



Summary of Public Review Comments and Responses:
Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016

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U.S. Environmental Protection Agency
Office of Atmospheric Programs
Washington, D.C.

Responses to Comments Received during the Public Review Period on
the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016*

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Preface

EPA thanks all commenters for their interest and feedback on the annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. Per [Federal Register Notice 2018-02546](#) published on February 7, 2018 the Environmental Protection Agency (EPA) announced document availability and request for comments on the draft “Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016” report. The EPA requested recommendations for improving the overall quality of the inventory report to be finalized in April 2018 and submitted to the United Nations Framework Convention on Climate Change (UNFCCC), as well as subsequent inventory reports.

During the 30-day public comment period which ended March 9, 2018, EPA received 37 unique comments in response to the notice. This document provides EPA’s responses to technical comments on methods and data used in developing the annual greenhouse gas inventory. The verbatim text of each comment extracted from the original comment letters is included in this document, arranged by commenter. Full comments can be found in the public docket here: <https://www.regulations.gov/docket?D=EPA-HQ-OAR-2017-0729>. EPA’s responses to comments are provided immediately following each comment excerpt.

Commenter: Steven C. Beckham

Utah Department of Environmental Quality

Docket ID Number: EPA-HQ-OAR-2017-0729-0019

Comment: The Office of Air and Radiation is to be commended for its Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016. Please accept the following analysis as a comment in support of the Draft Inventory.

Response: EPA appreciates the commenter's support for the annual development of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016.

Commenter: Trakref

Ted Atwood

Docket ID Number: EPA-HQ-OAR-2017-0729-0037

Comment: The Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016 (hereby referred to as Inventory) does not include usage emissions from CFCs and HCFCs, even though these are two of the most prominent greenhouse gases (GHGs) with significant ozone-depleting potential (ODP) and global warming potential (GWP). Excluding them from the Inventory misrepresents our GHG emissions and means that we are without a clear view of the total GHG inventory. This is where the discrepancy with the refrigerant numbers in the Inventory originates. Thus, the following is argued: 1) the emissions from CFCs and HCFCs should be included in the Inventory and 2) fluorocarbon emissions (CFCs, HCFCs, and HFCs) are undercounted across the board, particularly when factoring in reclaim rates, equipment sales, and leak rates.

Response: As indicated by the commenter, EPA does not include emissions from CFCs and HCFCs in national GHG inventories (per UNFCCC reporting guidelines¹), as these gases are controlled under the *Montreal Protocol on Substances that Deplete the Ozone Layer*. Therefore, the United States does not include emissions from CFCs and HCFCs in Table 4-94 of the U.S. GHG Inventory. For informational purposes and completeness, emission estimates of CFCs and HCFCs are summarized in the Inventory in Table A-278 of Annex 6.2 Ozone Depleting Substance Emissions. EPA has included a footnote in the introductory paragraph of section 4.24 referencing the Annex to facilitate finding this information.

EPA strives to provide the best estimates and are willing to consider any new information—on CFCs, HCFCs, HFCs, or any other chemicals used—to improve our estimates.

Comment: To explain this further, I have included my comment that I submitted on last year's Inventory (i.e., Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015) at the bottom of this message. (While a few variables may have changed, the same underlying message from my comment submitted last year still holds true, which is why I have re-attached it.)

Response: Thank you for supplying a copy of your comment on last year's Inventory. You may find EPA's response at: https://www.epa.gov/sites/production/files/2018-02/documents/1990-2015_inventory_public_review_comment_response.pdf.

Comment: In short, the majority of fluorocarbon refrigerants are not properly destructed at the end of their lives and thus the majority of them end up vented into our atmosphere. More attention needs to be

¹ <https://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2>

given to the emissions from the consumption of refrigerants in the refrigeration and air-conditioning sector. For example, why does the Inventory spend so much time detailing HCFC-22 Production and the emissions of its byproduct, HFC-23, when the more important issue is the consumption of HCFC-22 in refrigeration and air-conditioning end-uses?

Further, how can we reduce and prevent the venting of millions of pounds of fluorocarbon refrigerants into our atmosphere when the Inventory overlooks the importance of emissions from HCFC-consumption?

Response: This inventory assumes all refrigerant consumption is eventually emitted, during either use or servicing, upon equipment disposal, or after accumulation and possible delayed release because of recovery and reclamation in various products and equipment. See Annex 3.9 Substitution of Ozone Depleting Substances of the Inventory report for more information about the assumptions and methodology for emissions estimation. This report provides a robust and accurate accounting for all emissions included, as required by the UNFCCC. The length of the text is as required to explain the methodology and results—it is not a reflection of the relative magnitude of emissions from any given source.

Further, U.S. regulations establishes several requirements that control the use and emissions of fluorocarbon refrigerants. See 40 CFR Part 82, Subpart F – Recycling and Emissions Reduction or visit <https://www.epa.gov/ozone-layer-protection> for more information.

Commenter: The Fertilizer Institute (TFI)

Andrew O'Hare

Docket ID Number: EPA-HQ-OAR-2017-0729-0031

Comment: [Draft Inventory Pages 4-24 to 4-25] TFI Supports How Carbon Dioxide Captured During Ammonia Production and Used to Produce Urea Is Treated in the Draft Inventory:

As noted in the Draft Inventory, emissions of carbon dioxide occur during the production of synthetic ammonia through the use of natural gas, petroleum coke, or naphtha as a feedstock. However, the Draft Inventory reporting protocol for ammonia production only accounts for carbon dioxide emissions to the atmosphere. As correctly observed by EPA in the Draft Inventory, “[t]he [carbon dioxide] that is captured during the ammonia production process and used to produce urea does not contribute to the [carbon dioxide] emission estimates for ammonia production presented in the [Draft Inventory].” Rather, carbon dioxide emissions from the manufacture of urea are accounted for either in the Urea Consumption for Non-Agricultural Purposes section or the Agriculture section of the Draft Inventory. TFI supports this accounting, since carbon dioxide is not emitted to the atmosphere from the ammonia source category when the carbon dioxide is captured and used to produce urea.

By Contrast, and As Previously Pointed Out By TFI to EPA, the MGGRP Skews Reported Carbon Dioxide Emissions From Ammonia Production By Requiring Ammonia Producers to Report Captured Carbon Dioxide Used in Urea Production As An “Emission” to the Atmosphere:

The MGGRP for ammonia manufacturing does not distinguish between carbon dioxide emitted during the manufacture of ammonia and carbon dioxide captured during ammonia production and used to produce urea. Rather, all carbon dioxide generated during ammonia production must be reported.⁶ The result is that this over-reporting of carbon dioxide unfairly prejudices ammonia producers by overestimating their greenhouse “footprint.” In addition, the reporting of carbon dioxide captured during ammonia production and used to manufacture urea is inconsistent with the statements in Subpart G regarding what carbon

dioxide emissions ammonia producers must report, namely: (1) process emissions from steam reforming of a hydrocarbon or the gasification of solid and liquid raw material; (2) emissions from each stationary fuel combustion unit; and (3) emissions collected and transferred off-site. Carbon dioxide bound in urea does not fit into any of these categories.

