VHT summary is output by hour, link road type, link area type, and MOVES average speed bin for the user-specified county.

The utility creates five other tab-delimited outputs (state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction tables) using the user-supplied inputs. For the state table (optional), the utility extracts the data from the MOVES default state database table where the state ID is 48 and writes this data to the tab-delimited state table output. For the zone table (optional), the utility extracts the data from the MOVES default zone data for the county ID greater than 48000 and county ID less than 49000 and writes this data to the tab-delimited zone table output with the start allocation factors, idle allocation factors, and SHP allocation factors replaced with values of 1.

For the zoneroadtype table (optional), the utility extracts the MOVES default zoneroadtype data where the zone ID greater than 480000 and zone ID less than 490000 and writes this data to the tab-delimited zoneroadtype table output, with the SHO allocation factors replaced with values of 1. For the monthvmtfraction table (optional), the utility extracts the data from the MOVES default monthvmtfraction table and writes the data to the tab-delimited monthvmtfraction table output with the month VMT fraction set to 1 for the user-supplied month ID and 0 for all other months. For the dayvmtfraction table (optional), the utility extracts the data from the MOVES default dayvmtfraction table and writes this data to the tab-delimited dayvmtfraction table output with the day VMT fraction is set to 1 for the user-supplied day ID and 0 for all other months.

For the sourcetypeage table output (optional, also needed if the hoteling hours table output is to be created), the utility calculates the adjusted relative mileage accumulation rates (MAR) by multiplying the input relative MAR (categorized by SUT and age from the sourcetypeage input) by the SUT-specific relative MAR adjustment factors (one factor per SUT applied across all age categories). These adjustment factors are calculated using inventory SUT VMT fractions within each HPMS vehicle type and the sum of the SUT-specific normalized travel fractions within each HPMS vehicle type. The inventory SUT VMT fractions within each HPMS vehicle type are calculated by dividing the 24-hour SUT VMT by the 24-hour HPMS vehicle type VMT for the respective SUT.

For the sum of the SUT-specific normalized travel fractions within each HPMS vehicle type, the utility uses the same calculation procedures used by MOVES to calculate the normalized travel fractions. The SUT vehicle population is distributed to each age category using the SUT age distribution input. Using the sum of the vehicle population by HPMS vehicle type, the SUT population fraction for each age category within each HPMS vehicle type is calculated by dividing the SUT vehicle population by age by the sum of the vehicle population by HPMS vehicle type. The utility then calculates the initial travel fractions (by SUT and age) by multiplying the SUT population fraction for each age category within each HPMS vehicle type by the relative MAR input.

These initial travel fractions are then normalized within each HPMS vehicle type to produce the SUT and age-specific normalized travel fractions within each HPMS vehicle type. The utility then calculates the SUT-specific relative MAR adjustment factors by dividing the inventory SUT VMT fractions within each HPMS vehicle type by the sum of the SUT and age-specific normalized travel fractions (i.e., aggregated across the age category for each SUT); resulting in one SUT-specific relative MAR adjustment factor for each SUT.

For the starts table output (optional), the utility aggregates the SUT/fuel type hourly starts input (output from the OffNetActCalc utility) by SUT and multiplies the SUT hourly starts by the SUT age distribution (by SUT) to distribute the hourly SUT starts to each age category. The SUT hourly starts by age are written to the starts table output file, along with the user-supplied monthID, yearID, dayID (used to form the output hourDayID), and zoneID (set using the user-supplied county FIPS code.

For the hoteling hours table output (optional), the utility uses travel fractions specific to SUT 62 to distribute the hourly hoteling hours input (output from the OffNetActCalc utility) to each age category. These travel fractions are calculated by multiplying the SUT 62 age distribution by the calculated relative mileage accumulation rates (MOVES defaults adjusted so to reflect the emissions inventory 24-hour VMT mix) for each age category and dividing by the sum of the product for all the age categories. These travel fractions are multiplied by the hourly hoteling hours input and written to the hoteling hours table output, along with the user-supplied dayID (used to form the output hourDayID), monthID, yearID, and zoneID (set using the user-supplied county FIPS code.

MOVESfleetInputBuild

The MOVESfleetInputBuild utility builds the sourcetypeagedistribution database table and fuel/engine fraction inputs to MOVES using the TxDOT registration data sets and the MOVES default database tables. The TxDOT registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- Age registration data file, which lists 31 years of registration data for the Passenger Vehicles, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, Gas > 60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel > 33000, Diesel > 60000, and Diesel Totals diesel truck categories;
- SUT data sources input, which specifies the data source for each SUT to use when building the sourcetypeagedistribution database table;
- Fuel/engine fractions data sources input, which specifies the data source for each SUT to use when building the fuel/engine fractions;
- Default sourcetypeage distribution input;
- MOVES default database; and
- Year ID file (optional, only if year is not the registration data year as in a future year analysis), which specifies the year for calculating the output.

The SUT data sources input lists the data source for each SUT, either a single county, multiple counties, state, or MOVES default. As this input is processed, the utility maintains a list of the input sources. The same applies to the fuel/engine fractions, except data source inputs are only valid for source types 52, 53, and 61 (other are not valid due to data limitations and source type 62 are all considered diesel).

For each county (or state total) in the list of the input sources, the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, and Gas > 60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel > 33000, and Diesel > 60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array.

The age registration data array and the diesel/gas registration data array are combined to create the registration category data array (a total of seven categories for 31 years of data and the total) using the combinations in Table 33 (Registration Categories). The county is compared to the data sources for each SUT in the SUT data sources input. If the county is found for a given source type, then the 31 years of registration data from the source type's corresponding category in the registration category data array are added to the SUT age distribution array. Table 35 shows the source types and their corresponding registration categories.

Table 35. SUTs/Registration Categories Correlation for SUT Age Distribution.

SUT	Registration Category
11	2
21	1
31, 32	3
52, 53	4
61, 62	5

A similar process is followed for the fuel/engine fractions array. However, only SUTs 52, 53, 61, and 62 are processed due to data limitations. The registration data are saved in the fuel/engine fractions array based on fuel type. Table 36 shows the SUTs and their corresponding registration categories.

Table 36. SUTs/Registration Categories Correlation for Fuel/Engine Fractions.

SUT	Fuel Type	Registration Category
52, 53	Diesel	4
	Gas	6
61	Diesel	5
	Gas	7
62	Diesel	5 + 7
	Gas	None – all are assumed diesel

After processing all of the counties, the data from the default sourcetypeage distribution input are processed and the data for the registration data year are saved in the default age distribution array. For each source type in which the registration data are to be used for the age distribution, the 31 years of registration data in the SUT age distribution array are converted to a distribution by dividing the source type yearly registration data by the source type total registration data. For each source type in which the defaults are to be used, the defaults values from the default age distribution array are copied to the SUT age distribution array.

The MOVES default fuel/engine fractions are extracted from the MOVES default database (using the appropriate code for MySQL) and saved in the default fuel/engine fractions array. For source types 52, 53, and 61, the source type yearly registration data in the fuel/engine fractions array are converted to fuel/engine fractions by dividing the yearly source type diesel registration data by the sum of the yearly source type diesel registration data and the yearly source type gas registration data.

If the year ID input is used, then these fuel/engine fractions are adjusted to match the year from the year ID input. If the year from the year ID input is greater than the registration data year, then the first fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the end of the fuel/engine fractions to maintain the appropriate distribution. If the year from the year ID input is less than the registration data year, then the last fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the beginning of the fuel/engine fractions to maintain the appropriate distribution. For source type 62, all of the fuel/engine fractions in the fuel/engine fractions array are set to a value of 1.

Using the appropriate MySQL code, a new sourcetypeagedistribution database table is created and the data from the SUT age distribution array, along with the year ID (either from the registration data or the year ID input), are used to fill the new database table. A text format of this database table may be written as well. Using the appropriate MySQL code, a new AVFTfuelengfraction database table is created, and the data from the fuel/engine fractions array are used to fill the new database table for SUTs 52, 53, 61, and 62. For all other SUTs, the default fuel/engine fraction array data for the appropriate year (either the registration data year or the year ID input) are used to fill the new database table. A text format of this database table may be written as well.

RatesCalc

The RatesCalc utility calculates emissions rates in terms of rate/SHP for the evaporative emissions processes using the data in the CDB used in the MOVES emissions rates run and the MOVES default database. The utility also creates copies of the rateperdistance, rateperhour, and rateperstartemissions rate tables to include the units for each pollutant. If not specified, emissions rates are assembled for each pollutant and process combination (excluding total energy and the refueling emissions processes) in the MOVES emissions rate tables. The utility also uses the movesrun database table, along with a pollutant energy or mass lookup table (mass, TEQ, or gmole), to determine the units of the emissions rates, which are added to the emissions rate tables, which will allow the user to specify any of the units available in MOVES for the MOVES emissions rate run. The type of activity used for the emissions rate calculation is determined by the process, as Table 37 shows.

Table 37. MOVES2014a Emissions Process and Corresponding Activity for Rate-per-Activity Emissions Rates.

MOVES2014a Emissions Process	Activity	Emissions Rate Units
Running Exhaust	Miles Traveled	Rate/Mile
Crankcase Running Exhaust	Miles Traveled	Rate/Mile
Start Exhaust	Starts	Rate/Start
Crankcase Start Exhaust	Starts	Rate/Start
Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Crankcase Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Auxiliary Power Exhaust	APU Hours	Rate/APU Hour
Evaporative Permeation	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Vapor Venting	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Leaks	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Brake Wear	Miles Traveled	Rate/Mile
Tire Wear	Miles Traveled	Rate/Mile

For the rateperdistance (rate/mile emissions rates) emissions rate table, the utility creates a copy of the emissions rates in the specified output database with the table name ttirateperdistance. If specific pollutants are specified, only the emissions rates for those pollutants are copied to the ttirateperdistance table. Otherwise, the entire rateperdistance table is copied to the ttirateperdistance table. The utility also adds a "Units_Per_Activity" field to the ttirateperdistance table and fills that field based on the pollutants energy or mass designation (mass, TEQ, or gmole). For those pollutants designated as mass, the mass units from the movesrun table are added to the "Units_Per_Activity" field. For those pollutants designated as gmole, the mass units from the movesrun table, along with the text "-mole" (i.e., pound-mole or gram-mole) are added to the "Units_Per_Activity" field. For those pollutants designated as TEQ, the text "TEQ" is added to the "Units_Per_Activity" field. No unit conversions are performed in this utility. The rateperstart and rateperhour, emissions rate tables are processed in a similar manner to produce the ttirateperstart and ttirateperhour, emissions rate tables.

For the evaporative emissions rates, the utility uses the CDB from the MOVES run and the MOVES default database to replicate the MOVES vehicle population and SHP calculation process. Using the emissions rates from the rateperprofile and ratepervehicle emissions rate tables, the utility calculates the rate-per-SHP emissions rates by multiplying the emissions rate by the appropriate vehicle population and dividing by the appropriate SHP value. These rate-per-SHP emissions rates are then saved in the ttiratepershp emissions rate table. Similar to the previous RatesCalc emissions rate tables, the “Units_Per_Activity” field is added to the ttiratepershp table and filled based on the pollutants energy or mass designation.

RatesAdj

The RatesAdj utility applies emissions rate adjustments to an emissions rate database table produced by RatesCalc utility (ttirateperdistance, ttirateperstart, ttirateperhour, or ttiratepershp) or by this utility to produce a new emissions rate database table in the same format as the input emissions rate database table. The emissions rate adjustments can be linear adjustments that are applied to all emissions rates or can be applied by SUT, fuel type, pollutant, and process (adjustments may also include roadway type, average speed bin, and hour). The user has the option of selecting which pollutants will be in the new emissions rate database table, along with the output units of the emissions rates. This allows the user to perform any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) without providing any additional adjustment factors. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility. These types of conversions must be made using the emissions rate adjustment factors. The utility also has the option for combining multiple emissions rate database tables into one new emissions rate database table, if the input emissions rate database tables are in the same format.

For the first input emissions rate database table, the utility extracts the emissions rates for the specified pollutants (or all the pollutants if not specified) from the input database emissions rate table, applies the emissions rate adjustments (if necessary) and any unit conversion adjustments, and saves these adjusted emissions rates. If more than one emissions rate database table is input, then the utility performs a similar calculation process to the first input emissions rate database table for each input emissions rate database table. If pollutants are found in more than one input emissions rate database table, the adjusted emissions rates are summed to produce one emissions rate.

After processing all of the input emissions rate database tables, the utility creates a new emissions rate database table in the same format as the first input emissions rate database table and writes the adjusted emissions rates to this new emissions rate database table. Using MySQL code, the utility also creates a minimum and maximum emissions rate summary for each input emissions rate table and the output emissions rate table by pollutant, process, and source type/fuel type, which is written to a tab-delimited file specified by the user.

EmsCalc

The EmsCalc utility estimates the hourly link emissions for one user-specified county using the emissions factors (either from RatesCalc or RatesAdj), the 24-hour or time period VMT mix, the hourly link VMT and speeds activity estimates (either from TRANSVMT or VirtualLinkVMT), and the off-network activity (SHP, starts, and SHI). This utility produces a tab-delimited output summary (including hourly and 24-hour totals) and hourly link emissions output files (optional). The primary inputs to EmsCalcare:

- Emissions factors from RatesCalc or RatesAdj;
- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility. For each link, the following information is input to EmsCalc:

link start node, link end node, link county number, link roadway type number, link area type number, link VMT, and link operational speed estimate;

- 24-hour or time period VMT mix by roadway type, MOVES SUT, and MOVES fuel type;
- Off-network activity (SHP, starts, SHI, and APU hours) by hour and SUT/fuel type;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types;
- Pollutants input file, which specifies which pollutant/process combinations for which the emissions calculations will be performed and their respective units in the tab-delimited output;
- SCC input file (optional, only if the activity and emissions by SCC are to be created); and
- SCC pollutants input file (optional, only if the activity and emissions by SCC are to be created).

The emissions estimation can be categorized by two basic types based on the type of emissions factors: the roadway-based emissions and the off-network-based emissions. For the roadway-based emissions (ttirateperdistance emissions factors), the VMT for each link is distributed to each of the SUT/fuel type combinations listed in the VMT mix by roadway type (as designated in the VMT roadway type designations). If the time period VMT mix is input, each hour is assigned a time period by the user. Otherwise, the 24-hour VMT mix is used for all hours. For each pollutant/process combination in the pollutants input file, the emissions factors are selected based on the emissions rate roadway type (as designated in the VMT roadway type designations) and the link speed for each SUT/fuel type combinations listed in the VMT mix. For link speeds greater than 75 mph, the emissions factors for 75 mph are used. For link speeds less than 2.5 mph, the emissions factors for 2.5 mph are used. For those link speeds that fall between the 16 MOVES speeds, the emissions factors are interpolated using the emissions factor interpolation methodology in the following section. These SUT/fuel type combination-specific emissions factors are multiplied by the SUT/fuel type combination-specific VMT to estimate the mobile source emissions for that link by SUT/fuel type combination. If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file and by SCC pollutant using the SCC pollutants input file (thus allowing the user the option to combine multiple MOVES pollutants into one more aggregate pollutant).

For the off-network emissions , the ttirateperstart, ttirateperhour, and ttiratepershp emissions rates(by SUT/fuel type) are multiplied by the appropriate activity, which is determined by the emissions process (see Table 37). If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file and by SCC pollutant using the SCC pollutants input file (thus allowing the user the option to combine multiple MOVES pollutants into one more aggregate pollutant).

The emissions estimates are output in a tab-delimited file (including all of the SUT/fuel type combinations listed in the VMT mix on a single line, separated by a tab character) for the specified county by pollutant, link roadway type, and SUT/fuel type combination for each of the specified episode time periods. A 24-hour (or total if all 24 hours are not specified) output is also included in the tab-delimited file. Only those pollutant/process combinations in the pollutants input file with tab-delimited output units other than “NONE” will appear in the tab-delimited output file. Prior to output, any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) are performed by the utility. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility (these type of unit conversions must be done using the RatesAdj utility). This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity and VMT, VHT, and speed by link road type. Link emissions may also be output by county, pollutant, process, and each SUT/fuel type combination. If specified, the tab-delimited activity and emissions by SCC output file is also created, which lists the activity and emissions for each SCC pollutant by SCC.

Emissions Factor Interpolation Methodology

To calculate emissions factors for link speeds that fall between two of the 16 MOVES speed bin speeds, an interpolation methodology similar to the methodology used with MOBILE6 is used. This methodology interpolates each emissions factor using a factor developed from the inverse link speed and the inverse high and low bounding speed bin speeds. The following is an example for a link speed of 41.2 mph.