Additionally, the general policy of the MGGRP, as expressed in 40 C.F.R. § 98.1, is to gather greenhouse gas data from “certain facilities that directly emit GHGs” EPA’s stated intent, therefore, is to gather data on “direct emissions,” which from a common sense perspective, means releases to the atmosphere. The requirement to report carbon dioxide bound in urea, and not “emitted,” is thus inconsistent with EPA’s statements.

In part, as a result of EPA’s requirement to report carbon dioxide captured and used to produce urea, TFI filed a lawsuit against EPA when it promulgated the MGGRP. Ultimately, TFI and EPA agreed to a compromise to resolve the litigation when the Agency agreed to revise Subpart G to state that reported carbon dioxide emissions “may include [carbon dioxide] that is later consumed on site for urea production, and therefore is not released to the ambient air from the ammonia manufacturing process unit.” TFI appreciates the opportunity to provide comments on this Notice and the Draft Inventory, and the need to provide a consistent reporting scheme between the Draft Inventory and MGGRP. We look forward to subsequent dialogue with EPA regarding how to modify the MGGRP, Subpart G so that only carbon dioxide emissions to the atmosphere are reported.

Response: EPA appreciates the commenter’s support for the annual development of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016. Comments related to Subpart G have been forwarded to the EPA Greenhouse Gas Reporting Program (GHGRP) as they are out of scope for the Inventory. Any further feedback can be shared with EPA’s Greenhouse Gas Reporting Program at <https://www.epa.gov/ghgreporting/forms/contact-us-about-ghg-reporting>.

Commenter: National Association of Clean Water Agencies (NACWA)

Cynthia A. Finley

Docket ID Number: EPA-HQ-OAR-2017-0729-0039

Comment: NACWA has previously stated its concern that potentially outdated data were used in the emissions calculations, and this remains a concern with the current inventory. For example, the 1992, 1996, 2000, and 2004 Clean Watershed Needs Surveys (CWNS) are used as the basis for the percent of wastewater flow to aerobic and anaerobic systems, the percent of utilities that do and do not employ primary treatment, and the wastewater flow to POTWs that have anaerobic digesters. The 2004 CWNS is outdated, and forecasts made from it and the previous surveys likely do not accurately reflect recent trends and practices for wastewater utilities.

Response: EPA continues to search for and review updated sources of activity data for wastewater treatment system type to distinguish between aerobic, anaerobic, and aerobic systems with the potential to generate CH₄. Due to significant changes in format, CWNS data for 2008 and 2012 require additional evaluation to determine a methodology for incorporation into the Inventory. In addition, other data continue to be evaluated to update future years of the Inventory, including anaerobic digester data available at biogasdata.org. EPA will continue to monitor the status of these data as a potential source of digester, sludge, and biogas data from POTWs.

Comment: The wastewater flow of 100 gal/ person/ day was taken from a 2004 document published by the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental

Managers. Due to droughts and effective water conservation measures, other areas of the U.S. now have wastewater flows significantly less than this value.

Response: EPA continues to search for and review updated sources of activity data, including improved data on the amount of biogas generated in anaerobic digesters. EPA will continue to monitor the status of data available from biogasdata.org as a potential source of biogas generated from anaerobic digesters, which would obviate the need to use the estimated wastewater flow of 100 gal/person/day.

Comment: NACWA recommends that EPA consider updating the Metcalf and Eddy (2003) reference to the newest edition of this book.

Response: EPA will investigate using the most recent Metcalf and Eddy edition to update any remaining Metcalf and Eddy (2003) references.

Comment: The Association believes that the nitrogen loading rates for N₂O (effluent) are sources incorrectly and that using information from the existing National Pollution Discharge Elimination System database will yield more accurate and justifiable loading rates.

Response: EPA has considered the suggestion to estimate nitrogen effluent loads based on data reported under EPA's National Pollutant Discharge Elimination System (NPDES) Program. Unfortunately, very few POTWs are required to report their effluent nitrogen concentration or load, and those that do are typically required to meet more stringent limits than the average POTW. At this time, EPA is unable to confirm that these data would be representative of the entire industry. In addition, this would represent a departure from the IPCC accepted methodology, and would require substantiation that it results in a more robust estimation of these nitrous oxide emissions.

Comment: EPA should also investigate additional references for nitrogen loading rates. As EPA notes in the Inventory, the revisions to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories may incorporate newer scientific information, and the refinement of emissions factors used for wastewater treatment may help to resolve some of the issues with the methodology.

Response: EPA agrees that the potential refinements to the 2006 IPCC Guidelines will inform how the methodology may need to be revised. EPA continues to evaluate potential new data sources to update and improve the Inventory data as they become available, including improved activity data on wastewater treatment operations as well as nitrogen loading rates. Additional data sources will continue to be researched with the goal of reducing the uncertainty of the estimate of N entering municipal treatment systems, as well as the estimate of N discharged to receiving waters.

Commenter: Innovation Center for U.S. Dairy

Docket ID Number: EPA-HQ-OAR-2017-0729-0034

Comment: 1. Scope and boundary question

What is the definition of "manure management"? It would be very helpful to provide clear definition and boundary. In this section, land application of manure is not included, land application is included in soil

management sector which is aggregated from across species. Dairy farmers manage the whole set of procedures. Manure management means a set of processes, including manure collection, handling, treatment, storage and application. Farmers may go through all of them or in different order.

2. Alignment and consistency

Need greater alignment and consistency (standardization) between agencies, surveys, reports on waste management system (WMS) and regions (for ARMS, NASS, APHIS, and NRCS) For example: Table A-6 the description of WMS will need to be communicated well enough to farmers to ensure consistency and accuracy.

WMS calculation supplementary document Table 4, State Distribution Cow Regions, NRCS.

USDA farm production regions:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1048013.pdf

3. Report uncertainty, limitations and context (Statement about "EPA GHG inventory report is an abused report")

Report needs more robust section on uncertainty, limitations, could also provide context in how to use this report.

4. Communication and education comments:

Communicating the value of the survey and data gather efforts to farmers is extremely important for the farmers to care, understand the question fully, and answer accurately. Context: NASS workshop learning: ARMS survey takes 3-3.5 hours/farm, it is most difficult to answer.

5. Critical manure related GHG data that is very useful for livestock industry to calculate GHG emissions

More details could be included in Annex. Regarding to livestock manure related GHG emissions, it would be helpful to report manure management (treatment and storage) in chapter 5.2, and also the manure land application in with same level of details in chapter 5.4. Same level of details means report manure land application related GHG emission by state, by animal species, and by crops that receive manure. So that industry could use EPA GHG inventory report to inform their calculation, and make sure a consistent reporting.

6. What's the plan for improvement

a. Report needs more robust section on uncertainty, limitations, could also provide context in how to use this report.

b. Potential data sources (such as the USDA Agricultural Resource Management Survey) for updated WMS distribution estimates have been obtained and discussed with USDA. EPA is working with USDA to review these data sources for potential implementation in future Inventory reports. In addition, EPA may pursue the following improvements in future Inventory years:

I. Define manure management practices with more detailed descriptions, pay attention to farmer's term in different regions.

II. Give some explanation how the EPA inventory allocates to dairy and beef. Apparently, EPA inventory includes ALL animals that originate in a dairy farm are counted as "dairy" even if they end up in the beef supply chain.

- III. Implement a methodology to calculate monthly emissions estimates to present data that show seasonal changes in emissions from each WMS.
- IV. Revise the anaerobic digestion estimates to estimate CH₄ emissions reductions due to the use of anaerobic digesters (the Inventory currently estimates only emissions from anaerobic digestion systems)
- V. Update the B0 data used in the Inventory, which are dated
- VI. Compare CH₄ and N₂O emission estimates with estimates from other models and more recent studies and compare the results to the Inventory, such as USDA's Dairy Gas Emissions Model.
- VII. Compare manure management emission estimates with on-farm WMS measurement data to identify opportunities for improved estimates.
- VIII. Improve collaboration with the Enteric Fermentation source category estimates. For future inventories, it may be beneficial to have the CEFM and Manure Management calculations in the same model, as they rely on much of the same activity data and they depend on each other's outputs to properly calculation emissions.
- IX. Changes that have been implemented to the CH₄ and N₂O estimates warrant an assessment of the current uncertainty analysis; therefore, a revision of the quantitative uncertainty surrounding emission estimates from this source will be initiated.

c. What's the plan for using/enabling process-based models (mechanistic models) to improve the GHG inventory effort?

I. DACENT is used for crop/soil GHG emission calculation. The manure related GHG emission could also be enhanced by process-based model.

II. For example, NAEMS measurement data was collected, and can NAEMS data or other similar data be used to calibrate models and simulate manure storage, and land application and soil GHG emissions?

***Response:* EPA appreciates the commenter's recommendations on improvements to the Manure Management chapter of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016, and notes many recommendations are consistent with those already identified by EPA and listed in the draft inventory published for public review. The EPA has added clarity to the improvements listed within the Planned Improvements section of the Manure Management chapter of the current Inventory. EPA is currently reviewing many recommended data sources and improvements for potential implementation in future Inventory reports. Many of these improvements are major updates, including the recommended methodological changes, and may take multiple years to implement in full. Please see *Box 5-2: Biennial Inventory Compilation*, included in the current Inventory report, for more information on the timing of improvements to the Agriculture and LULUCF chapters. In the next Inventory report (i.e., 1990 through 2017), EPA will add clarity to the scope, boundary and methods used for the Manure Management chapter.**

Commenter: Frances Lamberts

Private Citizen

Docket ID Number: EPA-HQ-OAR-2017-0729-0033

Comment: I am glad to see the United States adhering to the commitment made under an earlier Administration, at the Rio Earth Summit treaty, to perform and submit to the United Nations an inventory of our greenhouse gas emissions. Thus, I thank you for publishing the inventory draft.

Taking note that emissions increased in the 2013-14 time span, I see them to have come down from 2015 levels, over the year 2016. That is a positive development which, through further gains in energy efficiency and electricity production from renewable sources, I hope you will promote and strongly support in the years ahead. Our country should accelerate these latter strategies -- energy conservation/ efficiency and renewable sources as much and as quickly as possible, both to

counteract the climate troubles we are under as also to save significantly on healthcare costs and avoid many lives prematurely cut short through carbon and related air pollutions.

Response: EPA appreciates the commenter’s support for the annual development of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016.

Commenter: Bridget Chadwick

Private Citizen

Docket ID number: EPA-HQ-OAR-2017-0729-0038

Comment: “...substitution from coal to natural gas and other sources in the electric power sector” (page ES-2)

Please clarify what “other sources” are by describing as either “non-fossil fuel energy” or “nuclear and renewable energy”.

Response: EPA has clarified the text to indicate other non-fossil energy sources on page ES-4 in Section ES-2.

Comment: Since the Industrial Revolution ...global atmospheric concentrations of CO₂ have risen...principally due to the combustion of fossil fuels (page ES-9)" I would add “for energy” to the end of the sentence to differentiate “the combustion of fossil fuels” from the non-energy use of fossil fuels discussed in section 3.2 of the Inventory.

Response: EPA has clarified the text to indicate for energy on pages ES-9&10.

Comment: A drop in the carbon intensity of energy consumed “by most sectors of the economy” (page ES-10) Comment: To be more specific, from 2005 to 2016, the carbon intensity of energy consumed by the power sector declined by 21%. Likewise, the carbon intensity of energy consumed by non-transport sectors (residential, commercial, and industrial) that consume significant amounts of electricity declined by 16%, 15% and 14%, respectively.

Response: EPA has clarified the text to indicate carbon intensity decreased in non-transport sectors on page ES-10.

Comment: “The fundamental factors influencing emissions levels include: (1) changes in demand for energy; and (2) a general decline in the carbon intensity of fuels combusted for energy” (page ES-10)

Comment: “Direct drivers” would be a more accurate description than “fundamental factors.”

Response: EPA has clarified the text on fundamental factors to important drivers on page ES-10.

Comment: Emissions from fossil fuel combustion (page ES-11)

Comment: Adding bar graphs for total energy consumption (from fossil and non-fossil sources) used by (i) the power sector and end-use sectors; and (ii) all end-use sectors with electricity allocated to each, would provide a more complete picture of energy-related CO₂ emissions. These graphs would tie in with the information provided in Figure ES-13: 2016 US Energy Consumption by Energy Source (Percent).

Response: Given timing of report these changes were not implemented for this year but can be considered as part of the next Inventory report. However, EPA notes that there are several figures

that already capture much of this information including for the power sector: **Figure ES-8: Electric Power Generation (Billion kWh) and Emissions (MMT CO₂ Eq.)** and **Figure 3 8: Fuels Used in Electric Power Generation (TBtu) and Total Electric Power Sector CO₂ Emissions**. For the residential and commercial sectors: **Figure 3 11: Fuels Used in Residential and Commercial Sectors (TBtu), Heating Degree Days, and Total Sector CO₂ Emissions**. For the transportation sector: **Figure 3 12: Fuels Used in Transportation Sector (TBtu), Onroad VMT, and Total Sector CO₂ Emissions**.

Comment: “The type of energy source used to generate electricity is the main factor influencing emissions” (pages ES 12 to 13).

More detail would make this point clearer. The carbon content and amount of fossil fuel energy sources with the following: utility coal, with an average CO₂ emission factor of 95.5 MMT CO₂ per quadrillion Btu and natural gas with a CO₂ emission factor of 53.0 MMT CO₂ produced about 69% and 30% of the power sector CO₂ emissions, respectively. Readers could be referred to Figure ES-6.

Response: A reference was made to **Figure ES-8 for trends in energy sources used to generate electricity and impact on CO₂ emissions on page ES-13**.