The interpolated emissions factor (EF_{Interp}) is expressed as:

$$EF_{Interp} = EF_{LowSpeed} - FAC_{Interp} \times (EF_{LowSpeed} - EF_{HighSpeed})$$

Where:

$EF_{LowSpeed}$ = emissions factor (EF) corresponding to the speed below the link speed;

$EF_{HighSpeed}$ = EF corresponding to the speed above the link speed; and

$$FAC_{Interp} = \left(\frac{1}{Speed_{link}} - \frac{1}{Speed_{low}}\right) \Big/ \left(\frac{1}{Speed_{high}} - \frac{1}{Speed_{low}}\right)$$

Given that:

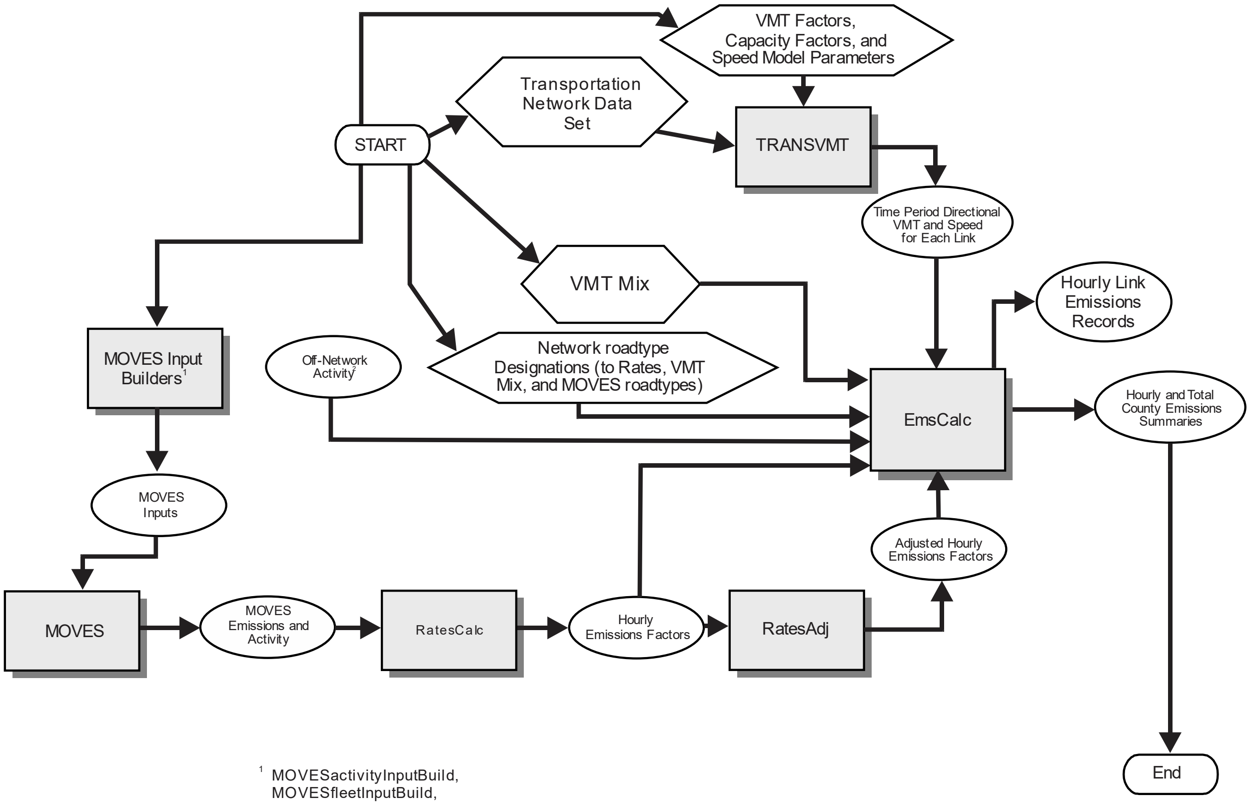
$EF_{LowSpeed}$ = 0.7413 g/mi;
$EF_{HighSpeed}$ = 0.7274 g/mi;
$Speed_{lnk}$ = 41.2 mph;
$Speed_{low}$ = 40 mph; and
$Speed_{high}$ = 45 mph.

$$FAC_{Interp} = \left(\frac{1}{41.2mph} - \frac{1}{40mph}\right) \Big/ \left(\frac{1}{45mph} - \frac{1}{40mph}\right) = \frac{-0.00073}{-0.00278} = 0.26214;$$

$$EF_{Interp} = 0.7413 \text{ g/mi} - (0.26214) \times (0.7413 \text{ g/mi} - 0.7274 \text{ g/mi});$$

$$= 0.7377 \text{ g/mi}.$$

Travel Demand Model Network Link-Based Hourly MOVES Emissions Estimates



[1] MOVESactivityInputBuild, MOVESfleetInputBuild, MOVESmetInputBuild, and VehPopulationBuild.

[2] VehPopulationBuild, and OffNetActCalc.

APPENDIX C:
TXDOT DISTRICT VMT MIX BY DAY OF WEEK

TxDOT District/HGB Counties

TxDOT District	HGB County
Beaumont	Liberty
	Chambers
Houston	Harris
	Galveston
	Fort Bend
	Brazoria
	Montgomery
	Waller

VMT Mix Year/Analysis Year Correlations

VMT Mix Year	Analysis Years
2000	1998 through 2002
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032

2010 Weekday VMT Mix - Beaumont TxDOT District (2011 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00200	0.00221	0.00225	0.00237	0.00196	0.00216	0.00217	0.00233	0.00207	0.00241	0.00228	0.00254	0.00169	0.00227	0.00204	0.00239
21_G	0.49880	0.55044	0.55977	0.59080	0.48923	0.53816	0.54090	0.57959	0.51481	0.59952	0.56679	0.63263	0.42150	0.56553	0.50726	0.59411
31_D	0.00303	0.00336	0.00305	0.00377	0.00284	0.00350	0.00288	0.00370	0.00285	0.00348	0.00298	0.00363	0.00241	0.00301	0.00245	0.00390
31_G	0.21360	0.23675	0.21502	0.26562	0.19975	0.24684	0.20314	0.26027	0.20096	0.24487	0.21016	0.25548	0.16991	0.21183	0.17264	0.27439
32_D	0.00298	0.00330	0.00300	0.00370	0.00279	0.00344	0.00283	0.00363	0.00280	0.00341	0.00293	0.00356	0.00237	0.00295	0.00241	0.00383
32_G	0.05323	0.05899	0.05358	0.06619	0.04977	0.06151	0.05062	0.06486	0.05007	0.06102	0.05237	0.06366	0.04234	0.05278	0.04302	0.06837
51_D	0.00156	0.00139	0.00110	0.00113	0.00156	0.00141	0.00128	0.00137	0.00117	0.00092	0.00085	0.00069	0.00131	0.00108	0.00096	0.00079
51_G	0.00044	0.00039	0.00031	0.00032	0.00044	0.00040	0.00036	0.00038	0.00033	0.00026	0.00024	0.00019	0.00037	0.00030	0.00027	0.00022
52_D	0.03363	0.02993	0.02366	0.02436	0.03370	0.03054	0.02769	0.02966	0.02537	0.02007	0.01843	0.01498	0.02897	0.02390	0.02131	0.01752
52_G	0.00943	0.00839	0.00663	0.00683	0.00945	0.00856	0.00776	0.00832	0.00711	0.00563	0.00517	0.00420	0.00812	0.00670	0.00598	0.00491
53_D	0.00173	0.00154	0.00122	0.00126	0.00151	0.00137	0.00124	0.00133	0.00103	0.00081	0.00075	0.00061	0.00065	0.00054	0.00048	0.00039
53_G	0.00049	0.00043	0.00034	0.00035	0.00042	0.00038	0.00035	0.00037	0.00029	0.00023	0.00021	0.00017	0.00018	0.00015	0.00013	0.00011
54_D	0.00118	0.00105	0.00083	0.00086	0.00118	0.00107	0.00097	0.00104	0.00088	0.00070	0.00064	0.00052	0.00099	0.00082	0.00073	0.00060
54_G	0.00033	0.00029	0.00023	0.00024	0.00033	0.00030	0.00027	0.00029	0.00025	0.00020	0.00018	0.00015	0.00028	0.00023	0.00020	0.00017
41_D	0.00109	0.00416	0.00132	0.00183	0.00139	0.00192	0.00137	0.00156	0.00104	0.00050	0.00106	0.00090	0.00196	0.00053	0.00151	0.00083
42_D	0.00045	0.00171	0.00054	0.00075	0.00057	0.00079	0.00057	0.00064	0.00043	0.00021	0.00044	0.00037	0.00081	0.00022	0.00062	0.00034
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00140	0.00534	0.00169	0.00235	0.00179	0.00247	0.00176	0.00200	0.00134	0.00065	0.00136	0.00116	0.00252	0.00069	0.00194	0.00106
43_G	0.00001	0.00005	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001	0.00003	0.00001	0.00002	0.00001
61_D	0.05403	0.02784	0.03875	0.00827	0.06067	0.02858	0.04630	0.01150	0.04689	0.01369	0.03330	0.00349	0.06270	0.02520	0.04715	0.00510
61_G	0.00534	0.00275	0.00383	0.00082	0.00600	0.00283	0.00458	0.00114	0.00464	0.00135	0.00329	0.00035	0.00620	0.00249	0.00466	0.00050
62_D	0.11474	0.05912	0.08230	0.01756	0.13415	0.06319	0.10237	0.02543	0.13516	0.03946	0.09600	0.01007	0.24428	0.09819	0.18371	0.01987
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00050	0.00055	0.00056	0.00059	0.00049	0.00054	0.00054	0.00058	0.00052	0.00060	0.00057	0.00064	0.00042	0.00057	0.00051	0.00060

2010 Weekday VMT Mix - Houston TxDOT District (2011 Activity Scenario)

SUF/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00276	0.00267	0.00286	0.00291	0.00253	0.00244	0.00269	0.00271	0.00281	0.00276	0.00290	0.00296	0.00241	0.00271	0.00286	0.00297
21_G	0.68684	0.66377	0.71301	0.72580	0.63085	0.60741	0.66873	0.67461	0.69973	0.68632	0.72275	0.73690	0.59886	0.67428	0.71290	0.73943
31_D	0.00225	0.00277	0.00251	0.00247	0.00234	0.00293	0.00263	0.00267	0.00217	0.00286	0.00251	0.00250	0.00174	0.00271	0.00225	0.00231
31_G	0.15839	0.19490	0.17649	0.17413	0.16458	0.20654	0.18517	0.18797	0.15286	0.20174	0.17659	0.17589	0.12265	0.19072	0.15844	0.16293
32_D	0.00225	0.00277	0.00251	0.00247	0.00234	0.00293	0.00263	0.00267	0.00217	0.00287	0.00251	0.00250	0.00174	0.00271	0.00225	0.00232
32_G	0.03943	0.04851	0.04393	0.04334	0.04097	0.05141	0.04609	0.04679	0.03805	0.05022	0.04396	0.04378	0.03053	0.04747	0.03944	0.04056
51_D	0.00069	0.00095	0.00066	0.00062	0.00086	0.00132	0.00100	0.00101	0.00047	0.00065	0.00048	0.00047	0.00064	0.00073	0.00052	0.00045
51_G	0.00041	0.00057	0.00039	0.00037	0.00051	0.00079	0.00060	0.00060	0.00028	0.00039	0.00029	0.00028	0.00038	0.00043	0.00031	0.00027
52_D	0.01294	0.01788	0.01235	0.01169	0.01650	0.02543	0.01928	0.01941	0.00896	0.01253	0.00928	0.00901	0.01321	0.01496	0.01067	0.00920
52_G	0.00773	0.01068	0.00738	0.00698	0.00986	0.01520	0.01152	0.01160	0.00535	0.00748	0.00554	0.00538	0.00789	0.00893	0.00637	0.00550
53_D	0.00261	0.00361	0.00249	0.00236	0.00291	0.00449	0.00340	0.00343	0.00159	0.00223	0.00165	0.00160	0.00129	0.00146	0.00104	0.00090
53_G	0.00156	0.00216	0.00149	0.00141	0.00174	0.00268	0.00203	0.00205	0.00095	0.00133	0.00099	0.00096	0.00077	0.00087	0.00062	0.00054
54_D	0.00052	0.00072	0.00050	0.00047	0.00065	0.00100	0.00076	0.00076	0.00035	0.00049	0.00037	0.00035	0.00048	0.00055	0.00039	0.00034
54_G	0.00031	0.00043	0.00030	0.00028	0.00039	0.00060	0.00045	0.00046	0.00021	0.00029	0.00022	0.00021	0.00029	0.00033	0.00023	0.00020
41_D	0.00082	0.00177	0.00151	0.00141	0.00089	0.00102	0.00094	0.00096	0.00070	0.00039	0.00109	0.00053	0.00076	0.00050	0.00109	0.00049
42_D	0.00034	0.00073	0.00062	0.00058	0.00037	0.00042	0.00039	0.00040	0.00029	0.00016	0.00045	0.00022	0.00031	0.00021	0.00045	0.00020
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00105	0.00228	0.00194	0.00182	0.00114	0.00131	0.00120	0.00123	0.00090	0.00050	0.00140	0.00069	0.00097	0.00065	0.00140	0.00063
43_G	0.00001	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
61_D	0.03872	0.02082	0.01400	0.00994	0.05635	0.03357	0.02341	0.01879	0.03653	0.01171	0.01179	0.00673	0.06507	0.01489	0.01761	0.00911
61_G	0.00314	0.00169	0.00113	0.00081	0.00457	0.00272	0.00190	0.00152	0.00296	0.00095	0.00096	0.00055	0.00528	0.00121	0.00143	0.00074
62_D	0.03653	0.01964	0.01320	0.00937	0.05900	0.03515	0.02451	0.01968	0.04194	0.01344	0.01354	0.00773	0.14412	0.03299	0.03900	0.02017
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00069	0.00067	0.00072	0.00073	0.00063	0.00061	0.00067	0.00068	0.00070	0.00069	0.00073	0.00074	0.00060	0.00068	0.00072	0.00074

2015 Weekday VMT Mix - Beaumont TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00351	0.00387	0.00393	0.00415	0.00344	0.00378	0.00380	0.00407	0.00362	0.00421	0.00398	0.00445	0.00296	0.00397	0.00357	0.00418
21_G	0.49730	0.54879	0.55808	0.58902	0.48775	0.53654	0.53927	0.57784	0.51326	0.59772	0.56508	0.63073	0.42023	0.56383	0.50573	0.59232
31_D	0.00370	0.00410	0.00372	0.00460	0.00346	0.00427	0.00352	0.00450	0.00348	0.00424	0.00364	0.00442	0.00294	0.00367	0.00299	0.00475
31_G	0.21376	0.23692	0.21517	0.26581	0.19989	0.24702	0.20329	0.26046	0.20110	0.24505	0.21032	0.25567	0.17003	0.21198	0.17277	0.27459
32_D	0.00294	0.00325	0.00295	0.00365	0.00275	0.00339	0.00279	0.00358	0.00276	0.00337	0.00289	0.00351	0.00233	0.00291	0.00237	0.00377
32_G	0.05245	0.05813	0.05280	0.06522	0.04905	0.06061	0.04988	0.06391	0.04935	0.06013	0.05161	0.06273	0.04172	0.05202	0.04239	0.06738
51_D	0.00160	0.00142	0.00113	0.00116	0.00159	0.00144	0.00131	0.00140	0.00119	0.00095	0.00087	0.00071	0.00134	0.00111	0.00099	0.00081
51_G	0.00045	0.00040	0.00032	0.00033	0.00045	0.00040	0.00037	0.00039	0.00034	0.00027	0.00024	0.00020	0.00038	0.00031	0.00028	0.00023
52_D	0.03352	0.02983	0.02358	0.02428	0.03359	0.03044	0.02760	0.02956	0.02529	0.02001	0.01837	0.01494	0.02887	0.02382	0.02124	0.01746
52_G	0.00940	0.00836	0.00661	0.00681	0.00942	0.00853	0.00774	0.00829	0.00709	0.00561	0.00515	0.00419	0.00810	0.00668	0.00596	0.00490
53_D	0.00173	0.00154	0.00122	0.00125	0.00151	0.00137	0.00124	0.00133	0.00103	0.00081	0.00075	0.00061	0.00065	0.00054	0.00048	0.00039
53_G	0.00048	0.00043	0.00034	0.00035	0.00042	0.00038	0.00035	0.00037	0.00029	0.00023	0.00021	0.00017	0.00018	0.00015	0.00013	0.00011
54_D	0.00126	0.00112	0.00088	0.00091	0.00125	0.00113	0.00103	0.00110	0.00094	0.00074	0.00068	0.00055	0.00105	0.00087	0.00077	0.00064
54_G	0.00035	0.00031	0.00025	0.00026	0.00035	0.00032	0.00029	0.00031	0.00026	0.00021	0.00019	0.00016	0.00030	0.00024	0.00022	0.00018
41_D	0.00035	0.00132	0.00042	0.00058	0.00044	0.00061	0.00044	0.00049	0.00033	0.00016	0.00033	0.00029	0.00062	0.00017	0.00048	0.00026
42_D	0.00069	0.00264	0.00083	0.00116	0.00088	0.00122	0.00087	0.00099	0.00066	0.00032	0.00067	0.00057	0.00124	0.00034	0.00096	0.00053
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00190	0.00724	0.00229	0.00319	0.00242	0.00335	0.00239	0.00271	0.00181	0.00088	0.00184	0.00157	0.00341	0.00093	0.00262	0.00144
43_G	0.00002	0.00007	0.00002	0.00003	0.00002	0.00003	0.00002	0.00003	0.00002	0.00001	0.00002	0.00002	0.00003	0.00001	0.00003	0.00001
61_D	0.05403	0.02784	0.03875	0.00827	0.06067	0.02858	0.04630	0.01150	0.04689	0.01369	0.03330	0.00349	0.06270	0.02520	0.04715	0.00510
61_G	0.00534	0.00275	0.00383	0.00082	0.00600	0.00283	0.00458	0.00114	0.00464	0.00135	0.00329	0.00035	0.00620	0.00249	0.00466	0.00050
62_D	0.11474	0.05912	0.08230	0.01756	0.13415	0.06319	0.10237	0.02543	0.13516	0.03946	0.09600	0.01007	0.24428	0.09819	0.18371	0.01987
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00050	0.00055	0.00056	0.00059	0.00049	0.00054	0.00054	0.00058	0.00052	0.00060	0.00057	0.00064	0.00042	0.00057	0.00051	0.00060