Comment: “For example, some electricity is generated through non-fossil fuel options such as nuclear, hydroelectric, wind, solar, or geothermal energy” (page ES-13)

Comment: Electricity generated from non-fossil fuel energy is quite significant (in 2016). I would suggest replacing the words: “some electricity” with some detail on the numbers. For example, in 2016, nuclear and renewable energy sources provided 1,382,566 million kWh of electricity, 35% of total electricity generated, 3,918,231 million kWh (EIA’s Feb 2018 Monthly Energy Review (MER), Table 7.2b, Electricity Net Generation: Electric Power Sector). Note that the EIA defines the power sector as: “electricity-only and combined-heat-and power (CHP) plants within the NAICS 22 category whose primary business is to sell electricity, or electricity and heat, to the public” (EIA, 2018).

Response: A reference was made to **Figure ES-8 for trends in energy sources used to generate electricity and impact on CO₂ emissions on page ES-13**.

Comment: Box ES-5: Recent Trends in Various U.S. Greenhouse Gas Emissions-Related Data (page ES-26)

Comment: Carbon intensity of total energy and energy consumption are the two main direct drivers of energy-related CO₂ emissions. Carbon intensity should be added to the list of variables, under “Energy Use” and the carbon intensity trend line should be presented in Figure ES-6: U.S. Greenhouse Gas Emissions Per Capita and Per Dollar of Gross Domestic Product (GDP).

Response: Given timing of report these changes were not implemented for this year but can be considered as part of the next Inventory report. Furthermore, EPA notes that the text already has some discussion of this driver: “Greenhouse gas emissions in the United States have decreased at an average annual rate of 1.0 percent since 2005. Total energy use and fossil fuel consumption have also decreased at slower rates than emissions since 2005” indicating a decrease in carbon intensity of total energy and fossil fuel consumption.

Commenter: American Petroleum Institute (API)

Karin Ritter

Docket ID Number: EPA-HQ-OAR-2017-0729-0035

Comment: First, EPA should incorporate a regional approach for key sources that will take into account the lack of uniformity of the industry across the country and provide a more accurate representation of industry activity and current practices. Second, EPA should also review their emission factors annually to account for changing industry practices and technological improvements, such as for well completions and workovers with hydraulic fracturing. Finally, in the interest of transparency, whenever EPA includes significant methodological changes, such as those being considered at this time, the agency should make a rigorous effort to specifically and clearly clarify and describe these methodological changes and their impact on emissions from year to year in 'plain English'.

Response: EPA received information and data related to the emission estimates through GHGRP reporting, the annual Inventory formal public notice periods, stakeholder feedback on updates under consideration, and new studies. EPA held several workshops and webinars on oil and gas in the Inventory and in June and October 2017, EPA released draft memoranda that discussed changes under consideration, and requested stakeholder feedback on those changes. EPA thoroughly evaluated relevant information available, and made several updates to the Inventory, including: to define an exploration segment separate from production (not a methodological change, but a change in presentation of information); calculate activity and emission factors for well testing and non-hydraulically fractured completions from GHGRP data; using GHGRP data to calculate year-specific emission factors for hydraulically fractured gas well completions and workovers and liquids unloading; recalculate production segment major equipment activity factors using updated GHGRP data; revising activity and CH₄ and CO₂ emissions data for associated gas venting and flaring and miscellaneous production flaring; and calculate new CO₂ emission factors for several sources throughout all segments directly from GHGRP data.

EPA assessed basin-level data and used a basin level production-based approach for miscellaneous production flaring and associated gas venting and flaring, and has retained the national level approach for liquids unloading. EPA assessed annual emissions data and made changes to use year specific emission factors for liquids unloading and hydraulically fractured gas well completions. For details on these specific changes, see pages 3-72 to 3-73 and 3-87 to 3-91. EPA provided additional documentation on recalculations in this year's inventory (for petroleum systems, see bulleted list on page 3-63, and tables on pages 3-69 to 3-70 and for natural gas systems see bulleted list on pages 3-77 to 3-87, and tables on page 3-85).

Comment: API encouraged EPA to adopt a basin level estimation approach, on either a production or well count basis, to account for regional operating differences and provide a more accurate representation of industry practices. In the Public Review version of the inventory, EPA has incorporated the basin-level approach on a well basis for associated gas venting and flaring and indicates that they are evaluating other changes, such as the production basis recommended by API, for the final inventory. However, by not providing in the draft GHGI a full accounting on how they intend to implement the revisions recommended by API, it is currently impossible to review and confirm these calculations or the potential results that will be published in the final GHGI.

Response: As noted above, EPA held a stakeholder process on updates under consideration for the 2018 GHG Inventory, and EPA has made changes to use a basin-level, production-based approach for associated gas venting and flaring. Where possible, EPA provided stakeholders with

preliminary estimates of emissions calculated using various approaches. At the time of the release of the public review draft, EPA had not yet fully assessed the production-based approach for associated gas venting and flaring and did not include detailed information in the public review draft, as it was unavailable at that time. The 2018 final inventory includes detailed discussion and annual emissions and activity data for these revisions, and final memos on updates implemented in the 2018 GHG Inventory are available on EPA's 2018 stakeholder process website, at <https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems-ghg-inventory-additional-information-1990-2016-ghg>.

Comment: API also recommends that 'plain English' descriptions of methodology changes and clarifications of their impact on emission calculations from year-to-year should be placed right upfront in the inventory report where EPA discusses the emission estimates for all the economic sectors. For example EPA should consider including language as follows:

The change(increase) in CO₂ emissions for the Natural Gas Systems and Petroleum Systems are due to implementing the following EPA methodological changes:

- 1) Added flaring emissions that were previously reported only under Natural Gas production.
- 2) Added emissions from flaring for petroleum production, natural gas processing, transmission, storage and LNG operations that were not previously reported in the inventory.
- 3) Revised CO₂ emission estimation methods for associated gas venting and flaring, oil and condensate tanks, gas well hydraulically fractured completions and workovers, pneumatic controllers, pneumatic pumps, and liquids unloading in the Natural Gas and Petroleum production segments to align with the approach applied for CH₄ emission estimates.
- 4) Added CO₂ emissions for gas processing plant emission sources (emissions from reciprocating compressors, centrifugal compressors, dehydrators, flares, and fugitives were grouped together), blowdowns, and Acid Gas Removal (AGR) units using GHGRP data.
- 5) Modified transmission GHGRP data.

Response: EPA has provided additional documentation on recalculations in the GHG Inventory. See new Box ES-3 (pages ES-5 and ES-6) in the 2018 GHG Inventory which lists all GHG Inventory sources with recalculations resulting in an average change over the time series of greater than 10 MMT CO₂ Eq., and page 3-2 which provides information on energy sector sources with recalculations resulting in an average change over the time series of greater than 10 MMT CO₂ Eq. In addition, for more detailed information on recalculations for petroleum systems, see bulleted list on page 3-63, and tables on pages 3-69 to 3-70 and for natural gas systems see bulleted list on pages 3-77 to 3-87, and tables on page 3-85.

Comment: In general, EPA has improved the transparency of the national inventory by engaging with stakeholders and convening workshops to discuss their planned updates throughout the year. API supports the transparency enabled by Annex 3 Tables 3.5 and 3.6 which provide access to the emission factors, activity data, and resulting CH₄ and CO₂ emissions for every source across the full time series (1990-2016).

Response: EPA has noted this comment.

Comment: API has requested that whenever EPA includes significant methodological changes, such as those being considered at this time, the agency should specifically identify and describe these methodological changes from year to year together with the results for each sector. Currently, all emission estimation revisions are addressed under the Recalculations Discussion for each source category and under Section 9, the overall Recalculations and Improvements discussion. For tables summarizing emission estimates for a few sources, EPA has added a line that provides the previous emission estimate for that source (i.e. the emission estimate from the 2017 GHGI), as

EPA has done in Tables 3-43 through 3-48 and Tables 3-64 through 4-69. API recommends including this comparison in tables for all emission sources and compiled emission data that incorporate methodological changes.

Response: EPA has provided additional documentation on recalculations in the GHG Inventory. See new Box ES-3 (pages ES-5 and ES-6) in the 2018 GHG Inventory which lists all GHG Inventory sources with recalculations resulting in an average change over the time series of greater than 10 MMT CO₂ Eq., and page 3-2 which provides information on energy sector sources with recalculations resulting in an average change over the time series of greater than 10 MMT CO₂ Eq. In addition, for more detailed information on recalculations for petroleum systems, see bulleted list on page 3-63, and tables on pages 3-69 to 3-70 and for natural gas systems see bulleted list on pages 3-77 to 3-87, and tables on page 3-85.

Comment: In addition, an overall summary table should be provided at the beginning of each source category section to show the impact of changes from the previous inventory report. Abbreviated example tables are provided below for Petroleum Systems and Natural Gas Systems. The suggested tables should provide the previous inventory emissions, the current inventory emissions for the previous year (2015 in this case), and the current inventory emissions for the current year.

Response: Please see previous comment response.

Comment: API reiterates that the EPA should carefully analyze and screen GHGRP reported data in order to improve the validity of data used in the national GHGI. Significant improvements have been made in the GHGRP reported gas production volumes. In 2015, the total GHGRP gas production volume was more than 14 times larger than the national gas production volume from the DrillingInfo database. For 2016, the total GHGRP reported gas production volume is 87% of the DrillingInfo gas production volume. However, further work is still needed. For 2016, the total GHGRP oil production volume is just slightly higher (104%) than the total oil production volume derived from DrillingInfo, and there are still individual basins with GHGRP reported gas and crude production volumes that are multiple times higher than volumes from the DrillingInfo database. EPA needs to be diligent in reviewing GHGRP data and working with reporting companies to correct erroneous information.

Response: The EPA has a multi-step data verification process for GHGRP data, including automatic checks during data-entry, statistical analyses on completed reports, and staff review of the reported data. Based on the results of the verification process, the EPA follows up with facilities to resolve mistakes that may have occurred.

Comment: In addition, as EPA is evaluating data available from new studies, it is important to understand the applicability of these studies for a national inventory, especially as they relate to temporal and spatial representativeness concerns. API reiterates the need to vet data from new studies through a multi-stakeholder group prior to using their results for updating the GHGI. API encourages EPA to continue with ongoing stakeholder engagement throughout 2018.

Response: EPA plans to continue engaging with stakeholders on updates to the GHG inventory.

Comment: EPA has made significant changes in the estimation methods for associated gas venting and flaring emissions starting with the 2017 GHG Inventory compared to previous years in which they addressed associated gas emissions only from stripper wells. API indicated in comments on

the draft 2017 GHGI that this is an area requiring further review since data are now available through the GHGRP. Also, operational practices that result in either venting or flaring are linked to the availability of appropriate infrastructure to capture and use associated gas, rather than vent or flare it, and as a result are highly variable according to regional differences. This is a dynamic situation that varies from year to year and from region to region, and requires further analysis of the information available through the GHGRP.

Response: As noted above, EPA has implemented a basin-level approach to calculate these emissions, with year-specific data when available.

Comment: API provided a memo to EPA in October 2017 presenting API's basin-level analysis of the 2015 GHGRP data for associated gas venting and flaring under both a well count and a production volume basis. API recommends that EPA apply a basin level approach and use the volume of oil produced to extrapolate GHGRP data for associated gas venting and flaring emissions for the national GHGI. Emissions from associated gas occur due to CO₂ produced by flaring of gases separated from the production liquids, or venting of CH₄ and CO₂ entrained in the produced hydrocarbon liquids (commonly termed gas-to-oil ratio). Therefore, emissions are directly related to the volume of hydrocarbon liquids produced with associated gas venting and flaring rather than to the number of wells with associated gas venting and flaring.

Response: As noted above, EPA has implemented a basin-level, production-based approach to calculate these emissions.

Comment: EPA has adopted the basin level recommendation in the emission estimates provided in the Public Review draft inventory. However, the emissions data are currently extrapolated on a well count basis, which is not directly linked to associated gas emissions. EPA notes that it is evaluating a production-based approach for the final version of the inventory. For associated gas venting and flaring emissions in the final inventory, EPA should incorporate production-based emission estimates applied at the basin level.

Response: As noted above, EPA has implemented a basin-level, production-based approach to calculate these emissions.

Comment: EPA has developed new estimates for CO₂ and CH₄ emissions from miscellaneous production flaring using 2015 and 2016 GHGRP data. API provided a memo to EPA in October 2017, presenting API's analysis of the 2015 GHGRP data for flare stack emissions in petroleum and natural gas production. API recommends that EPA use production volumes to apportion flare emissions between Petroleum and Natural Gas Systems and to extrapolate the flare stack emissions to a national level. API contends that this approach is more robust than using well counts and is consistent with API's recommendation for extrapolating associated gas venting and flaring emissions. This is also an emission source that changes from year to year based on operating practices, and therefore emissions should be estimated annually using the most recent data. In the Draft GHGI, emissions data are currently extrapolated on a well basis at the national level, without a basin-level analysis. EPA notes that it is evaluating a production-based approach and developing emission factors at a basin-level. API recommends developing miscellaneous flare emission estimates using a basin level approach and scaling the GHGRP data to the national level based on production volume.

Table 2 compares API's estimate of national GHG emissions from Flare Stacks to EPA's estimate provided in the Public Review inventory.

Response: As noted above, EPA has implemented a basin-level, production-based approach, with year-specific data when available to calculate these emissions.

Comment: EPA's Methodology discussion for Petroleum Systems indicates that emission factors for hydraulically fractured (HF) oil well completions (controlled and uncontrolled) were developed using DrillingInfo data analyzed for the 2015 NSPS OOOOa proposal. EPA has indicated in the Planned Improvements section that they will review GHGRP data for oil well completions and workovers with hydraulic fracturing. API supports this planned improvement. This will provide consistency with the emission factors currently used in the GHGI for gas well completions and workovers with hydraulic fracturing. API also recommends that the emission factors for this source category be updated annually to reflect changes in operational practices. We recognize that these updates will not be incorporated in the final inventory. API looks forward to future dialog with EPA in preparation of the 2019 inventory.

Response: EPA is considering this update for the 2019 GHG Inventory. For additional information, please see https://www.epa.gov/sites/production/files/2018-04/documents/ghgemissions_additional_revisions_2018.pdf.