2015 Weekday VMT Mix - Houston TxDOT District (2017 Activity Scenario)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00483	0.00467	0.00501	0.00510	0.00443	0.00427	0.00470	0.00474	0.00492	0.00482	0.00508	0.00518	0.00421	0.00474	0.00501	0.00520
21_G	0.68477	0.66177	0.71087	0.72362	0.62895	0.60558	0.66671	0.67258	0.69762	0.68425	0.72057	0.73468	0.59706	0.67225	0.71076	0.73721
31_D	0.00274	0.00337	0.00305	0.00301	0.00285	0.00357	0.00320	0.00325	0.00265	0.00349	0.00306	0.00304	0.00212	0.00330	0.00274	0.00282
31_G	0.15851	0.19504	0.17662	0.17426	0.16470	0.20669	0.18530	0.18811	0.15297	0.20188	0.17672	0.17602	0.12274	0.19086	0.15855	0.16304
32_D	0.00214	0.00263	0.00238	0.00235	0.00222	0.00278	0.00250	0.00253	0.00206	0.00272	0.00238	0.00237	0.00165	0.00257	0.00214	0.00220
32_G	0.03893	0.04791	0.04338	0.04280	0.04046	0.05077	0.04552	0.04621	0.03757	0.04959	0.04341	0.04324	0.03015	0.04688	0.03895	0.04005
51_D	0.00070	0.00097	0.00067	0.00064	0.00088	0.00135	0.00103	0.00103	0.00048	0.00067	0.00049	0.00048	0.00066	0.00074	0.00053	0.00046
51_G	0.00042	0.00058	0.00040	0.00038	0.00052	0.00081	0.00061	0.00062	0.00029	0.00040	0.00030	0.00029	0.00039	0.00044	0.00032	0.00027
52_D	0.01290	0.01782	0.01231	0.01165	0.01645	0.02535	0.01922	0.01935	0.00893	0.01249	0.00925	0.00898	0.01317	0.01491	0.01063	0.00917
52_G	0.00771	0.01065	0.00735	0.00696	0.00983	0.01515	0.01148	0.01156	0.00534	0.00746	0.00553	0.00537	0.00787	0.00891	0.00635	0.00548
53_D	0.00260	0.00360	0.00248	0.00235	0.00290	0.00447	0.00339	0.00341	0.00159	0.00222	0.00164	0.00160	0.00129	0.00146	0.00104	0.00090
53_G	0.00156	0.00215	0.00148	0.00141	0.00173	0.00267	0.00203	0.00204	0.00095	0.00133	0.00098	0.00095	0.00077	0.00087	0.00062	0.00054
54_D	0.00055	0.00076	0.00053	0.00050	0.00069	0.00106	0.00081	0.00081	0.00038	0.00052	0.00039	0.00038	0.00052	0.00058	0.00042	0.00036
54_G	0.00033	0.00046	0.00032	0.00030	0.00041	0.00064	0.00048	0.00049	0.00022	0.00031	0.00023	0.00023	0.00031	0.00035	0.00025	0.00021
41_D	0.00026	0.00056	0.00048	0.00045	0.00028	0.00032	0.00030	0.00030	0.00022	0.00012	0.00035	0.00017	0.00024	0.00016	0.00035	0.00016
42_D	0.00052	0.00112	0.00096	0.00090	0.00056	0.00065	0.00059	0.00061	0.00044	0.00025	0.00069	0.00034	0.00048	0.00032	0.00069	0.00031
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00142	0.00309	0.00263	0.00246	0.00155	0.00178	0.00163	0.00167	0.00122	0.00068	0.00190	0.00093	0.00132	0.00088	0.00190	0.00086
43_G	0.00001	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00002	0.00001
61_D	0.03872	0.02082	0.01400	0.00994	0.05635	0.03357	0.02341	0.01879	0.03653	0.01171	0.01179	0.00673	0.06507	0.01489	0.01761	0.00911
61_G	0.00314	0.00169	0.00113	0.00081	0.00457	0.00272	0.00190	0.00152	0.00296	0.00095	0.00096	0.00055	0.00528	0.00121	0.00143	0.00074
62_D	0.03653	0.01964	0.01320	0.00937	0.05900	0.03515	0.02451	0.01968	0.04194	0.01344	0.01354	0.00773	0.14412	0.03299	0.03900	0.02017
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00069	0.00067	0.00072	0.00073	0.00063	0.00061	0.00067	0.00068	0.00070	0.00069	0.00073	0.00074	0.00060	0.00068	0.00072	0.00074

2020 Weekday VMT Mix - Beaumont TxDOT District (2018, 2020 and 2021 Activity Scenarios)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00451	0.00497	0.00506	0.00534	0.00442	0.00486	0.00489	0.00524	0.00465	0.00542	0.00512	0.00572	0.00381	0.00511	0.00458	0.00537
21_G	0.49630	0.54768	0.55696	0.58783	0.48677	0.53546	0.53819	0.57668	0.51222	0.59651	0.56394	0.62945	0.41938	0.56269	0.50471	0.59112
31_D	0.00391	0.00434	0.00394	0.00487	0.00366	0.00452	0.00372	0.00477	0.00368	0.00449	0.00385	0.00468	0.00311	0.00388	0.00316	0.00503
31_G	0.21354	0.23668	0.21495	0.26554	0.19969	0.24677	0.20308	0.26020	0.20090	0.24480	0.21010	0.25541	0.16986	0.21176	0.17259	0.27431
32_D	0.00288	0.00319	0.00290	0.00358	0.00269	0.00333	0.00274	0.00351	0.00271	0.00330	0.00283	0.00344	0.00229	0.00286	0.00233	0.00370
32_G	0.05251	0.05820	0.05285	0.06529	0.04910	0.06068	0.04994	0.06398	0.04940	0.06019	0.05166	0.06280	0.04177	0.05207	0.04244	0.06745
51_D	0.00156	0.00139	0.00110	0.00113	0.00156	0.00141	0.00128	0.00137	0.00117	0.00092	0.00085	0.00069	0.00131	0.00108	0.00096	0.00079
51_G	0.00044	0.00039	0.00031	0.00032	0.00044	0.00040	0.00036	0.00038	0.00033	0.00026	0.00024	0.00019	0.00037	0.00030	0.00027	0.00022
52_D	0.03363	0.02993	0.02366	0.02436	0.03370	0.03054	0.02769	0.02966	0.02537	0.02007	0.01843	0.01498	0.02897	0.02390	0.02131	0.01752
52_G	0.00943	0.00839	0.00663	0.00683	0.00945	0.00856	0.00776	0.00832	0.00711	0.00563	0.00517	0.00420	0.00812	0.00670	0.00598	0.00491
53_D	0.00173	0.00154	0.00122	0.00126	0.00151	0.00137	0.00124	0.00133	0.00103	0.00081	0.00075	0.00061	0.00065	0.00054	0.00048	0.00039
53_G	0.00049	0.00043	0.00034	0.00035	0.00042	0.00038	0.00035	0.00037	0.00029	0.00023	0.00021	0.00017	0.00018	0.00015	0.00013	0.00011
54_D	0.00118	0.00105	0.00083	0.00086	0.00118	0.00107	0.00097	0.00104	0.00088	0.00070	0.00064	0.00052	0.00099	0.00082	0.00073	0.00060
54_G	0.00033	0.00029	0.00023	0.00024	0.00033	0.00030	0.00027	0.00029	0.00025	0.00020	0.00018	0.00015	0.00028	0.00023	0.00020	0.00017
41_D	0.00035	0.00132	0.00042	0.00058	0.00044	0.00061	0.00044	0.00049	0.00033	0.00016	0.00033	0.00029	0.00062	0.00017	0.00048	0.00026
42_D	0.00070	0.00265	0.00084	0.00117	0.00088	0.00122	0.00087	0.00099	0.00066	0.00032	0.00067	0.00057	0.00125	0.00034	0.00096	0.00053
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00190	0.00723	0.00229	0.00318	0.00241	0.00334	0.00239	0.00270	0.00181	0.00088	0.00184	0.00156	0.00341	0.00093	0.00262	0.00144
43_G	0.00002	0.00007	0.00002	0.00003	0.00002	0.00003	0.00002	0.00003	0.00002	0.00001	0.00002	0.00002	0.00003	0.00001	0.00003	0.00001
61_D	0.05403	0.02784	0.03875	0.00827	0.06067	0.02858	0.04630	0.01150	0.04689	0.01369	0.03330	0.00349	0.06270	0.02520	0.04715	0.00510
61_G	0.00534	0.00275	0.00383	0.00082	0.00600	0.00283	0.00458	0.00114	0.00464	0.00135	0.00329	0.00035	0.00620	0.00249	0.00466	0.00050
62_D	0.11474	0.05912	0.08230	0.01756	0.13415	0.06319	0.10237	0.02543	0.13516	0.03946	0.09600	0.01007	0.24428	0.09819	0.18371	0.01987
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00050	0.00055	0.00056	0.00059	0.00049	0.00054	0.00054	0.00058	0.00052	0.00060	0.00057	0.00064	0.00042	0.00057	0.00051	0.00060

2020 Weekday VMT Mix - Houston TxDOT District (2018, 2020 and 2021 Activity Scenarios)

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5	RT2	RT3	RT4	RT5
21_D	0.00621	0.00600	0.00644	0.00656	0.00570	0.00549	0.00604	0.00610	0.00632	0.00620	0.00653	0.00666	0.00541	0.00609	0.00644	0.00668
21_G	0.68339	0.66044	0.70943	0.72216	0.62768	0.60436	0.66537	0.67123	0.69622	0.68288	0.71912	0.73320	0.59585	0.67090	0.70932	0.73572
31_D	0.00306	0.00377	0.00341	0.00337	0.00318	0.00399	0.00358	0.00364	0.00296	0.00390	0.00342	0.00340	0.00237	0.00369	0.00306	0.00315
31_G	0.15818	0.19464	0.17626	0.17390	0.16437	0.20626	0.18492	0.18772	0.15266	0.20147	0.17636	0.17566	0.12249	0.19047	0.15823	0.16271
32_D	0.00214	0.00263	0.00238	0.00235	0.00222	0.00278	0.00250	0.00253	0.00206	0.00272	0.00238	0.00237	0.00165	0.00257	0.00214	0.00220
32_G	0.03893	0.04791	0.04338	0.04280	0.04046	0.05077	0.04552	0.04621	0.03757	0.04959	0.04341	0.04324	0.03015	0.04688	0.03895	0.04005
51_D	0.00069	0.00095	0.00066	0.00062	0.00086	0.00132	0.00100	0.00101	0.00047	0.00065	0.00048	0.00047	0.00064	0.00073	0.00052	0.00045
51_G	0.00041	0.00057	0.00039	0.00037	0.00051	0.00079	0.00060	0.00060	0.00028	0.00039	0.00029	0.00028	0.00038	0.00043	0.00031	0.00027
52_D	0.01294	0.01788	0.01235	0.01169	0.01650	0.02543	0.01928	0.01941	0.00896	0.01253	0.00928	0.00901	0.01321	0.01496	0.01067	0.00920
52_G	0.00773	0.01068	0.00738	0.00698	0.00986	0.01520	0.01152	0.01160	0.00535	0.00748	0.00554	0.00538	0.00789	0.00893	0.00637	0.00550
53_D	0.00261	0.00361	0.00249	0.00236	0.00291	0.00449	0.00340	0.00343	0.00159	0.00223	0.00165	0.00160	0.00129	0.00146	0.00104	0.00090
53_G	0.00156	0.00216	0.00149	0.00141	0.00174	0.00268	0.00203	0.00205	0.00095	0.00133	0.00099	0.00096	0.00077	0.00087	0.00062	0.00054
54_D	0.00052	0.00072	0.00050	0.00047	0.00065	0.00100	0.00076	0.00076	0.00035	0.00049	0.00037	0.00035	0.00048	0.00055	0.00039	0.00034
54_G	0.00031	0.00043	0.00030	0.00028	0.00039	0.00060	0.00045	0.00046	0.00021	0.00029	0.00022	0.00021	0.00029	0.00033	0.00023	0.00020
41_D	0.00026	0.00056	0.00048	0.00045	0.00028	0.00032	0.00030	0.00030	0.00022	0.00012	0.00035	0.00017	0.00024	0.00016	0.00035	0.00016
42_D	0.00052	0.00113	0.00096	0.00090	0.00057	0.00065	0.00060	0.00061	0.00045	0.00025	0.00070	0.00034	0.00048	0.00032	0.00069	0.00031
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00142	0.00308	0.00263	0.00246	0.00155	0.00178	0.00163	0.00167	0.00122	0.00067	0.00190	0.00093	0.00131	0.00088	0.00190	0.00086
43_G	0.00001	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00002	0.00001
61_D	0.03872	0.02082	0.01400	0.00994	0.05635	0.03357	0.02341	0.01879	0.03653	0.01171	0.01179	0.00673	0.06507	0.01489	0.01761	0.00911
61_G	0.00314	0.00169	0.00113	0.00081	0.00457	0.00272	0.00190	0.00152	0.00296	0.00095	0.00096	0.00055	0.00528	0.00121	0.00143	0.00074
62_D	0.03653	0.01964	0.01320	0.00937	0.05900	0.03515	0.02451	0.01968	0.04194	0.01344	0.01354	0.00773	0.14412	0.03299	0.03900	0.02017
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00069	0.00067	0.00072	0.00073	0.00063	0.00061	0.00067	0.00068	0.00070	0.00069	0.00073	0.00074	0.00060	0.00068	0.00072	0.00074

APPENDIX D:
TXDOT DISTRICT AGGREGATE WEEKDAY VMT MIX

TxDOT District/HGB Counties

TxDOT District	HGB County
Beaumont	Liberty
	Chambers
Houston	Harris
	Galveston
	Fort Bend
	Brazoria
	Montgomery
	Waller

VMT Mix Year/Analysis Year Correlations

VMT Mix Year	Analysis Years
2000	1998 through 2002
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032

Aggregate Weekday VMT Mix - Beaumont TxDOT District

SUT/FT	2010[1]	2015[2]	2020[3]
21_D	0.00216	0.00378	0.00486
21_G	0.53786	0.53625	0.53517
31_D	0.00306	0.00373	0.00395
31_G	0.21559	0.21575	0.21553
32_D	0.00301	0.00296	0.00291
32_G	0.05372	0.05294	0.05300
51_D	0.00122	0.00125	0.00122
51_G	0.00034	0.00035	0.00034
52_D	0.02662	0.02653	0.02662
52_G	0.00746	0.00744	0.00746
53_D	0.00105	0.00105	0.00105
53_G	0.00029	0.00029	0.00029
54_D	0.00092	0.00098	0.00092
54_G	0.00026	0.00028	0.00026
41_D	0.00147	0.00046	0.00046
42_D	0.00060	0.00093	0.00093
42_G	0.00000	0.00000	0.00000
43_D	0.00188	0.00255	0.00255
43_G	0.00002	0.00003	0.00003
61_D	0.03848	0.03848	0.03848
61_G	0.00381	0.00381	0.00381
62_D	0.09962	0.09962	0.09962
62_G	0.00000	0.00000	0.00000
11_G	0.00054	0.00054	0.00054

[1] 2011 activity scenario.
[2] 2017 activity scenario.
[3] 2018, 2020 and 2021 activity scenarios.

Aggregate Weekday VMT Mix - Houston TxDOT District

SUT/FT	2010[1]	2015[2]	2020[3]
21_D	0.00278	0.00487	0.00626
21_G	0.69244	0.69033	0.68895
31_D	0.00253	0.00308	0.00344
31_G	0.17786	0.17799	0.17763
32_D	0.00253	0.00240	0.00240
32_G	0.04427	0.04372	0.04372
51_D	0.00077	0.00079	0.00077
51_G	0.00046	0.00047	0.00046
52_D	0.01492	0.01487	0.01492
52_G	0.00891	0.00889	0.00891
53_D	0.00247	0.00246	0.00247
53_G	0.00148	0.00147	0.00148
54_D	0.00058	0.00062	0.00058
54_G	0.00035	0.00037	0.00035
41_D	0.00107	0.00034	0.00034
42_D	0.00044	0.00068	0.00068
42_G	0.00000	0.00000	0.00000
43_D	0.00138	0.00187	0.00186
43_G	0.00001	0.00002	0.00002
61_D	0.01936	0.01936	0.01936
61_G	0.00157	0.00157	0.00157
62_D	0.02313	0.02313	0.02313
62_G	0.00000	0.00000	0.00000
11_G	0.00070	0.00070	0.00070

[1] 2011 activity scenario.

[2] 2017 activity scenario.

[3] 2018, 2020 and 2021 activity scenarios.

APPENDIX E:
CAPACITY FACTORS, SPEED FACTORS, AND SPEED REDUCTION FACTORS

Capacity Factors

Time of Day Assignment	Capacity Factor[1]
AM Peak	0.3333333
Mid-Day	0.1666667
PM Peak	0.2500000
Overnight	0.0909091

[1] To obtain hourly capacities, a single capacity factor for each time-of-day assignment is used for all area types and functional classifications.