Comment: EPA has developed new emission factors for gas well completions and workovers without hydraulic fracturing using GHGRP data. GHGRP specifies a default emission factor of 3,114 standard cubic feet natural gas per well workover without hydraulic fracturing; while the emission factors used in the GHGI differ each year for 2011 through 2016. API assumes this variability in the emission factor is based on different gas compositions and fractions of completions and workovers that are flared versus vented. API intends to review the emissions data more carefully and provide comments at a later time. We look forward to future dialog with EPA in preparation for the 2019 inventory.

Response: The variability is based on different gas compositions and different fractions of venting and flaring.

Comment: API provided a memo to EPA in October 2017 presenting API's analysis of the 2015 GHGRP data for gas well completions and workovers with hydraulic fracturing. In that memo, API pointed out that the most significant driver for the difference between EPA's emission estimates and API's estimates is that EPA's emission factors continue to be based on an average of GHGRP data from 2011-2013. API demonstrated that applying the average from these three years clearly overestimates emissions for 2014 and 2015. In addition, EPA includes all GHGRP reported data from 2011-2013, which is comprised of completions in both gas and oil formations, prior to the requirement for separate reporting of emissions from oil completions with hydraulic fracturing.

API recommends developing separate emission factors specific to completions and workovers with hydraulic fracturing for oil formations and gas formations. API also recommends that the emission factors for this source category should be updated annually. Such an approach will reflect current, dynamic trends in completion and workover practices with hydraulic fracturing, mainly due to regulations that now require the use of reduced emission completions (RECs). EPA indicates that they are considering year-specific GHGRP-based emission factors for this source.

For completions and workovers with hydraulic fracturing, API recommends developing separate emission estimates for oil well versus gas well completions. These emission factors should be updated annually with current GHGRP data to reflect changing industry

practices.

Response: As noted above, EPA calculated HF gas completion emissions using an annual emission factor approach. EPA plans to assess HF oil completions data for updates to the 2019 GHG inventory. For additional information, please see https://www.epa.gov/sites/production/files/2018-04/documents/ghgemissions_year_specific_2018.pdf and https://www.epa.gov/sites/production/files/2018-04/documents/ghgemissions_additional_revisions_2018.pdf

Comment: Liquids unloading operations are not conducted uniformly across the natural gas production regions of the U.S. and have changed dramatically over the years GHG reporting has been required for natural gas production operations. API provided a memo to EPA in October 2017 presenting API's analysis of the 2015 GHGRP data for liquids unloading and recommended extrapolating emissions from liquids unloading at the basin level for those basins with the most significant contribution to emissions. API recommends that these emission estimates be performed on a well count basis since emissions from liquids unloading are related to the number of liquid unloading events and are not directly or inversely related to gas production rate. In addition, due to changes in liquids unloading operations over time, API recommends that the emissions be evaluated each year. EPA's current emission factors are based on an average of the 2011-2015 GHGRP data which biases the emission estimates high for 2014 and 2015. EPA indicates that they are considering region-specific emission factors and activity factors for this source.

API reiterates our recommendations that emissions associated with liquids unloading be evaluated on a well-count basis at a basin level and updated each year in order to reflect geographic variability and changes in venting practices associated with liquids unloading rather than using averaged historical data.

Table 3 compares API's emissions (using a basin-specific approach applied annually) to EPA's emissions which are based on an average of the 2011-2015 GHGRP data.

Response: As noted above, EPA has calculated these emissions using an annual emission factor approach. EPA assessed these emissions at the basin level and found them to be similar to emissions calculated at the national level (e.g. within about 5%) and has retained the national level approach.

Comment: Equipment Counts: EPA notes that activity factors were recalculated using the latest GHGRP reporting year (RY) "2015 data" (ENERGY page 3-87, line 31). Since RY 2016 GHGRP data are now available, API requests that the latest GHGRP data be used to establish equipment counts. Or, if this is a misprint, API requests correcting the reporting year cited in the final inventory report. API requests clarification of what year is used for developing equipment counts.

Response: EPA clarified that the method uses the resubmitted GHGRP 2015 equipment count data for these sources. Those equipment counts are applied to years 2011-forward, while earlier years use GRI equipment counts and interpolation. For more information on this approach and other options considered, please see pages 2-3 of the memo "Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2016: Additional Revisions Considered for 2018 and Future GHGIs," available at https://www.epa.gov/sites/production/files/2018-04/documents/ghgemissions_additional_revisions_2018.pdf.

Comment: EPA developed emission factors for abandoned wells using data from Kang et al. (2016) and

Townsend-Small et al. (2016). API notes that the studies conducted so far have limited geographical coverage, with the University of Cincinnati study having the broadest coverage with 138 abandoned wells in four basins, where a total of 9 wells have been identified as leaking CH₄. To date no data are available from the state of Texas or many other major producing areas, which makes it unrealistic and unrepresentative to extrapolate the results of the current studies to a nationwide estimate of the contribution of CH₄ emissions from Abandoned Wells in the GHGI. API contends that this is an area that requires further study as it is well recognized that many attributes can influence leakage from abandoned wells, including depth, plugging status, well type (oil or gas), geographic location, and abandonment method. Therefore, determining a robust estimate for a national count of abandoned wells throughout the time-series will be challenging. API cautions EPA that current studies have focused on very old wells and the data obtained are limited in scope, limited geographically, and should not be extrapolated broadly.

***Response:* EPA assessed data and methodologies for abandoned well emissions and engaged with stakeholders on this emission source throughout the development of the 2018 GHG Inventory. Taking stakeholder feedback into account (including feedback on approaches for using regional data, approaches for calculating the population of older abandoned wells, and approaches for calculating the fraction of wells that are plugged), EPA has incorporated an estimate for abandoned wells into the 2018 GHG Inventory and has calculated an uncertainty range associated with that estimate of -83% to +215%. EPA will continue to look for new data on abandoned wells and make revisions to the sources in future GHG inventories as appropriate. See pages 3-96 to 3-100.**

Comment: EPA continues to evaluate emission sources that currently use voluntary reduction data to identify where an emission source's calculation methodology could be updated to calculate net emissions. EPA notes two areas of corrections in the Public Review draft inventory. In the Production segment, a spreadsheet error resulted in a miscalculation of the scaling factor for the "other reductions". In the Transmission and Storage segment, Gas STAR reductions were not removed for data where the emissions are recalculated using a net emission approach. API agrees that many emission sources in the GHGI are now calculated using net emissions approaches, with technology-specific activity data and emission factors, and annual data from the GHGRP. For these emission sources it may not be necessary to adjust for Natural Gas Star reductions, which may result in double-counting of reductions. Removing the Natural Gas Star reductions from these sources would improve transparency of the results and methods by relying on direct net emission calculations. However, where applicable, EPA should continue to apply the Natural Gas Star reductions for those specific sources for which only potential emission data is available.

***Response:* EPA has removed Gas STAR reductions that were incorrectly applied to net emissions sources.**

Comment: Page 3-67, lines 7-9. API suggests the following insert:
Petroleum systems includes emission estimates for activities occurring in petroleum systems from the oil wellhead through crude oil refining, including activities for crude oil exploration, production field operations, crude oil transportation activities, and refining operations.