Free-Flow (V/C=0) Speed Factors for Houston/Galveston Speed Model

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	Description	Code	Description			
1	Urban Interstate	1	CBD	50.85	56.40	1.10906
1	Urban Interstate	2	Urban	52.55	61.40	1.16842
2	Urban Other Freeway	1	CBD	N/A	58.00	1.21154
2	Urban Other Freeway	2	Urban	52.00	63.00	1.21154
3	Toll Road	1	CBD	N/A	34.50	0.62652
3	Toll Road	2	Urban	57.58	36.08	0.62652
3	Toll Road	3	Urban Fringe	61.69	36.14	0.58577
3	Toll Road	4	Suburban	64.34	37.99	0.59040
3	Toll Road	5	Rural	59.13	38.43	0.64991
4	Ramp	1	CBD	28.62	35.13	1.22734
4	Ramp	2	Urban	40.06	36.26	0.90509
4	Ramp	3	Urban Fringe	43.22	38.52	0.89119
4	Ramp	4	Suburban	44.82	45.71	1.01987
4	Ramp	5	Rural	55.16	52.11	0.94478
5	Urban Principal Arterial	1	CBD	24.72	26.52	1.07262
5	Urban Principal Arterial	2	Urban	35.78	29.69	0.82974
6	Urban Other Arterial	1	CBD	22.00	24.64	1.11996
6	Urban Other Arterial	2	Urban	34.57	27.31	0.79001
7	Urban Collector	1	CBD	20.94	24.17	1.15413
7	Urban Collector	2	Urban	35.36	25.78	0.72901
10	Rural Interstate	3	Urban Fringe	57.84	61.40	1.06152
10	Rural Interstate	4	Suburban	59.15	67.20	1.13613
10	Rural Interstate	5	Rural	62.00	68.57	1.10599
11	Rural Other Freeway	3	Urban Fringe	62.00	63.00	1.01613
11	Rural Other Freeway	4	Suburban	62.00	69.00	1.11290
11	Rural Other Freeway	5	Rural	64.00	71.00	1.10938
12	Rural Principal Arterial	3	Urban Fringe	40.23	33.75	0.83890
12	Rural Principal Arterial	4	Suburban	46.12	42.48	0.92125
12	Rural Principal Arterial	5	Rural	60.00	55.53	0.92536
13	Rural Other Arterial	3	Urban Fringe	39.05	30.51	0.78131
13	Rural Other Arterial	4	Suburban	43.03	39.85	0.92612
13	Rural Other Arterial	5	Rural	53.97	54.07	1.00194

Free-Flow (V/C=0) Speed Factors for Houston/Galveston Speed Model - Continued

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	Description	Code	Description			
14	Rural Major Collector	3	Urban Fringe	38.00	27.76	0.73061
14	Rural Major Collector	4	Suburban	41.00	49.22	1.20059
14	Rural Major Collector	5	Rural	53.00	54.06	1.02009
15	Rural Collector	3	Urban Fringe	36.00	24.07	0.66864
15	Rural Collector	4	Suburban	40.00	35.58	0.88938
15	Rural Collector	5	Rural	49.00	49.86	1.01762

[1] Based on 2012 TDM data.
[2] Calculated from detailed speed model runs by H-GAC with link volumes set to 0 (V/C=0).
[3] When input speeds are not available, speed factors are taken from the nearest area type.

LOS E (V/C=1) Speed Factors for Houston/Galveston Speed Model

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	Description	Code	Description			
1	Urban Interstate	1	CBD	50.85	34.35	0.67549
1	Urban Interstate	2	Urban	52.55	34.35	0.65370
2	Urban Other Freeway	1	CBD	N/A	35.00	0.67308
2	Urban Other Freeway	2	Urban	52.00	35.00	0.67308
3	Toll Road	1	CBD	N/A	24.77	0.43011
3	Toll Road	2	Urban	57.58	24.77	0.43011
3	Toll Road	3	Urban Fringe	61.69	26.52	0.42983
3	Toll Road	4	Suburban	64.34	29.54	0.45920
3	Toll Road	5	Rural	59.13	29.70	0.50229
4	Ramp	1	CBD	28.62	31.68	1.10692
4	Ramp	2	Urban	40.06	30.03	0.74952
4	Ramp	3	Urban Fringe	43.22	33.24	0.76908
4	Ramp	4	Suburban	44.82	41.22	0.91979
4	Ramp	5	Rural	55.16	49.01	0.88861
5	Urban Principal Arterial	1	CBD	24.72	22.13	0.89529
5	Urban Principal Arterial	2	Urban	35.78	24.44	0.68294
6	Urban Other Arterial	1	CBD	22.00	20.80	0.94565
6	Urban Other Arterial	2	Urban	34.57	22.76	0.65833
7	Urban Collector	1	CBD	20.94	20.06	0.95782
7	Urban Collector	2	Urban	35.36	21.23	0.60033
10	Rural Interstate	3	Urban Fringe	57.84	39.25	0.67860
10	Rural Interstate	4	Suburban	59.15	49.08	0.82973
10	Rural Interstate	5	Rural	62.00	49.08	0.79157
11	Rural Other Freeway	3	Urban Fringe	62.00	40.00	0.64516
11	Rural Other Freeway	4	Suburban	62.00	50.00	0.80645
11	Rural Other Freeway	5	Rural	64.00	50.00	0.78125
12	Rural Principal Arterial	3	Urban Fringe	40.23	27.30	0.67871
12	Rural Principal Arterial	4	Suburban	46.12	32.64	0.70784
12	Rural Principal Arterial	5	Rural	60.00	38.32	0.63858
13	Rural Other Arterial	3	Urban Fringe	39.05	24.81	0.63540
13	Rural Other Arterial	4	Suburban	43.03	30.15	0.70070
13	Rural Other Arterial	5	Rural	53.97	38.46	0.71270

LOS E (V/C=1) Speed Factors for Houston/Galveston Speed Model - Continued

Functional Class		Area Type		Distance Weighted Input Speeds[1]	Distance Weighted Free-Flow Speeds[2]	Free-Flow Speed Factor[3]
Code	**Description**	**Code**	**Description**			
14	Rural Major Collector	3	Urban Fringe	38.00	22.22	0.58465
14	Rural Major Collector	4	Suburban	41.00	34.09	0.83151
14	Rural Major Collector	5	Rural	53.00	36.83	0.69499
15	Rural Collector	3	Urban Fringe	36.00	19.74	0.54845
15	Rural Collector	4	Suburban	40.00	26.40	0.65994
15	Rural Collector	5	Rural	49.00	34.33	0.70057

[1] Based on 2012 TDM data.
[2] Calculated from detailed speed model runs by H-GAC with link volumes set to 0 (V/C=0).
[3] When input speeds are not available, speed factors are taken from the nearest area type.

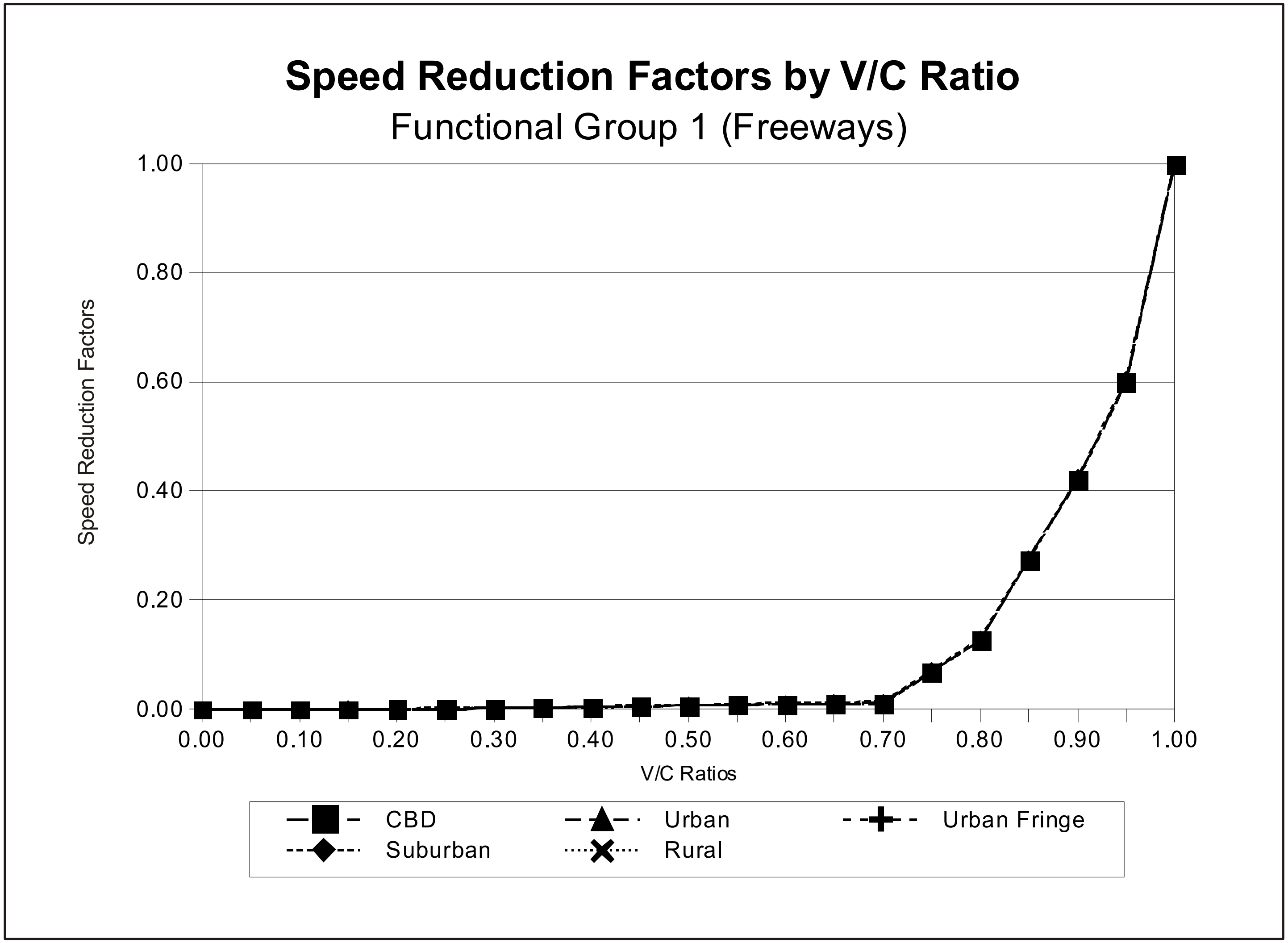


Figure 1. Freeway Speed Reduction Factors by V/C Ratio.

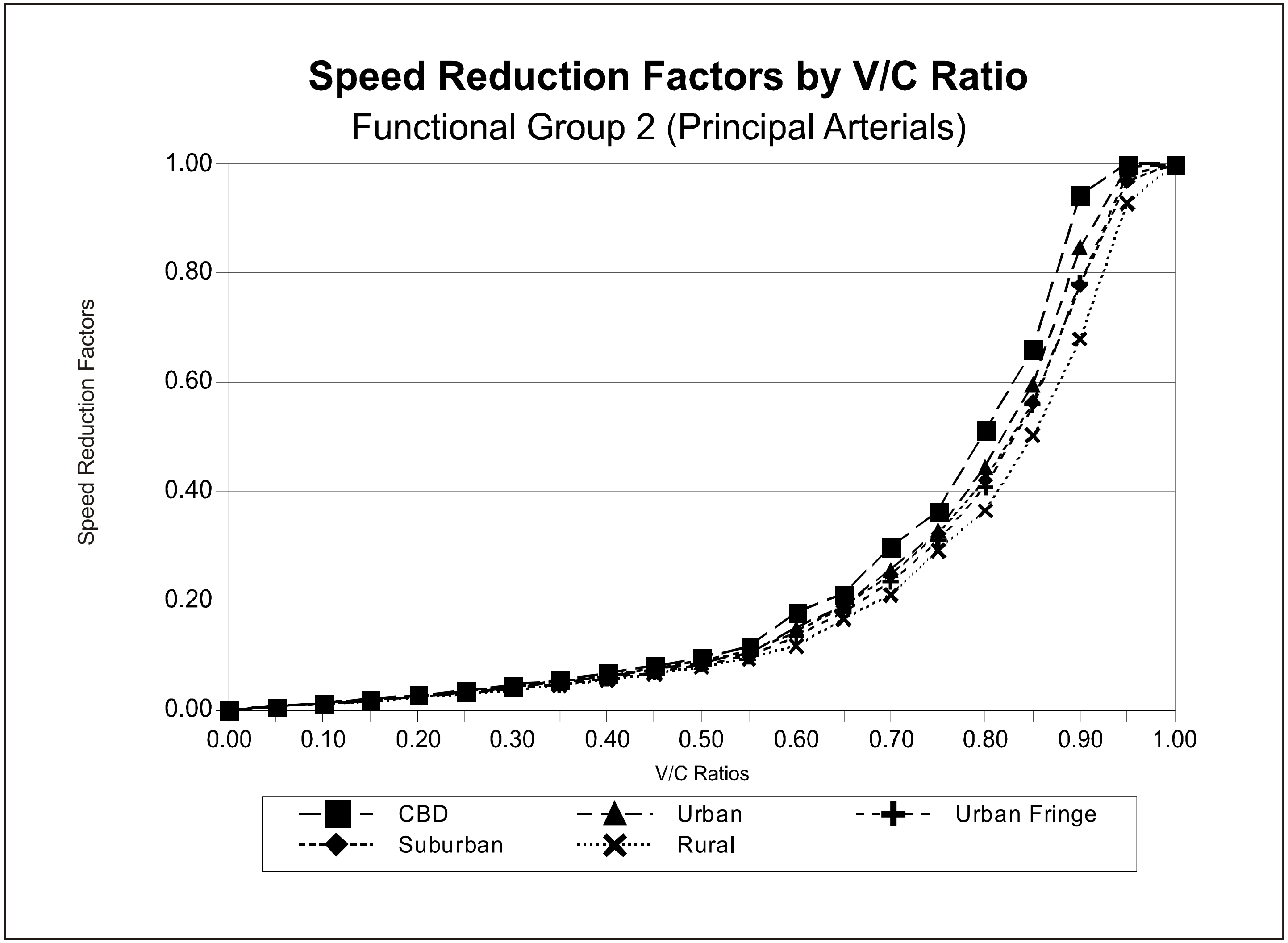


Figure 2. Principal Arterial Speed Reduction Factors by V/C Ratio.

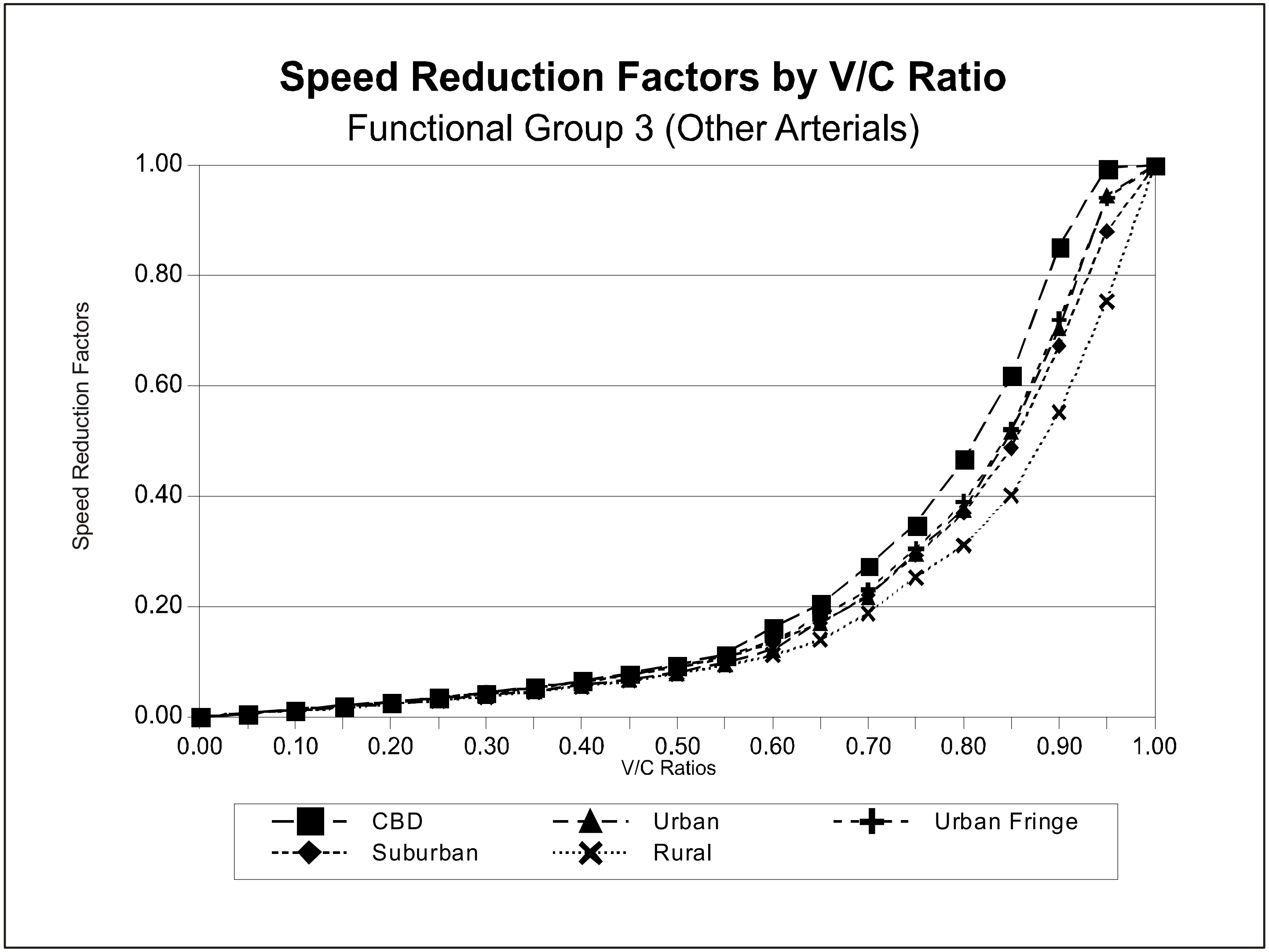


Figure 3. Other Arterial Speed Reduction Factors by V/C Ratio.