***Response:* EPA has incorporated the suggested edit, on page 3-65.**

Commenter: Waste Management et al.
Kerry Kelly

Docket ID Number: EPA-HQ-OAR-2017-0729-0032

Comment: We are pleased that in response to the analysis, the 2018 Inventory employs a lower scale-up factor of nine percent as compared to the use of 12.5 percent in the previous year's inventory. Nonetheless, the analysis conducted for the Agency warrants an even lower scale-up factor of five percent as we recommended.

As part of the expert review of the draft 2018 Inventory, the landfill sector recommended that EPA recalculate the scale-up factor using Option (a) and an adjusted WIP amount that was at least 60 percent lower than the amount assumed in the Agency's previous calculation. This reflected the findings that over 60% of assumed waste-in-place was in error due to problems with the EPA database. EPA's assessment of non-reporting MSW landfills shows that the GHGRP captures most emissions from the MSW landfills and a scale-up factor of no greater than five percent would be far more appropriate for use in the Inventory.

Response: EPA appreciates the commenter's feedback supporting planned improvements for estimating emissions from landfill in Chapter 7 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016. EPA also appreciates the effort undertaken by the landfill industry to review the list of landfills that do not report to the GHGRP and the attempt to remove reporting landfills and duplicates, as well as fill in missing waste-in-place and open/closure year data where available. Based on further review within EPA and industry input, EPA has revised the scale-up factor used in the emissions estimations for 2004-2016 in the time series from 12.5% to 9%. Please refer to the Recalculations Discussion in Section 7.1 of the Inventory text as well as the supporting [memo](#) "Methodological refinements as applied in the 1990-2016 estimates of U.S. greenhouse gas emissions from MSW landfills to account for emissions from facilities not reporting to the Greenhouse Gas Reporting Program" from Kate Bronstein and Meaghan McGrath of RTI International to Rachel Schmeltz of EPA/CCD, April 4, 2018 for more detail on the steps taken to refine the scale-up factor and additional steps that may be taken in the future to further refine the scale-up factor as appropriate.²

Comment: The landfill sector is pleased that EPA is considering revisions to the value of the oxidation factor used for the earlier time series. During the Agency's expert review process on the draft 2018 inventory in late 2017, EPA posed several questions about the inclusion of two oxidation factors: one for waste disposed at facilities with landfill gas collection and control systems (GCCS), and the other for landfills without GCCS. EPA acknowledged that the Agency has not developed a way of assigning a percentage of waste disposed in landfills with gas collection or without for those years. The landfill sector provided comments in opposition to establishing methane oxidation factors based predominantly on the presence or absence of gas collection systems. Nonetheless, EPA notes in Chapter 7 that it is investigating trends in landfill gas collection and control and other factors to evaluate applying differing oxidation factors, and we find this troubling as the Agency lacks the data and a peer-reviewed method for doing so.

Response: EPA appreciates commenter's feedback on the oxidation factor as applied to estimating emissions from MSW landfills in Chapter 7 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016 and that the existence of a GCCS is not the sole factor in estimating the amount of methane oxidation. As stated in the Planned Improvement section of Section 7.1 of the Inventory, EPA is continuing to investigate options to adjust the oxidation factor from the 10 percent currently

² https://www.epa.gov/sites/production/files/2018-04/documents/rti_2018_scaleupfactor_memo_final_4-4-18.pdf

used for 1990 to 2004 to another value or approach such as the binned approach used in the GHGRP (e.g., 10 percent, 25 percent, or 35 percent based on methane flux). The oxidation factor currently applied in the later portion of the time series (2005 to 2016) averages at 19.5 percent due to the use of the GHGRP data while the earlier portion of the time series applies the default of 10 percent.

Comment: Regarding the oxidation questions posed during the expert review:

1) Are there available data sources to address trends in installation of landfill gas collection systems?

The landfill sector is not aware of sources that would provide information on the extent of landfill gas collection within the industry or the trends in gas system installation outside of the reporting landfills in the GHGRP. The EPA LMOP dataset only indicates whether a landfill has a gas collection system, but does not note the date of installation or expansion.

Response: EPA appreciates commenter's feedback and takes note that the commenter is not aware of any data sources to address trends in installation of landfill gas collection system. As stated in the Planned Improvement section of Section 7.1 of the Inventory, EPA is continuing to investigate options to adjust the oxidation factor from the 10 percent currently used for 1990 to 2004 to another value or approach such as the binned approach used in the GHGRP (e.g., 10 percent, 25 percent, or 35 percent based on methane flux). The oxidation factor currently applied in the later portion of the time series (2005 to 2016) averages at 19.5 percent due to the use of the GHGRP data while the earlier portion of the time series applies the default of 10 percent.

Comment: 2) Is it appropriate to assign oxidation factors for landfills with and without landfill gas collection systems?

The landfill sector does not think that it is appropriate to assign oxidation factors to a landfill based solely on whether it operates a GCCS. As explained above, other site-specific landfill attributes, such as WIP, type and extent of cover and modeled methane generation are also important factors in assessing potential methane oxidation. Developing an accurate estimate of methane oxidation is significantly more complicated than relying on whether the landfill has a gas collection system.

Response: EPA appreciates commenter's feedback on the oxidation factor as applied to estimating emissions from MSW landfills in Chapter 7 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016 and that the existence of a GCCS is not the sole factor in estimating the amount of methane oxidation. As stated in the Planned Improvement section of Section 7.1 of the Inventory, EPA is continuing to investigate options to adjust the oxidation factor from the 10 percent currently used for 1990 to 2004 to another value or approach such as the binned approach used in the GHGRP (e.g., 10 percent, 25 percent, or 35 percent based on methane flux). The oxidation factor currently applied in the later portion of the time series (2005 to 2016) averages at 19.5 percent due to the use of the GHGRP data while the earlier portion of the time series applies the default of 10 percent.

Comment: 3) What is an appropriate oxidation factor if only one factor is used for all waste disposed between 1990 and 2004?

The existing Subpart HH treatment of methane oxidation requires knowledge of landfill attributes to calculate methane flux and assess the corresponding methane oxidation value based on the bin approach. The bin approach is a conservative estimate based on 800 field estimates of oxidation for a range of methane flux results, as provided in the SWICS addendum and RTI memo. It is our view that EPA

should use the flux-based oxidation factor, as it could be applied more broadly than the current application in Subpart HH and is the most defensible approach.

Response: EPA appreciates commenter's feedback on the oxidation factor as applied to estimating emissions from MSW landfills in Chapter 7 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016. As stated in the Planned Improvement section of Section 7.1 of the Inventory, EPA is continuing to investigate options to adjust the oxidation factor from the 10 percent currently used for 1990 to 2004 to another value or approach such as the binned approach used in the GHGRP (e.g., 10 percent, 25 percent, or 35 percent based on methane flux). The oxidation factor currently applied in the later portion of the time series (2005 to 2016) averages at 19.5 percent due to the use of the GHGRP data while the earlier portion of the time series applies the default of 10 percent.