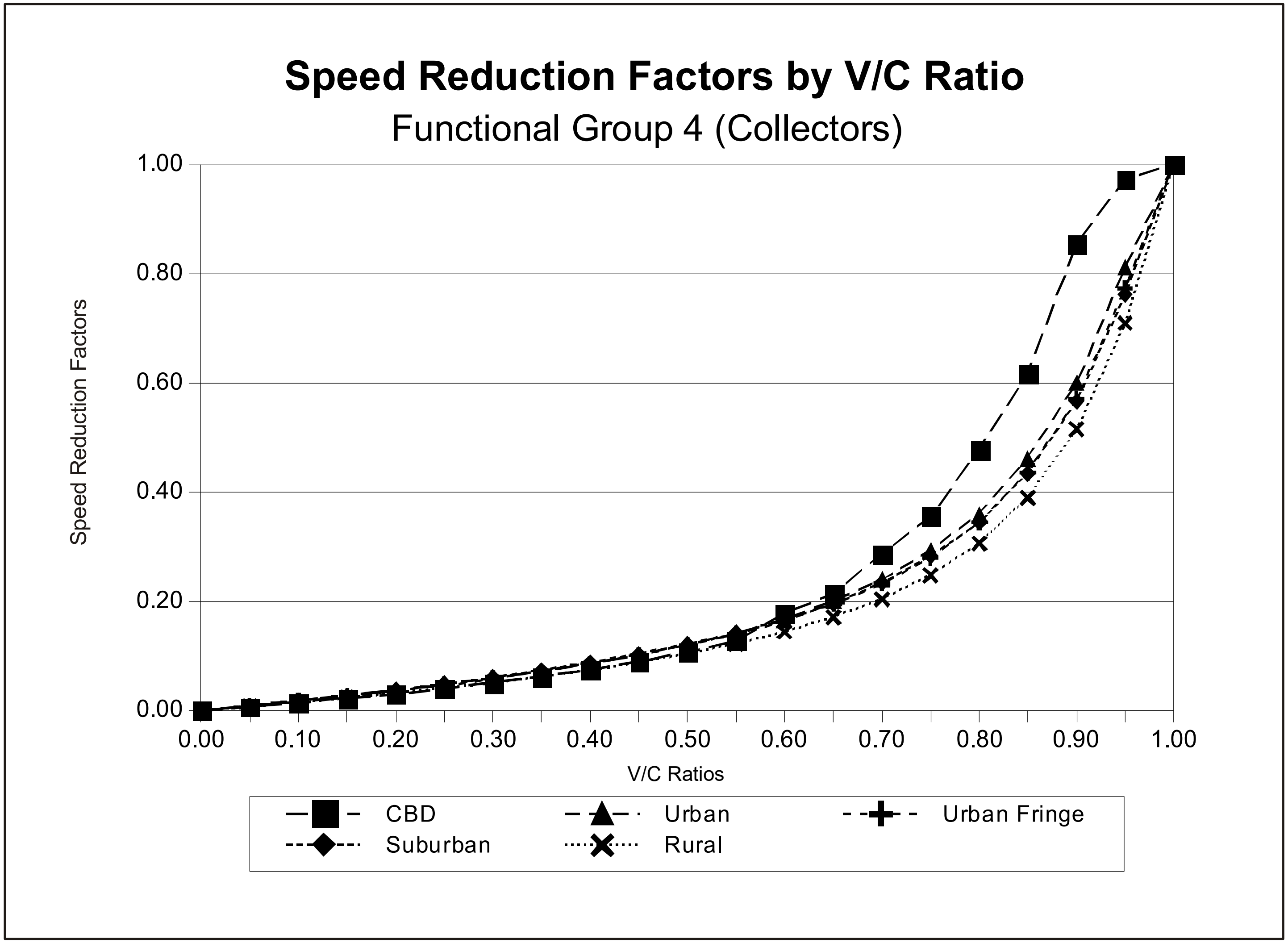


Figure 4. Collector Speed Reduction Factors by V/C Ratio.

Functional Classification to Functional Group Relationship for the Application of Speed Reduction Factors

Functional Group	**Corresponding Network Functional Classifications**
1. Freeways, Interstates	1. Urban Interstate Freeways 2. Urban Other Freeways 3. Toll Roads 10. Rural Interstate Freeways 11. Rural Other Freeways
2. Principal Arterials	5. Urban Principal Arterials 12. Rural Principal Arterials
3. Other Arterials, Major Collectors	6. Urban Other Arterials 13. Rural Other Arterials 14. Rural Major Collectors
4. Collectors	4. Ramps 7. Urban Collectors 15. Rural Collectors

APPENDIX F:
VEHICLE POPULATION ESTIMATES AND 24-HOUR SHP, STARTS, AND SHI SUMMARIES

2011 Vehicle Population Estimates by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	7,223	1,010	7,748	7,923	47,961	1,829	10,976	870
21_G	133,937	13,981	288,170	128,849	1,817,900	26,015	199,774	15,180
21_D	538	56	1,157	517	7,299	104	802	61
31_G	63,199	10,434	75,100	56,011	608,705	19,383	87,034	10,026
31_D	899	148	1,068	797	8,659	275	1,238	143
32_G	15,730	2,600	18,693	13,941	151,509	4,830	21,663	2,496
32_D	899	146	1,068	797	8,659	271	1,238	143
41_D	216	39	174	150	1,899	75	277	50
42_G	0	0	0	0	0	0	0	0
42_D	89	16	71	62	781	31	114	20
43_G	2	1	2	1	18	1	3	0
43_D	278	50	224	194	2,450	96	357	64
51_G	93	9	75	65	817	17	119	21
51_D	155	32	125	108	1,367	63	199	36
52_G	1,796	197	1,446	1,250	15,817	383	2,304	415
52_D	3,007	704	2,422	2,094	26,486	1,365	3,858	695
53_G	298	8	240	208	2,627	15	383	69
53_D	498	28	401	347	4,385	54	639	115
54_G	71	7	57	49	621	13	90	16
54_D	117	24	94	81	1,030	47	150	27
61_G	69	14	92	42	1,312	37	95	16
61_D	853	146	1,134	519	16,180	373	1,165	197
62_G	0	0	0	0	0	0	0	0
62_D	1,019	377	1,355	620	19,331	966	1,392	235

2017 Vehicle Population Estimates by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	9,850	1,044	11,171	9,442	57,054	1,795	13,634	1,083
21_G	210,858	16,966	463,175	176,128	2,453,280	30,493	284,258	20,741
21_D	1,488	120	3,268	1,243	17,307	215	2,005	146
31_G	91,754	11,455	106,280	69,451	743,278	21,399	112,259	13,042
31_D	1,588	198	1,839	1,202	12,862	370	1,943	226
32_G	22,538	2,811	26,106	17,059	182,573	5,251	27,574	3,203
32_D	1,237	157	1,433	936	10,022	294	1,514	176
41_D	138	20	108	77	884	37	170	26
42_G	0	0	0	0	0	0	0	0
42_D	277	41	215	154	1,768	74	341	52
43_G	8	1	6	5	52	2	10	2
43_D	761	113	592	424	4,863	203	937	144
51_G	191	16	149	107	1,222	28	235	36
51_D	322	55	250	179	2,054	100	396	61
52_G	3,620	330	2,812	2,016	23,118	592	4,453	686
52_D	6,054	1,176	4,704	3,373	38,669	2,112	7,448	1,147
53_G	599	13	465	333	3,823	23	736	113
53_D	1,002	47	778	558	6,397	84	1,232	190
54_G	151	12	117	84	962	22	185	29
54_D	252	43	196	141	1,612	78	311	48
61_G	113	26	144	55	1,546	45	151	25
61_D	1,399	263	1,779	674	19,065	453	1,856	309
62_G	0	0	0	0	0	0	0	0
62_D	1,671	681	2,125	806	22,777	1,173	2,218	369

2018 Vehicle Population Estimates by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	9,917	1,266	12,738	8,490	60,328	2,072	15,279	907
21_G	211,871	20,530	527,086	158,038	2,588,830	35,124	317,909	17,336
21_D	1,925	186	4,789	1,436	23,523	319	2,889	158
31_G	92,194	13,874	120,944	62,318	784,341	24,673	125,547	10,901
31_D	1,785	254	2,342	1,207	15,190	452	2,431	211
32_G	22,692	3,412	29,768	15,338	193,050	6,067	30,901	2,683
32_D	1,246	187	1,634	842	10,597	333	1,696	147
41_D	140	25	123	69	936	42	191	22
42_G	0	0	0	0	0	0	0	0
42_D	279	50	246	139	1,872	85	382	44
43_G	8	2	7	4	55	3	11	1
43_D	763	137	672	380	5,120	234	1,045	120
51_G	189	18	166	94	1,266	31	258	30
51_D	316	66	278	157	2,119	112	433	50
52_G	3,656	401	3,217	1,819	24,525	686	5,006	576
52_D	6,122	1,431	5,387	3,046	41,068	2,447	8,383	965
53_G	607	16	534	302	4,074	27	832	96
53_D	1,014	56	892	504	6,799	97	1,388	160
54_G	144	14	126	71	963	24	197	23
54_D	238	49	209	118	1,596	85	326	38
61_G	114	32	164	49	1,635	52	169	21
61_D	1,408	319	2,028	606	20,159	523	2,080	259
62_G	0	0	0	0	0	0	0	0
62_D	1,682	825	2,423	724	24,084	1,354	2,485	309

2020 Vehicle Population Estimates by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	10,493	1,354	13,822	8,950	63,377	2,135	16,256	938
21_G	224,169	21,961	571,936	166,615	2,719,670	36,201	338,240	17,940
21_D	2,037	199	5,197	1,514	24,712	329	3,073	163
31_G	97,545	14,842	131,235	65,700	823,980	25,429	133,576	11,281
31_D	1,889	272	2,542	1,272	15,957	466	2,587	218
32_G	24,009	3,650	32,301	16,171	202,806	6,253	32,877	2,776
32_D	1,318	200	1,773	888	11,133	343	1,805	152
41_D	148	26	133	73	983	44	203	23
42_G	0	0	0	0	0	0	0	0
42_D	295	53	266	146	1,966	88	407	46
43_G	9	2	8	4	58	3	12	1
43_D	808	147	729	400	5,378	242	1,112	124
51_G	200	20	180	99	1,330	32	275	31
51_D	334	70	302	166	2,227	116	460	52
52_G	3,868	429	3,491	1,918	25,765	707	5,326	596
52_D	6,478	1,531	5,846	3,211	43,144	2,522	8,919	998
53_G	643	17	580	319	4,280	27	885	99
53_D	1,072	60	968	532	7,142	99	1,477	165
54_G	152	15	137	75	1,012	25	209	23
54_D	252	53	227	125	1,677	87	347	39
61_G	121	34	178	52	1,717	53	179	22
61_D	1,490	341	2,201	639	21,178	539	2,213	268
62_G	0	0	0	0	0	0	0	0
62_D	1,780	883	2,629	764	25,301	1,395	2,644	320

2021 Vehicle Population Estimates by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	10,659	1,375	14,226	9,074	64,524	2,189	16,684	961
21_G	227,733	22,301	588,640	168,909	2,768,850	37,112	347,152	18,368
21_D	2,069	203	5,349	1,535	25,159	337	3,154	167
31_G	99,096	15,071	135,068	66,604	838,881	26,070	137,096	11,550
31_D	1,919	276	2,616	1,290	16,246	478	2,655	224
32_G	24,391	3,706	33,244	16,393	206,474	6,411	33,743	2,843
32_D	1,339	203	1,825	900	11,334	352	1,852	156
41_D	150	27	137	74	1,001	45	209	23
42_G	0	0	0	0	0	0	0	0
42_D	300	54	274	148	2,002	90	417	47
43_G	9	2	8	4	59	3	12	1
43_D	820	149	750	406	5,476	248	1,141	127
51_G	203	20	185	100	1,354	33	282	32
51_D	340	71	311	168	2,267	118	472	53
52_G	3,930	436	3,593	1,944	26,231	725	5,467	610
52_D	6,581	1,554	6,017	3,255	43,924	2,586	9,154	1,022
53_G	653	17	597	323	4,357	28	908	101
53_D	1,089	61	996	539	7,272	102	1,515	169
54_G	154	15	141	76	1,030	25	215	24
54_D	256	54	234	127	1,707	89	356	40
61_G	123	34	184	53	1,748	55	184	22
61_D	1,514	346	2,265	648	21,561	553	2,271	274
62_G	0	0	0	0	0	0	0	0
62_D	1,808	897	2,706	774	25,759	1,430	2,714	328

2011 24-Hour Weekday SHP Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	173,242	24,210	185,746	190,034	1,148,817	43,866	263,200	20,852
21_G	3,105,237	305,841	6,711,188	2,975,286	41,395,220	594,627	4,571,518	336,308
21_D	12,467	1,228	26,944	11,945	166,195	2,388	18,354	1,350
31_G	1,487,793	237,902	1,749,946	1,314,970	14,055,037	452,560	2,029,999	232,276
31_D	21,164	3,377	24,894	18,706	199,941	6,423	28,878	3,304
32_G	370,317	59,280	435,567	327,301	3,498,345	112,767	505,273	57,814
32_D	21,164	3,322	24,893	18,705	199,937	6,319	28,877	3,304
41_D	5,040	850	3,922	3,466	42,778	1,730	6,369	1,160
42_G	0	0	0	0	0	0	0	0
42_D	2,072	347	1,612	1,425	17,585	706	2,619	477
43_G	46	12	35	32	388	24	58	11
43_D	6,501	1,087	5,058	4,470	55,177	2,212	8,215	1,496
51_G	2,155	198	1,671	1,483	18,371	402	2,715	491
51_D	3,607	712	2,797	2,483	30,748	1,443	4,544	822
52_G	41,749	4,355	32,378	28,736	355,925	8,825	52,589	9,512
52_D	69,910	15,542	54,219	48,121	596,019	31,492	88,064	15,928
53_G	6,926	169	5,364	4,765	58,946	342	8,720	1,579
53_D	11,558	611	8,951	7,952	98,365	1,240	14,551	2,635
54_G	1,640	152	1,272	1,129	13,983	308	2,066	374
54_D	2,717	537	2,107	1,870	23,160	1,088	3,423	619
61_G	1,477	227	1,899	846	28,384	792	1,903	315
61_D	18,210	2,293	23,421	10,429	350,063	8,001	23,470	3,884
62_G	0	0	0	0	0	0	0	0
62_D	21,768	5,827	27,945	12,439	417,962	20,654	28,012	4,622

2017 24-Hour Weekday SHP Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	236,256	25,037	267,856	226,483	1,366,951	43,049	326,968	25,957
21_G	4,925,357	382,514	10,871,303	4,097,226	56,544,540	703,902	6,572,077	468,042
21_D	34,747	2,696	76,694	28,905	398,910	4,962	46,365	3,302
31_G	2,166,412	264,706	2,488,149	1,634,082	17,253,732	501,734	2,628,919	304,825
31_D	37,489	4,576	43,057	28,278	298,579	8,674	45,493	5,275
32_G	532,139	64,953	611,167	401,382	4,238,055	123,114	645,746	74,875
32_D	29,212	3,632	33,551	22,034	232,655	6,883	35,449	4,110
41_D	3,269	467	2,485	1,800	20,248	855	3,984	617
42_G	0	0	0	0	0	0	0	0
42_D	6,537	944	4,969	3,599	40,501	1,729	7,968	1,234
43_G	192	31	146	106	1,191	56	234	36
43_D	17,978	2,590	13,666	9,898	111,388	4,742	21,914	3,394
51_G	4,502	354	3,418	2,480	27,959	652	5,488	847
51_D	7,568	1,264	5,748	4,170	47,012	2,330	9,227	1,425
52_G	85,163	7,525	64,682	46,928	529,067	13,867	103,832	16,030
52_D	142,447	26,832	108,190	78,494	884,928	49,447	173,673	26,813
53_G	14,074	293	10,679	7,752	87,326	540	17,153	2,649
53_D	23,552	1,061	17,871	12,972	146,140	1,955	28,705	4,433
54_G	3,544	283	2,691	1,953	22,010	522	4,321	667
54_D	5,939	991	4,510	3,272	36,889	1,826	7,241	1,118
61_G	2,425	412	3,055	1,105	33,465	965	3,124	492
61_D	29,908	4,155	37,681	13,625	412,700	9,747	38,521	6,061
62_G	0	0	0	0	0	0	0	0
62_D	35,563	10,383	44,895	16,202	491,775	25,146	45,740	7,112

2018 24-Hour Weekday SHP Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	237,869	30,358	305,426	203,633	1,445,362	49,688	366,407	21,740
21_G	4,948,912	462,718	12,366,608	3,677,213	59,638,740	810,618	7,344,360	391,338
21_D	44,968	4,202	112,368	33,413	541,904	7,361	66,734	3,556
31_G	2,176,771	320,557	2,830,246	1,466,437	18,199,417	578,410	2,938,653	254,822
31_D	42,156	5,875	54,811	28,399	352,449	10,600	56,910	4,935
32_G	535,767	78,827	696,606	360,933	4,479,402	142,234	723,288	62,719
32_D	29,411	4,328	38,241	19,814	245,904	7,810	39,706	3,443
41_D	3,294	566	2,834	1,620	21,419	987	4,467	517
42_G	0	0	0	0	0	0	0	0
42_D	6,588	1,145	5,668	3,240	42,836	1,996	8,933	1,035
43_G	194	37	167	95	1,260	65	263	30
43_D	18,021	3,140	15,503	8,862	117,172	5,474	24,436	2,830
51_G	4,441	417	3,818	2,186	28,959	731	6,024	696
51_D	7,434	1,496	6,390	3,659	48,471	2,625	10,083	1,164
52_G	86,026	9,149	73,953	42,340	560,980	16,050	116,683	13,472
52_D	144,053	32,646	123,837	70,901	939,390	57,273	195,391	22,559
53_G	14,282	355	12,266	7,027	93,024	623	19,365	2,237
53_D	23,834	1,286	20,469	11,726	155,236	2,256	32,316	3,733
54_G	3,379	319	2,905	1,663	22,039	559	4,584	529
54_D	5,599	1,128	4,813	2,756	36,507	1,979	7,594	877
61_G	2,442	499	3,478	994	35,342	1,114	3,492	412
61_D	30,110	5,032	42,892	12,264	435,853	11,244	43,071	5,079
62_G	0	0	0	0	0	0	0	0
62_D	35,804	12,573	51,111	14,582	519,418	29,010	51,153	5,960

2020 24-Hour Weekday SHP Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	251,678	32,474	331,418	32,384	1,518,417	51,211	389,836	22,497
21_G	5,237,418	495,120	13,422,148	405,879	62,662,100	835,451	7,809,835	404,912
21_D	47,589	4,496	121,959	3,686	569,376	7,587	70,964	3,679
31_G	2,303,443	342,973	3,071,851	325,634	19,121,598	596,145	3,125,379	263,703
31_D	44,609	6,286	59,490	5,936	370,309	10,925	60,526	5,107
32_G	566,945	84,339	756,072	80,068	4,706,377	146,596	769,246	64,905
32_D	31,123	4,631	41,506	4,397	258,364	8,049	42,229	3,563
41_D	3,486	606	3,076	587	22,504	1,017	4,750	535
42_G	0	0	0	0	0	0	0	0
42_D	6,971	1,225	6,152	1,187	45,006	2,057	9,500	1,071
43_G	205	40	181	39	1,323	67	279	31
43_D	19,069	3,360	16,828	3,256	123,105	5,641	25,985	2,929
51_G	4,700	446	4,143	398	30,428	754	6,405	720
51_D	7,867	1,600	6,935	1,564	50,931	2,705	10,722	1,205
52_G	91,037	9,787	80,264	8,918	589,447	16,542	124,078	13,942
52_D	152,445	34,924	134,406	34,430	987,060	59,029	207,773	23,346
53_G	15,114	380	13,313	188	97,750	642	20,592	2,315
53_D	25,223	1,376	22,217	1,056	163,124	2,325	34,363	3,863
54_G	3,576	341	3,153	305	23,158	576	4,875	548
54_D	5,926	1,207	5,224	1,180	38,359	2,040	8,076	907
61_G	2,592	532	3,755	616	37,120	1,147	3,705	426
61_D	31,964	5,367	46,315	5,792	457,780	11,584	45,697	5,254
62_G	0	0	0	0	0	0	0	0
62_D	38,032	13,403	55,148	18,249	545,382	29,886	54,272	6,162

2021 24-Hour Weekday SHP Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	255,678	32,976	341,097	217,641	1,545,869	52,500	400,106	23,034
21_G	5,320,352	502,732	13,813,613	3,930,974	63,787,700	856,388	8,014,088	414,547
21_D	48,343	4,565	125,516	35,718	579,604	7,777	72,820	3,767
31_G	2,339,976	348,256	3,161,411	1,567,521	19,465,464	611,111	3,207,329	269,988
31_D	45,316	6,383	61,224	30,357	376,968	11,200	62,113	5,229
32_G	575,937	85,638	778,115	385,813	4,791,015	150,276	789,417	66,452
32_D	31,617	4,702	42,716	21,180	263,010	8,251	43,336	3,648
41_D	3,541	615	3,166	1,732	22,908	1,043	4,875	548
42_G	0	0	0	0	0	0	0	0
42_D	7,082	1,244	6,331	3,463	45,813	2,109	9,749	1,096
43_G	208	41	186	102	1,347	68	287	32
43_D	19,372	3,412	17,317	9,474	125,314	5,783	26,666	2,999
51_G	4,774	453	4,264	2,337	30,975	773	6,573	737
51_D	7,992	1,625	7,137	3,911	51,846	2,773	11,003	1,234
52_G	92,481	9,938	82,602	45,263	600,032	16,958	127,332	14,274
52_D	154,863	35,463	138,322	75,795	1,004,785	60,512	213,223	23,902
53_G	15,353	386	13,701	7,512	99,505	658	21,131	2,370
53_D	25,622	1,397	22,864	12,536	166,051	2,384	35,264	3,955
54_G	3,633	346	3,245	1,778	23,574	591	5,002	561
54_D	6,020	1,225	5,376	2,946	39,048	2,091	8,287	929
61_G	2,632	540	3,864	1,064	37,780	1,176	3,802	436
61_D	32,461	5,451	47,653	13,125	465,918	11,876	46,882	5,380
62_G	0	0	0	0	0	0	0	0
62_D	38,625	13,615	56,744	15,599	555,091	30,640	55,684	6,310

2011 24-Hour Weekday Starts Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	3,272	458	3,510	3,589	21,728	829	4,972	394
21_G	720,260	75,183	1,549,663	692,896	9,775,899	139,896	1,074,303	81,632
21_D	2,892	302	6,222	2,782	39,249	562	4,313	328
31_G	352,442	58,189	418,812	312,360	3,394,589	108,096	485,366	55,914
31_D	5,013	826	5,957	4,443	48,287	1,534	6,904	795
32_G	94,647	15,644	112,470	83,883	911,602	29,061	130,343	15,015
32_D	5,409	877	6,428	4,794	52,097	1,628	7,449	858
41_D	621	112	500	432	5,468	217	797	143
42_G	0	0	0	0	0	0	0	0
42_D	422	75	340	294	3,714	146	541	97
43_G	12	3	10	8	104	6	15	3
43_D	1,636	293	1,318	1,139	14,410	567	2,099	378
51_G	357	35	287	248	3,143	67	458	82
51_D	597	124	481	416	5,261	241	766	138
52_G	12,826	1,410	10,332	8,931	112,978	2,733	16,456	2,963
52_D	21,477	5,030	17,301	14,955	189,184	9,752	27,556	4,962
53_G	1,326	34	1,068	924	11,684	66	1,702	306
53_D	2,214	124	1,783	1,541	19,499	239	2,840	511
54_G	40	4	32	28	354	8	52	9
54_D	67	14	54	46	587	27	86	15
61_G	420	87	558	255	7,963	224	574	97
61_D	5,176	884	6,883	3,149	98,200	2,264	7,074	1,196
62_G	0	0	0	0	0	0	0	0
62_D	4,368	1,616	5,808	2,658	82,868	4,140	5,969	1,009

2017 24-Hour Weekday Starts Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	4,462	473	5,061	4,278	25,847	813	6,177	491
21_G	1,133,910	91,236	2,490,768	947,142	13,192,729	163,978	1,528,622	111,536
21_D	7,999	643	17,571	6,682	93,069	1,156	10,784	787
31_G	511,690	63,880	592,695	387,312	4,145,070	119,338	626,039	72,730
31_D	8,854	1,104	10,256	6,702	71,728	2,063	10,833	1,259
32_G	135,606	16,912	157,073	102,644	1,098,508	31,593	165,910	19,275
32_D	7,444	946	8,622	5,635	60,302	1,766	9,108	1,058
41_D	399	59	310	222	2,545	105	490	75
42_G	0	0	0	0	0	0	0	0
42_D	1,316	196	1,023	733	8,408	352	1,619	249
43_G	48	8	37	27	306	14	59	9
43_D	4,479	665	3,480	2,495	28,605	1,194	5,509	848
51_G	736	60	572	410	4,704	107	906	140
51_D	1,238	213	962	690	7,907	383	1,523	234
52_G	25,854	2,355	20,088	14,403	165,130	4,231	31,805	4,897
52_D	43,245	8,399	33,600	24,092	276,206	15,088	53,199	8,192
53_G	2,662	57	2,068	1,483	17,000	103	3,274	504
53_D	4,454	207	3,461	2,481	28,449	372	5,479	844
54_G	86	7	67	48	549	13	106	16
54_D	144	25	112	80	920	45	177	27
61_G	688	158	875	332	9,383	272	914	152
61_D	8,489	1,596	10,794	4,093	115,709	2,750	11,265	1,875
62_G	0	0	0	0	0	0	0	0
62_D	7,164	2,918	9,109	3,454	97,643	5,028	9,506	1,582

2018 24-Hour Weekday Starts Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	4,493	574	5,771	3,846	27,330	939	6,922	411
21_G	1,139,354	110,402	2,834,453	849,866	13,921,679	188,883	1,709,583	93,227
21_D	10,352	1,003	25,755	7,722	126,496	1,715	15,534	847
31_G	514,141	77,373	674,471	347,530	4,374,066	137,594	700,145	60,791
31_D	9,957	1,418	13,062	6,730	84,709	2,522	13,559	1,177
32_G	136,532	20,528	179,108	92,287	1,161,545	36,505	185,925	16,143
32_D	7,495	1,127	9,832	5,066	63,762	2,004	10,206	886
41_D	402	71	353	200	2,694	122	550	63
42_G	0	0	0	0	0	0	0	0
42_D	1,327	238	1,167	660	8,899	406	1,817	209
43_G	48	9	42	24	324	16	66	8
43_D	4,490	806	3,951	2,234	30,116	1,379	6,148	707
51_G	726	70	639	361	4,873	120	995	114
51_D	1,216	252	1,070	605	8,157	432	1,665	192
52_G	26,116	2,864	22,981	12,993	175,180	4,898	35,759	4,115
52_D	43,732	10,221	38,482	21,757	293,343	17,479	59,879	6,891
53_G	2,701	69	2,377	1,344	18,117	119	3,698	426
53_D	4,507	251	3,966	2,243	30,235	429	6,172	710
54_G	82	8	72	41	550	14	112	13
54_D	136	28	119	68	911	48	186	21
61_G	693	192	998	298	9,922	314	1,024	127
61_D	8,547	1,935	12,309	3,680	122,348	3,174	12,624	1,570
62_G	0	0	0	0	0	0	0	0
62_D	7,213	3,538	10,387	3,105	103,246	5,803	10,653	1,325

2020 24-Hour Weekday Starts Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	4,753	614	6,262	614	28,712	967	7,364	425
21_G	1,205,487	118,100	3,075,638	118,100	14,625,278	194,674	1,818,918	96,475
21_D	10,953	1,072	27,946	1,072	132,889	1,768	16,527	877
31_G	543,985	82,768	731,862	82,768	4,595,126	141,813	744,921	62,909
31_D	10,535	1,517	14,173	1,517	88,990	2,599	14,426	1,218
32_G	144,457	21,959	194,348	21,959	1,220,248	37,625	197,816	16,706
32_D	7,930	1,206	10,669	1,206	66,985	2,066	10,859	917
41_D	425	76	384	76	2,830	125	585	65
42_G	0	0	0	0	0	0	0	0
42_D	1,404	254	1,267	254	9,349	419	1,933	216
43_G	51	10	46	10	340	17	70	8
43_D	4,750	863	4,287	863	31,638	1,421	6,541	732
51_G	769	75	694	75	5,119	124	1,058	118
51_D	1,287	270	1,161	270	8,570	445	1,772	198
52_G	27,632	3,064	24,936	3,064	184,033	5,048	38,046	4,259
52_D	46,270	10,933	41,756	10,933	308,167	18,014	63,708	7,131
53_G	2,858	74	2,579	74	19,032	122	3,935	440
53_D	4,769	268	4,304	268	31,763	442	6,567	735
54_G	87	9	78	9	577	14	119	13
54_D	144	30	130	30	957	50	198	22
61_G	733	205	1,083	205	10,423	324	1,089	132
61_D	9,043	2,070	13,356	2,070	128,531	3,271	13,432	1,625
62_G	0	0	0	0	0	0	0	0
62_D	7,631	3,785	11,271	3,785	108,464	5,981	11,335	1,371

2021 24-Hour Weekday Starts Summaries by County FIPS

SUT/FT	48039	48071	48157	48167	48201	48291	48339	48473
11_G	4,829	623	6,445	4,111	29,231	992	7,558	435
21_G	1,224,654	119,924	3,165,465	908,325	14,889,747	199,574	1,866,841	98,777
21_D	11,128	1,089	28,762	8,253	135,293	1,812	16,963	898
31_G	552,633	84,046	753,237	371,435	4,678,223	145,383	764,549	64,410
31_D	10,702	1,540	14,587	7,193	90,599	2,664	14,806	1,247
32_G	146,753	22,298	200,024	98,636	1,242,315	38,572	203,028	17,104
32_D	8,056	1,224	10,980	5,415	68,196	2,118	11,145	939
41_D	432	77	395	214	2,882	129	601	67
42_G	0	0	0	0	0	0	0	0
42_D	1,426	258	1,304	705	9,518	429	1,984	221
43_G	52	10	47	26	346	17	72	8
43_D	4,826	876	4,412	2,387	32,210	1,457	6,713	750
51_G	781	76	714	386	5,212	127	1,086	121
51_D	1,307	274	1,195	647	8,725	456	1,818	203
52_G	28,071	3,111	25,665	13,887	187,361	5,175	39,048	4,360
52_D	47,006	11,102	42,976	23,253	313,740	18,468	65,387	7,301
53_G	2,903	75	2,654	1,436	19,376	125	4,038	451
53_D	4,845	273	4,430	2,397	32,338	454	6,740	753
54_G	88	9	81	44	588	14	122	14
54_D	146	31	133	72	974	51	203	23
61_G	745	208	1,115	319	10,612	332	1,118	135
61_D	9,187	2,102	13,746	3,933	130,856	3,353	13,786	1,664
62_G	0	0	0	0	0	0	0	0
62_D	7,753	3,843	11,600	3,319	110,426	6,132	11,633	1,404

2011 Weekday Hotelling Hours Summaries by Operating Mode

County FIPS	Hotelling Hours	SHI	APU Hours	Other Mode Hours
48039	691	550	3	138
48071	1,838	1,462	8	368
48157	2,987	2,377	13	597
48167	292	232	1	58
48201	30,035	23,899	128	6,007
48291	1,107	881	5	221
48339	3,742	2,978	16	748
48473	1,978	1,574	8	396

2017 Weekday Hotelling Hours Summaries by Operating Mode

County FIPS	Hotelling Hours	SHI	APU Hours	Other Mode Hours
48039	1,449	1,106	53	290
48071	4,244	3,239	156	849
48157	4,462	3,406	164	892
48167	443	338	16	89
48201	40,902	31,222	1,500	8,180
48291	1,526	1,164	56	305
48339	6,144	4,690	225	1,229
48473	3,907	2,982	143	781

2018 Weekday Hotelling Hours Summaries by Operating Mode

County FIPS	Hotelling Hours	SHI	APU Hours	Other Mode Hours
48039	1,459	1,105	62	292
48071	5,145	3,897	219	1,029
48157	5,088	3,854	217	1,018
48167	399	302	17	80
48201	43,249	32,757	1,842	8,650
48291	1,761	1,334	75	352
48339	6,885	5,215	293	1,377
48473	3,275	2,480	139	655

2020 Weekday Hotelling Hours Summaries by Operating Mode

County FIPS	Hotelling Hours	SHI	APU Hours	Other Mode Hours
48039	1,486	1,114	75	297
48071	5,543	4,155	280	1,109
48157	5,820	4,362	294	1,164
48167	422	316	21	84
48201	45,795	34,325	2,311	9,159
48291	1,823	1,366	92	365
48339	7,319	5,486	369	1,464
48473	3,406	2,553	172	681

2021 Weekday Hotelling Hours Summaries by Operating Mode

County FIPS	Hotelling Hours	SHI	APU Hours	Other Mode Hours
48039	1,511	1,103	97	311
48071	5,623	4,106	362	1,155
48157	5,993	4,376	386	1,232
48167	428	312	28	88
48201	46,631	34,047	3,002	9,582
48291	1,864	1,361	120	383
48339	7,497	5,474	483	1,541
48473	3,482	2,543	224	716

APPENDIX G:
SOURCE TYPE AGE AND FUEL ENGINE FRACTIONS INPUTS TO MOVES

Brazoria County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.029489	0.041465	0.025332	0.025332	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.035165	0.059996	0.041857	0.041857	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.084868	0.058323	0.038005	0.038005	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.097743	0.088039	0.069630	0.069630	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.113526	0.091720	0.077310	0.077310	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.102174	0.081450	0.069196	0.069196	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.078222	0.075970	0.063213	0.063213	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.059532	0.065633	0.070261	0.070261	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.071577	0.061826	0.073680	0.073680	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.064655	0.060152	0.075947	0.075947	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.049702	0.054189	0.069147	0.069147	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.033504	0.053452	0.056586	0.056586	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028243	0.043257	0.050776	0.050776	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.022290	0.034683	0.035564	0.035564	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.015368	0.027046	0.036060	0.036060	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.015921	0.020837	0.025890	0.025890	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.013014	0.019007	0.025506	0.025506	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.011076	0.013489	0.021554	0.021554	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007615	0.010277	0.013849	0.013849	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.007061	0.007808	0.011582	0.011582	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.003323	0.006053	0.009291	0.009291	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.004015	0.004439	0.007457	0.007457	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003738	0.003324	0.006937	0.006937	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.003600	0.002372	0.005215	0.005215	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002769	0.001837	0.002564	0.002564	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004984	0.001398	0.002973	0.002973	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.003600	0.001450	0.002155	0.002155	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003600	0.001034	0.002329	0.002329	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003184	0.000647	0.001102	0.001102	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.004430	0.000565	0.001028	0.001028	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.022013	0.008262	0.008002	0.008002	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Brazoria County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.034051	0.049888	0.026692	0.026692	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.058353	0.082092	0.050348	0.050348	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.051368	0.076969	0.045098	0.045098	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.037398	0.066351	0.048366	0.048366	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033469	0.060897	0.042381	0.042381	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.072905	0.052089	0.034989	0.034989	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.082800	0.076409	0.063810	0.063810	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.093277	0.075794	0.068950	0.068950	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.086147	0.065460	0.063712	0.063712	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.066938	0.060303	0.056247	0.056247	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.053842	0.050644	0.062244	0.062244	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.062427	0.045919	0.064202	0.064202	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.054424	0.043597	0.066490	0.066490	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.038271	0.037030	0.057875	0.057875	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.026193	0.035876	0.046175	0.046175	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.024447	0.027141	0.040423	0.040423	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.018626	0.020587	0.028099	0.028099	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.013097	0.016206	0.028393	0.028393	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.013242	0.011191	0.020022	0.020022	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.011496	0.010260	0.018614	0.018614	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.009313	0.006635	0.015628	0.015628	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005384	0.005164	0.009974	0.009974	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.004220	0.003598	0.007979	0.007979	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.003783	0.003078	0.005936	0.005936	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.003929	0.002369	0.005054	0.005054	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003347	0.001822	0.004699	0.004699	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002474	0.001390	0.003525	0.003525	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.001455	0.001188	0.001799	0.001799	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.002910	0.000769	0.001775	0.001775	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002328	0.000918	0.001493	0.001493	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.028085	0.008363	0.009007	0.009007	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Chambers County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.016832	0.043599	0.026411	0.026411	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.028713	0.062691	0.040891	0.040891	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.086139	0.063048	0.046444	0.046444	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.094059	0.103227	0.077431	0.077431	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.130693	0.098597	0.083433	0.083433	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.109901	0.091757	0.075180	0.075180	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.080198	0.077652	0.066627	0.066627	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.068317	0.062122	0.075405	0.075405	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.075248	0.052148	0.073980	0.073980	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.067327	0.055639	0.069928	0.069928	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.045545	0.048372	0.067977	0.067977	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.039604	0.045166	0.051170	0.051170	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.040594	0.037900	0.045618	0.045618	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.023762	0.028924	0.031813	0.031813	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.010891	0.025219	0.031438	0.031438	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.011881	0.019377	0.022209	0.022209	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.006931	0.017953	0.024010	0.024010	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008911	0.011968	0.020408	0.020408	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007921	0.010401	0.013205	0.013205	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.003960	0.007053	0.010579	0.010579	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.004950	0.007124	0.008929	0.008929	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.001980	0.005486	0.007428	0.007428	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003960	0.004203	0.006227	0.006227	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.002970	0.002208	0.004727	0.004727	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.001980	0.002636	0.002776	0.002776	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.001980	0.001781	0.002701	0.002701	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.001980	0.001781	0.002176	0.002176	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003960	0.001282	0.002326	0.002326	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.000000	0.000427	0.001050	0.001050	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.002970	0.000712	0.000975	0.000975	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.015842	0.009546	0.006528	0.006528	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Chambers County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.026205	0.056954	0.034963	0.034963	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.041929	0.098149	0.057648	0.057648	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.062893	0.095394	0.053231	0.053231	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.036688	0.071753	0.059444	0.059444	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.037736	0.063809	0.044546	0.044546	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.080713	0.054904	0.042674	0.042674	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.070231	0.079185	0.070150	0.070150	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.094340	0.072202	0.073070	0.073070	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.106918	0.068038	0.064910	0.064910	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.068134	0.054328	0.054503	0.054503	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.057652	0.043308	0.059370	0.059370	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.064990	0.034595	0.059744	0.059744	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.045073	0.037927	0.056300	0.056300	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.032495	0.031136	0.052931	0.052931	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.039832	0.028894	0.041102	0.041102	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.028302	0.022551	0.035487	0.035487	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.016771	0.016849	0.024931	0.024931	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.012579	0.013582	0.022161	0.022161	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.014675	0.010827	0.016096	0.016096	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.006289	0.008393	0.017219	0.017219	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.009434	0.007111	0.012802	0.012802	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005241	0.005061	0.009882	0.009882	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.006289	0.003075	0.007112	0.007112	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.001048	0.002691	0.005465	0.005465	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.003145	0.002306	0.004567	0.004567	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003145	0.002306	0.003743	0.003743	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002096	0.001345	0.002770	0.002770	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.001048	0.001217	0.001348	0.001348	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.001048	0.000641	0.001872	0.001872	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.004193	0.001217	0.002171	0.002171	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.018868	0.010250	0.007786	0.007786	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Fort Bend County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.043366	0.046518	0.029637	0.029637	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.048141	0.065960	0.053790	0.053790	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.102478	0.064906	0.044450	0.044450	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.101058	0.094485	0.079934	0.079934	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.120289	0.096165	0.088972	0.088972	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.103898	0.085778	0.072731	0.072731	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.079375	0.075541	0.066153	0.066153	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.059241	0.067667	0.078277	0.078277	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.067759	0.063112	0.078099	0.078099	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.056402	0.059721	0.078037	0.078037	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.043753	0.053351	0.065736	0.065736	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.032137	0.050441	0.050913	0.050913	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028653	0.038721	0.042448	0.042448	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.019489	0.031594	0.032045	0.032045	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.011745	0.024350	0.029011	0.029011	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.011874	0.017987	0.019202	0.019202	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.008776	0.015595	0.018680	0.018680	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.006324	0.010355	0.015689	0.015689	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007486	0.007780	0.010508	0.010508	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.003098	0.006066	0.008235	0.008235	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.002710	0.004559	0.006130	0.006130	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.001678	0.003633	0.005494	0.005494	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.002194	0.002202	0.004555	0.004555	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.002323	0.001756	0.003357	0.003357	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002710	0.001362	0.002450	0.002450	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.002323	0.001013	0.002085	0.002085	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.002581	0.000971	0.001939	0.001939	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.002452	0.000847	0.001887	0.001887	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.002839	0.000591	0.001136	0.001136	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.003872	0.000505	0.001220	0.001220	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.018973	0.006470	0.007203	0.007203	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Fort Bend County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.050696	0.058337	0.032080	0.032080	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.073662	0.090001	0.064914	0.064914	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.068043	0.083425	0.056273	0.056273	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.050452	0.073275	0.058103	0.058103	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.041656	0.066488	0.051514	0.051514	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.080015	0.057682	0.038498	0.038498	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.074884	0.080274	0.070114	0.070114	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.096995	0.077799	0.074872	0.074872	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.080625	0.066166	0.061161	0.061161	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.062790	0.056728	0.056222	0.056222	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.046787	0.048539	0.063535	0.063535	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.053872	0.043165	0.062248	0.062248	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.043000	0.038870	0.062761	0.062761	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.032861	0.033461	0.051736	0.051736	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.026631	0.030643	0.040127	0.040127	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.021500	0.022460	0.031838	0.031838	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.016003	0.017884	0.023579	0.023579	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.009406	0.013139	0.021809	0.021809	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.008307	0.008985	0.014224	0.014224	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.006719	0.007194	0.013731	0.013731	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.004520	0.004944	0.011025	0.011025	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005375	0.003593	0.007585	0.007585	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003298	0.002656	0.005553	0.005553	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.001832	0.002039	0.003953	0.003953	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.001344	0.001697	0.003802	0.003802	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.002077	0.001082	0.003159	0.003159	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002199	0.000933	0.002223	0.002223	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.002443	0.000837	0.001418	0.001418	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.003176	0.000641	0.001398	0.001398	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.001099	0.000664	0.001207	0.001207	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.027730	0.006398	0.009335	0.009335	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Galveston County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.025243	0.043574	0.026319	0.026319	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.037738	0.058903	0.049632	0.049632	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.100719	0.063386	0.042001	0.042001	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.098574	0.088516	0.079627	0.079627	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.108166	0.090634	0.082367	0.082367	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.097816	0.083909	0.072569	0.072569	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.080020	0.075971	0.063120	0.063120	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.058437	0.064917	0.073910	0.073910	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.073457	0.062605	0.074861	0.074861	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.059447	0.059629	0.076888	0.076888	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.044806	0.052487	0.068292	0.068292	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.034709	0.050206	0.051254	0.051254	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.030418	0.041696	0.045928	0.045928	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.020825	0.033502	0.032860	0.032860	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.015777	0.026784	0.031798	0.031798	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.016534	0.020083	0.022671	0.022671	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.009719	0.018745	0.021832	0.021832	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008709	0.012337	0.017681	0.017681	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.007952	0.010034	0.012957	0.012957	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.004670	0.007490	0.008889	0.008889	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.004039	0.005813	0.007785	0.007785	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.003786	0.005017	0.007548	0.007548	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.004670	0.003564	0.005996	0.005996	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.004670	0.002427	0.004025	0.004025	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.003155	0.002056	0.002376	0.002376	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004670	0.001778	0.002404	0.002404	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.003155	0.001662	0.002111	0.002111	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.002524	0.001376	0.002264	0.002264	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003282	0.000873	0.001384	0.001384	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.005301	0.000657	0.001132	0.001132	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.027010	0.009369	0.007520	0.007520	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Galveston County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.032675	0.050373	0.031659	0.031659	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.064163	0.084895	0.058659	0.058659	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.054941	0.076401	0.045384	0.045384	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.040580	0.065228	0.049650	0.049650	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033597	0.059393	0.045749	0.045749	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.083267	0.054553	0.038002	0.038002	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.079842	0.074858	0.068974	0.068974	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.091304	0.073456	0.072187	0.072187	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.081686	0.066351	0.062813	0.062813	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.064032	0.059954	0.054126	0.054126	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.049407	0.049882	0.063950	0.063950	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.060079	0.045968	0.064146	0.064146	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.048090	0.042939	0.064708	0.064708	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.035046	0.036829	0.057621	0.057621	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.031489	0.034073	0.041553	0.041553	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.024506	0.027557	0.037301	0.037301	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.020158	0.020845	0.025190	0.025190	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.015020	0.016188	0.024643	0.024643	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.012516	0.011650	0.017359	0.017359	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.009486	0.010535	0.016980	0.016980	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.006192	0.006895	0.013360	0.013360	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005929	0.005043	0.008869	0.008869	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.004480	0.003928	0.006217	0.006217	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.003162	0.003086	0.005080	0.005080	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002767	0.002490	0.005094	0.005094	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003557	0.002083	0.004182	0.004182	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002635	0.001557	0.002624	0.002624	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.002240	0.001164	0.001431	0.001431	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.004216	0.001108	0.001628	0.001628	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002899	0.000996	0.001473	0.001473	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.030040	0.009721	0.009388	0.009388	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Harris County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.035445	0.047178	0.027418	0.027418	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.042013	0.057736	0.040492	0.040492	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.102145	0.052988	0.035349	0.035349	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.098830	0.078010	0.069539	0.069539	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.117470	0.082164	0.077581	0.077581	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.098789	0.076988	0.066823	0.066823	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.077021	0.071964	0.064280	0.064280	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.055649	0.062982	0.073246	0.073246	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.068660	0.060872	0.076613	0.076613	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.057818	0.061481	0.079337	0.079337	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.044703	0.058503	0.071480	0.071480	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.035425	0.057776	0.057650	0.057650	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028273	0.046624	0.051219	0.051219	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.020850	0.039183	0.038065	0.038065	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.014449	0.031811	0.035592	0.035592	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.013490	0.024008	0.023130	0.023130	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.011238	0.021505	0.023112	0.023112	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008924	0.015239	0.019319	0.019319	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.006484	0.011823	0.013504	0.013504	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.004962	0.009001	0.010016	0.010016	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.003419	0.006878	0.007798	0.007798	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.003482	0.005110	0.006732	0.006732	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003336	0.003481	0.005890	0.005890	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.003607	0.002469	0.004190	0.004190	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002877	0.001852	0.002588	0.002588	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004253	0.001431	0.002746	0.002746	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.004024	0.001468	0.002465	0.002465	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003440	0.001175	0.002283	0.002283	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.002648	0.000789	0.001410	0.001410	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.003982	0.000576	0.001734	0.001734	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.022289	0.006934	0.008398	0.008398	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Harris County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.041700	0.065600	0.031518	0.031518	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.074575	0.076227	0.050539	0.050539	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.064531	0.068965	0.043006	0.043006	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.043713	0.058501	0.045770	0.045770	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033668	0.055270	0.037853	0.037853	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.080294	0.048562	0.033218	0.033218	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.076032	0.070340	0.064775	0.064775	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.094751	0.071820	0.071330	0.071330	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.080786	0.066148	0.061027	0.061027	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.063717	0.060102	0.058713	0.058713	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.045983	0.051641	0.066065	0.066065	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.057506	0.048348	0.067479	0.067479	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.048853	0.046294	0.068120	0.068120	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.035232	0.041390	0.060118	0.060118	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.027479	0.039102	0.047321	0.047321	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.022403	0.030110	0.040584	0.040584	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.015785	0.023947	0.029053	0.029053	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.011351	0.018569	0.027243	0.027243	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.010966	0.013123	0.017448	0.017448	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.009274	0.010889	0.017264	0.017264	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.007068	0.007378	0.013932	0.013932	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.005569	0.005564	0.009254	0.009254	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003641	0.004043	0.006578	0.006578	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.002699	0.003098	0.005093	0.005093	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002741	0.002350	0.004350	0.004350	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.002420	0.001633	0.003927	0.003927	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.002484	0.001253	0.002622	0.002622	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.001928	0.001002	0.001749	0.001749	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.003491	0.000833	0.001985	0.001985	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002806	0.000826	0.001763	0.001763	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.026558	0.007070	0.010301	0.010301	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Liberty County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.023510	0.031586	0.022295	0.022295	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.029524	0.046288	0.032190	0.032190	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.083652	0.045982	0.031827	0.031827	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.092947	0.079865	0.065471	0.065471	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.107709	0.080018	0.072378	0.072378	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.109896	0.074275	0.065269	0.065269	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.082559	0.070868	0.054768	0.054768	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.061236	0.056013	0.062038	0.062038	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.061782	0.054520	0.069147	0.069147	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.064516	0.052950	0.070883	0.070883	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.057408	0.057736	0.069712	0.069712	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.041006	0.056893	0.054606	0.054606	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.035539	0.051725	0.051133	0.051133	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.025150	0.042536	0.042974	0.042974	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.019683	0.038707	0.044428	0.044428	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.015309	0.030476	0.030373	0.030373	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.009841	0.028294	0.032635	0.032635	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.007654	0.021134	0.027546	0.027546	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.006014	0.017191	0.017812	0.017812	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.003827	0.013668	0.016156	0.016156	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.002734	0.011716	0.011753	0.011753	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.002734	0.008002	0.010663	0.010663	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.004921	0.006394	0.009088	0.009088	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.004374	0.005054	0.007634	0.007634	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.002187	0.002948	0.004241	0.004241	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.009841	0.002259	0.003918	0.003918	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.003827	0.002106	0.003958	0.003958	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.004374	0.001646	0.003110	0.003110	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003827	0.000536	0.001494	0.001494	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.001640	0.000689	0.001535	0.001535	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.020776	0.007925	0.008966	0.008966	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Liberty County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.035294	0.045784	0.025960	0.025960	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.051393	0.072277	0.047689	0.047689	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.044582	0.065762	0.043050	0.043050	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.035913	0.055592	0.041626	0.041626	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.031579	0.051321	0.033407	0.033407	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.081115	0.041911	0.030843	0.030843	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.074303	0.068404	0.059774	0.059774	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.092879	0.068006	0.061849	0.061849	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.085449	0.065364	0.061646	0.061646	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.078638	0.059428	0.050781	0.050781	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.052012	0.048136	0.057292	0.057292	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.050774	0.046797	0.064860	0.064860	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.060681	0.045277	0.062785	0.062785	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.043344	0.044915	0.061727	0.061727	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.029721	0.043540	0.047933	0.047933	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.023529	0.036518	0.042074	0.042074	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.022291	0.028882	0.035360	0.035360	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.014861	0.022367	0.035726	0.035726	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.016718	0.018277	0.024414	0.024414	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.008669	0.015201	0.024618	0.024618	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.012384	0.012052	0.020955	0.020955	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.004954	0.008578	0.013916	0.013916	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003715	0.007419	0.010295	0.010295	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.002477	0.005718	0.007446	0.007446	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002477	0.003511	0.006266	0.006266	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.005573	0.003004	0.005656	0.005656	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.003096	0.002316	0.004232	0.004232	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.000619	0.001810	0.002523	0.002523	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.004334	0.001194	0.002319	0.002319	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.000619	0.001484	0.002075	0.002075	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.026006	0.009157	0.010905	0.010905	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Montgomery County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.040452	0.047069	0.031806	0.031806	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.035805	0.066982	0.050435	0.050435	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.089468	0.060890	0.043266	0.043266	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.087281	0.093845	0.077591	0.077591	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.110787	0.092229	0.083330	0.083330	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.105047	0.083485	0.068758	0.068758	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.082088	0.074366	0.064179	0.064179	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.061771	0.066269	0.073435	0.073435	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.074708	0.060237	0.076143	0.076143	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.056669	0.058257	0.073597	0.073597	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.047103	0.052050	0.068659	0.068659	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.038539	0.049792	0.050687	0.050687	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.028972	0.040304	0.044102	0.044102	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.019679	0.032307	0.033524	0.033524	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.015853	0.025846	0.032391	0.032391	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.015306	0.018497	0.023396	0.023396	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.011935	0.017126	0.021777	0.021777	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.008746	0.012005	0.017801	0.017801	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.008200	0.009174	0.012323	0.012323	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.006013	0.007304	0.009139	0.009139	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.003462	0.005529	0.007088	0.007088	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.003371	0.004268	0.006494	0.006494	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.003644	0.003410	0.005325	0.005325	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.003735	0.002438	0.003562	0.003562	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.003098	0.001875	0.002276	0.002276	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.004191	0.001436	0.002546	0.002546	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.004282	0.001256	0.002393	0.002393	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.003735	0.001077	0.002357	0.002357	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.003735	0.000858	0.001520	0.001520	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.004191	0.000653	0.001250	0.001250	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.018130	0.009169	0.008851	0.008851	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Montgomery County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.039192	0.062061	0.031242	0.031242	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.073451	0.096070	0.059737	0.059737	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.062945	0.084156	0.054686	0.054686	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.044034	0.068771	0.055112	0.055112	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.033894	0.061796	0.046689	0.046689	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.072355	0.051148	0.037301	0.037301	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.076192	0.074088	0.066309	0.066309	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.092363	0.070885	0.069620	0.069620	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.080395	0.063575	0.059763	0.059763	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.065047	0.056213	0.055086	0.055086	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.050978	0.048773	0.062753	0.062753	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.061392	0.042868	0.062527	0.062527	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.047597	0.040514	0.061693	0.061693	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.037091	0.034744	0.055790	0.055790	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.027864	0.031977	0.041743	0.041743	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.023479	0.024845	0.034797	0.034797	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.015257	0.019141	0.025722	0.025722	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.011785	0.014755	0.025244	0.025244	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.010963	0.010269	0.017516	0.017516	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.009410	0.009168	0.015882	0.015882	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.007126	0.006100	0.012857	0.012857	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.006578	0.004421	0.008606	0.008606	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.004202	0.003329	0.006537	0.006537	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.002467	0.002654	0.004937	0.004937	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.002832	0.002324	0.004485	0.004485	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.003746	0.001832	0.003781	0.003781	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.003289	0.001392	0.002747	0.002747	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.002284	0.001157	0.001695	0.001695	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.002558	0.000918	0.001886	0.001886	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.003198	0.000814	0.001886	0.001886	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.026037	0.009242	0.011370	0.011370	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Waller County 2011 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.032184	0.023292	0.017334	0.017334	0.047687	0.062818	0.036849	0.033428	0.100184	0.104789	0.045953	0.022568	0.021517
1	0.031034	0.039236	0.032092	0.032092	0.042103	0.038454	0.040281	0.026487	0.051441	0.054592	0.040571	0.023917	0.018938
2	0.078161	0.041730	0.029125	0.029125	0.035297	0.039335	0.047982	0.035139	0.054203	0.051380	0.034013	0.035695	0.033960
3	0.072414	0.072239	0.061138	0.061138	0.045828	0.055480	0.052913	0.027283	0.152909	0.148094	0.044161	0.047339	0.047549
4	0.120690	0.071583	0.069415	0.069415	0.060053	0.053891	0.054825	0.095613	0.091936	0.091287	0.057870	0.108389	0.100800
5	0.101149	0.070009	0.063012	0.063012	0.061688	0.038869	0.064428	0.071821	0.098539	0.100234	0.059445	0.079662	0.075154
6	0.083908	0.068959	0.057469	0.057469	0.063774	0.060743	0.057400	0.067711	0.085962	0.091233	0.061455	0.068333	0.065321
7	0.058621	0.055902	0.071133	0.071133	0.061962	0.049803	0.056548	0.040684	0.059676	0.063794	0.059709	0.051025	0.044275
8	0.074713	0.054130	0.069806	0.069806	0.057427	0.048803	0.048690	0.039962	0.050670	0.051239	0.055339	0.042259	0.037609
9	0.050575	0.059051	0.073007	0.073007	0.053788	0.049468	0.051137	0.028968	0.043809	0.040653	0.051832	0.043562	0.037406
10	0.044828	0.059839	0.069962	0.069962	0.051722	0.056977	0.046668	0.035743	0.044015	0.042649	0.049841	0.056600	0.052107
11	0.042529	0.062594	0.050051	0.050051	0.049187	0.038547	0.050778	0.048848	0.038221	0.034783	0.047398	0.064916	0.064101
12	0.032184	0.054721	0.052393	0.052393	0.047816	0.037370	0.046984	0.070182	0.032016	0.031295	0.046077	0.057678	0.056536
13	0.025287	0.043435	0.042008	0.042008	0.036236	0.043858	0.037078	0.064510	0.013503	0.014618	0.027088	0.044327	0.046019
14	0.013793	0.038843	0.044741	0.044741	0.029483	0.040074	0.034539	0.031179	0.018346	0.016614	0.041707	0.036010	0.035234
15	0.016092	0.033134	0.031233	0.031233	0.024376	0.036913	0.029786	0.040575	0.011306	0.009689	0.025824	0.030435	0.032591
16	0.018391	0.031560	0.033497	0.033497	0.031680	0.030250	0.038049	0.052069	0.012102	0.010658	0.030470	0.040685	0.040969
17	0.009195	0.024014	0.026860	0.026860	0.024393	0.026379	0.018362	0.036669	0.007387	0.006977	0.029053	0.025310	0.026449
18	0.011494	0.020471	0.017569	0.017569	0.020079	0.021880	0.021927	0.016697	0.005165	0.005036	0.019993	0.022433	0.024074
19	0.004598	0.016141	0.016710	0.016710	0.014790	0.018996	0.017686	0.014910	0.004240	0.003477	0.017538	0.016634	0.017590
20	0.004598	0.012204	0.010541	0.010541	0.016760	0.019214	0.022576	0.023337	0.004278	0.003744	0.013046	0.016184	0.019591
21	0.005747	0.008792	0.009916	0.009916	0.018809	0.028123	0.025499	0.016557	0.004124	0.003655	0.017088	0.014431	0.017397
22	0.004598	0.007086	0.008745	0.008745	0.018655	0.021395	0.014549	0.025590	0.003726	0.003071	0.022075	0.012723	0.013278
23	0.006897	0.005118	0.007340	0.007340	0.017357	0.016843	0.017300	0.014728	0.002698	0.002499	0.019579	0.009710	0.010967
24	0.004598	0.004462	0.004919	0.004919	0.018042	0.015582	0.017524	0.013208	0.001747	0.001536	0.019123	0.007013	0.009105
25	0.008046	0.001968	0.004216	0.004216	0.015134	0.013127	0.015295	0.006775	0.001824	0.001835	0.014099	0.004046	0.008763
26	0.006897	0.002428	0.004216	0.004216	0.013218	0.011264	0.013132	0.006808	0.000951	0.001467	0.014969	0.003462	0.008281
27	0.004598	0.002493	0.003904	0.003904	0.010401	0.008781	0.010141	0.005584	0.000784	0.001153	0.015184	0.003731	0.006291
28	0.009195	0.001378	0.002342	0.002342	0.004105	0.008327	0.003705	0.002521	0.000450	0.000748	0.009836	0.001349	0.002814
29	0.004598	0.001115	0.002577	0.002577	0.003459	0.004491	0.002713	0.002915	0.000642	0.001073	0.005743	0.001708	0.004440
30	0.018391	0.012073	0.012727	0.012727	0.004692	0.003943	0.004656	0.003501	0.003148	0.006131	0.003919	0.007867	0.020875

Waller County 2014 Age Distribution Inputs to MOVES (2017, 2018, 2020 and 2021 Analysis Years)

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.032768	0.039187	0.020653	0.020653	0.055548	0.055650	0.055556	0.064759	0.084720	0.080736	0.064928	0.040776	0.044007
1	0.051977	0.063437	0.044613	0.044613	0.049844	0.049946	0.049851	0.058272	0.099024	0.097975	0.058445	0.045307	0.048909
2	0.054237	0.062910	0.038365	0.038365	0.046005	0.046100	0.046012	0.053507	0.139229	0.150497	0.053673	0.043397	0.050486
3	0.038418	0.048559	0.039247	0.039247	0.042194	0.055697	0.032610	0.028999	0.095185	0.104892	0.039988	0.031182	0.032874
4	0.032768	0.049379	0.035352	0.035352	0.037253	0.034095	0.035647	0.022977	0.034371	0.036093	0.035305	0.020122	0.017742
5	0.070056	0.042701	0.027561	0.027561	0.031054	0.034678	0.042221	0.030317	0.035143	0.034013	0.029436	0.028828	0.031415
6	0.072316	0.061856	0.057695	0.057695	0.039992	0.048516	0.046183	0.023359	0.101750	0.093698	0.037928	0.045973	0.043640
7	0.092655	0.063730	0.059827	0.059827	0.052280	0.047012	0.047736	0.081433	0.059089	0.057695	0.049441	0.104962	0.094086
8	0.067797	0.063730	0.059018	0.059018	0.053395	0.033713	0.055776	0.060642	0.066056	0.064010	0.050348	0.074224	0.070679
9	0.074576	0.060918	0.050860	0.050860	0.055067	0.052559	0.049572	0.057049	0.057215	0.057569	0.051939	0.068094	0.061342
10	0.049718	0.049965	0.066956	0.066956	0.053502	0.043092	0.048835	0.034170	0.040706	0.040882	0.050306	0.053036	0.041119
11	0.056497	0.047680	0.065192	0.065192	0.049301	0.041983	0.041807	0.033378	0.033980	0.033007	0.046365	0.034735	0.032913
12	0.055367	0.048676	0.064971	0.064971	0.046064	0.042452	0.043802	0.024143	0.029049	0.026419	0.043333	0.034069	0.032437
13	0.041808	0.047856	0.062987	0.062987	0.044038	0.048613	0.039741	0.029530	0.028527	0.027473	0.041306	0.044819	0.043530
14	0.035028	0.050199	0.049831	0.049831	0.041777	0.032808	0.043136	0.040271	0.025129	0.021921	0.039197	0.055168	0.052520
15	0.036158	0.038425	0.045201	0.045201	0.040613	0.031807	0.039913	0.057677	0.020569	0.019697	0.037984	0.042464	0.044225
16	0.023729	0.033271	0.033588	0.033588	0.030598	0.037111	0.031314	0.052718	0.008941	0.009478	0.022205	0.034913	0.037120
17	0.011299	0.027413	0.036601	0.036601	0.024835	0.033826	0.029099	0.025424	0.010264	0.010221	0.034115	0.026429	0.028101
18	0.015819	0.020326	0.025503	0.025503	0.020412	0.030975	0.024947	0.032795	0.005473	0.005665	0.020938	0.024519	0.025898
19	0.007910	0.017690	0.025062	0.025062	0.026464	0.025322	0.031789	0.041995	0.006415	0.006044	0.024651	0.033048	0.032080
20	0.012429	0.011949	0.018668	0.018668	0.020257	0.021952	0.015251	0.029313	0.003919	0.003876	0.023297	0.021543	0.020867
21	0.006780	0.009489	0.012568	0.012568	0.016633	0.018163	0.018167	0.013318	0.002726	0.002748	0.015998	0.017856	0.017990
22	0.003390	0.007146	0.011392	0.011392	0.012252	0.015769	0.014653	0.011855	0.002065	0.001875	0.013989	0.012970	0.012870
23	0.005650	0.005858	0.007350	0.007350	0.013801	0.015855	0.018594	0.018450	0.001774	0.002168	0.010346	0.013059	0.014209
24	0.004520	0.003925	0.007497	0.007497	0.015450	0.023149	0.020950	0.013061	0.001594	0.001735	0.013522	0.011060	0.012572
25	0.004520	0.003222	0.005806	0.005806	0.015324	0.017611	0.011953	0.020123	0.001333	0.001442	0.017413	0.009550	0.009605
26	0.003390	0.003163	0.004777	0.004777	0.014173	0.013781	0.014128	0.011515	0.001143	0.001180	0.015355	0.007596	0.007859
27	0.003390	0.002402	0.003454	0.003454	0.014695	0.012718	0.014276	0.010304	0.000561	0.000678	0.014965	0.004842	0.006202
28	0.004520	0.000879	0.002499	0.002499	0.012327	0.010714	0.012460	0.005268	0.000601	0.000875	0.010998	0.003243	0.006083
29	0.002260	0.001289	0.002278	0.002278	0.010701	0.009139	0.010634	0.005263	0.000652	0.000762	0.011609	0.002710	0.005596
30	0.028249	0.012769	0.014626	0.014626	0.014149	0.015191	0.013386	0.008114	0.002797	0.004677	0.020675	0.009506	0.021026

Texas Statewide 2011 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996	0.997	0.997	0.998	0.998	0.999	0.999
PC	Diesel	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001
PT	Gas	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981
PT	Diesel	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019
LCT	Gas	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971
LCT	Diesel	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.042
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.958
RT	Gas	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005	0.006	0.002	0.169	0.404	0.019	0.012
RT	Diesel	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995	0.994	0.998	0.831	0.596	0.981	0.988
SUShT	Gas	0.211	0.221	0.307	0.256	0.238	0.219	0.211	0.229	0.250	0.266	0.312	0.348	0.359	0.426	0.423	0.435
SUShT	Diesel	0.789	0.779	0.693	0.744	0.762	0.781	0.789	0.771	0.750	0.734	0.688	0.652	0.641	0.574	0.577	0.565
SULhT	Gas	0.211	0.221	0.307	0.256	0.238	0.219	0.211	0.229	0.250	0.266	0.312	0.348	0.359	0.426	0.423	0.435
SULhT	Diesel	0.789	0.779	0.693	0.744	0.762	0.781	0.789	0.771	0.750	0.734	0.688	0.652	0.641	0.574	0.577	0.565
MH	Gas	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600	0.630	0.660	0.680	0.710	0.740	0.770
MH	Diesel	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400	0.370	0.340	0.320	0.290	0.260	0.230
CShT	Gas	0.046	0.071	0.047	0.053	0.026	0.059	0.048	0.050	0.050	0.078	0.077	0.083	0.102	0.131	0.152	0.146
CShT	Diesel	0.954	0.929	0.953	0.947	0.974	0.941	0.952	0.950	0.950	0.922	0.923	0.917	0.898	0.869	0.848	0.854
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2011 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000	0.987	0.991	0.966	0.956	0.923	0.893	0.924
PC	Diesel	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000	0.013	0.009	0.034	0.044	0.077	0.107	0.076
PT	Gas	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996	0.986	0.984	0.979	0.972	0.943	0.982
PT	Diesel	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004	0.014	0.016	0.021	0.028	0.057	0.018
LCT	Gas	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986	0.956	0.958	0.948	0.933	0.892	0.929
LCT	Diesel	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014	0.044	0.042	0.052	0.067	0.108	0.071
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.265	0.327	0.484	0.615	0.676	0.674	0.736
SBus	Diesel	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.735	0.673	0.516	0.385	0.324	0.326	0.264
RT	Gas	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106	0.106	0.062	0.051	0.054	0.099	0.090	0.040
RT	Diesel	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894	0.894	0.938	0.949	0.946	0.901	0.910	0.960
SUShT	Gas	0.674	0.516	0.523	0.515	0.497	0.530	0.540	0.658	0.719	0.768	0.767	0.825	0.773	0.847	0.976
SUShT	Diesel	0.326	0.484	0.477	0.485	0.503	0.470	0.460	0.342	0.281	0.232	0.233	0.175	0.227	0.153	0.024
SULhT	Gas	0.674	0.516	0.523	0.515	0.497	0.530	0.540	0.658	0.719	0.768	0.767	0.825	0.773	0.847	0.976
SULhT	Diesel	0.326	0.484	0.477	0.485	0.503	0.470	0.460	0.342	0.281	0.232	0.233	0.175	0.227	0.153	0.024
MH	Gas	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.306	0.112	0.123	0.164	0.161	0.153	0.124	0.170	0.148	0.250	0.239	0.284	0.384	0.311	0.626
CShT	Diesel	0.694	0.888	0.877	0.836	0.839	0.847	0.876	0.830	0.852	0.750	0.761	0.716	0.616	0.689	0.374
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2017 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995
SUShT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SUShT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
SULhT	Gas	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268
SULhT	Diesel	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400
CShT	Gas	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055	0.077
CShT	Diesel	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945	0.923
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2017 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000	0.987
PC	Diesel	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000	0.013
PT	Gas	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996
PT	Diesel	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004
LCT	Gas	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986
LCT	Diesel	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.265
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.735
RT	Gas	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106	0.106
RT	Diesel	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894	0.894
SUShT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SUShT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
SULhT	Gas	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654
SULhT	Diesel	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346
MH	Gas	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144	0.114	0.157	0.163
CShT	Diesel	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856	0.886	0.843	0.837
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2018 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2018 Fuel Engine Fractions Summary - Continued

SUT	**Fuel Type**	**Model Year**														
		2002	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**	**1988**
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.996	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000
PC	Diesel	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000
PT	Gas	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997
PT	Diesel	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003
LCT	Gas	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952
LCT	Diesel	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750
RT	Gas	0.005	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106
RT	Diesel	0.995	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894
SUShT	Gas	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640
SUShT	Diesel	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360
SULhT	Gas	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640
SULhT	Diesel	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360
MH	Gas	0.600	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.400	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.077	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144	0.114	0.157
CShT	Diesel	0.923	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856	0.886	0.843
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2020 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

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[1] Conventional internal combustion engine technology only.

Texas Statewide 2020 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		2004	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**	**1991**	**1990**
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.997	0.996	0.996	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999
PC	Diesel	0.003	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001
PT	Gas	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989
PT	Diesel	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011
LCT	Gas	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984
LCT	Diesel	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876
RT	Gas	0.005	0.004	0.005	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204
RT	Diesel	0.995	0.996	0.995	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796
SUShT	Gas	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539
SUShT	Diesel	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461
SULhT	Gas	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539
SULhT	Diesel	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461
MH	Gas	0.570	0.590	0.600	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850
MH	Diesel	0.430	0.410	0.400	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150
CShT	Gas	0.052	0.055	0.077	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144
CShT	Diesel	0.948	0.945	0.923	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2021 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993
PC	Diesel	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007
PT	Gas	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975
PT	Diesel	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025
LCT	Gas	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938
LCT	Diesel	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003
RT	Diesel	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997
SUShT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238
SUShT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762
SULhT	Gas	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238
SULhT	Diesel	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460
CShT	Gas	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050
CShT	Diesel	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

Texas Statewide 2021 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991
MC	Gas	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PC	Gas	0.995	0.997	0.996	0.996	0.997	0.997	0.998	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997
PC	Diesel	0.005	0.003	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003
PT	Gas	0.979	0.982	0.982	0.983	0.989	0.992	0.981	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994
PT	Diesel	0.021	0.018	0.018	0.017	0.011	0.008	0.019	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006
LCT	Gas	0.946	0.951	0.951	0.956	0.908	0.949	0.929	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937
LCT	Diesel	0.054	0.049	0.049	0.044	0.092	0.051	0.071	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910
RT	Gas	0.003	0.005	0.004	0.005	0.006	0.002	0.169	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101
RT	Diesel	0.997	0.995	0.996	0.995	0.994	0.998	0.831	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899
SUShT	Gas	0.232	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465
SUShT	Diesel	0.768	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535
SULhT	Gas	0.232	0.245	0.260	0.268	0.311	0.350	0.348	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465
SULhT	Diesel	0.768	0.755	0.740	0.732	0.689	0.650	0.652	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535
MH	Gas	0.560	0.570	0.590	0.600	0.630	0.660	0.680	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850
MH	Diesel	0.440	0.430	0.410	0.400	0.370	0.340	0.320	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150
CShT	Gas	0.051	0.052	0.055	0.077	0.084	0.090	0.107	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161
CShT	Diesel	0.949	0.948	0.945	0.923	0.916	0.910	0.893	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

[1] Conventional internal combustion engine technology only.

APPENDIX H:
MOVES RUN SUMMARIES

Appendix H is in the form of a spreadsheet and was transmitted electronically (as “Appendix_H_hgbrfp18.xlsx”).