Comment: 4) Should a factor be applied to address methane leakage from cracks and fissures in landfill cover when assigning oxidation rates?

We do not understand how the Agency could know or even estimate the extent of cracks and fissures at landfills on a site-specific basis or more broadly on a nationwide, inventory basis. Furthermore, there is no proven or accepted method to determine leakage from cracks and fissures. The reason is that the flux through the cover (and the fraction oxidized) is dependent upon the interactions among many factors, including soil and physical properties of cover such as gas porosity; organic content and moisture; microbiological factors such as temperature and substrate availability; and the presence or absence of a gas collection system. In a 2011 paper in Environmental Science & Technology, researchers looked at the surface air methane ^{13}C value at 20 landfills and found that the oxidation percentage was 36%, as compared to an oxidation rate of 37% measured in surface chambers. Based on this result, methane emitted via cracks and fissures did not appear to be a significant factor, and the presence of cracks and fissures did not necessarily result in higher emissions or lower oxidation.

The landfill sector does not support the development of additional leakage factors for landfills because leakage is already reflected in the calculated flux rates. The higher the flux rate the lower the oxidation rate. We think it is neither valid, nor reasonable to develop leakage factors beyond the GHGRP flux rate calculations for determining an appropriate methane oxidation rate, without extensive scientific support.

Response: EPA notes commenter's feedback on developing an additional leakage factor when assigning oxidation rates as applied to estimating emissions from MSW landfills in Chapter 7 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016. As stated in the Planned Improvement section of Section 7.1 of the Inventory, EPA is continuing to investigate options to adjust the oxidation factor from the 10 percent currently used for 1990 to 2004 to another value or approach such as the binned approach used in the GHGRP (e.g., 10 percent, 25 percent, or 35 percent based on methane flux). The oxidation factor currently applied in the later portion of the time series (2005 to 2016) averages at 19.5 percent due to the use of the GHGRP data while the earlier portion of the time series applies the default of 10 percent.

Comment: Degradable Organic Carbon (DOC)

Chapter 7 explains that EPA uses one DOC value of 0.20 to calculate emissions for the years 1990 through 2004 and uses emissions reported through the GHGRP for years 2005 through 2016. The GHGRP allows landfills to use 0.20 for bulk MSW or allows a landfill to further delineate waste streams by accounting for shipments of C&D waste, which uses a DOC of 0.08, and inert wastes, which may use a DOC of 0.0. If a landfill delineates in this way, it must use a DOC of 0.31 for its MSW waste volumes, which applies an artificially high DOC to MSW, and inappropriately overestimates emissions. We are

pleased to read that EPA plans to revisit the DOC value of 0.20 used in the early years of the inventory. However, the Agency should also reevaluate the DOC values incorporated in the GHGRP, as they too need to be updated.

In 2016, the Environmental Research and Education Foundation (EREF) undertook a state-based study of DOC values for both MSW Only Landfills and Non-MSW Material going to MSW Landfills. The DOC guideline recommended by EPA for MSW Only Landfills is 0.31 and the recommended guideline for Non-MSW material going to MSW landfills is 0.20. As described below, these guidelines over-estimate the amount of organic waste deposited in landfills, which results in inaccurate estimates of landfill gas generation and methane emissions. We note that neither of the recommended DOC guidelines have been reviewed by EPA in many years, and we support EPA's view that it is time to update the DOC values.

Response: As stated in the Planned Improvement section of Section 7.1 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016, the Inventory currently uses one value of 0.20 for the DOC for years 1990 to 2004. With respect to improvements to the DOC value, EPA developed a database with MSW characterization data from individual studies across the United States. EPA will review this data against the Inventory time series to assess the validity of the current DOC value and how it is applied in the FOD method. Waste characterization studies vary greatly in terms of the granularity of waste types included and the spatial boundaries of each study (e.g., one landfill, a metro area, statewide). EPA also notes the longer term recommendation from the commenter regarding DOC values used in the GHGRP, in the context of the new information on composition of waste disposed in MSW landfills, these newer values could then be reflected in the 2005 and later years of the Inventory.

Comment: Based on this review of the DOC values for MSW landfills, the landfill sector concludes that the long-standing DOC values developed in the past are inaccurate and are likely to over-estimate both landfill gas generation and methane emissions. The data provided by EREF confirms that two trends are driving the changes at MSW Landfills. First, many MSW Landfills are handling less organic matter now, and this trend is anticipated to continue due to state and local organics diversion goals, and second, the increase of Subtitle D non-MSW waste disposed has altered the DOC for all waste deposited in MSW Landfills. EPA validates these trends in the Inventory's Chapter 6 discussion of carbon sequestration of harvested wood products, yard waste and food waste, which shows a significant reduction in sequestered carbon since 1990 due to reduced volumes of organic wastes disposed in landfills.

Based on EREF's research, we urge EPA to update the DOC values to reflect significant changes in the amounts and types of organic materials being landfilled over the last several years. The values now in use are inaccurate and should not be used going forward. We request that EPA review and update the DOC values in not only the next version of the GHG Inventory, but also update the DOC values used in calculating GHG emissions under Subpart HH of the GHGRP.

Response: As stated in the Planned Improvement section of Section 7.1 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016, the Inventory currently uses one value of 0.20 for the DOC for years 1990 to 2004. With respect to improvements to the DOC value, EPA developed a database with MSW characterization data from individual studies across the United States. EPA will review this data against the Inventory time series to assess the validity of the current DOC value and how it is applied in the FOD method. Waste characterization studies vary greatly in terms of the granularity of waste types included and the spatial boundaries of each study (e.g., one landfill, a metro area, statewide). EPA also notes the longer term recommendation from the commenter regarding DOC values used in the GHGRP, in the context of the new information on composition of waste disposed in MSW landfills, these newer values could then be reflected in the 2005 and later years of the Inventory.

Comment: Further, as EPA clearly recognizes that the composition of the waste at MSW Landfills has changed and continues to change, we suggest the Agency add an additional factor, “(5) the composition of the waste” to the sentence on line 1, page 4 of the waste chapter that begins: “Methane generation and emissions from landfills are a function of several factors.”

Response: EPA appreciates and agrees with commenter’s suggestion and has revised the section referenced such that item (1) in the list of factors now reads “the total amount and composition of waste-in-place...”

Comment: The landfill sector strongly supports EPA’s plans to review these k values against new data and other landfill gas models, as well as assess the uncertainty factor applied to these k values in the Waste Model. We have been concerned that these k-values are outdated and rife with uncertainty. The landfill sector has previously highlighted the significant issues with the k values used in the Draft AP-42 Section 2.4: Municipal Solid Waste Landfills. In fact, EPA has never finalized AP-42 for MSW landfills, despite the k-value issues identified by EPA in both AP-42 and the Background Information Document. With uncertainties in CH₄ emissions ranging from -30% to 400% under EPA’s assessment of the LandGEM model, it is difficult to take these data seriously. For this reason, we support EPA’s plan to review and resolve the significant problems in the k value data set.

Response: As stated in the Planned Improvement section of Section 7.1 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016, in a future Inventory cycle, EPA will review the k values for the three climate types (dry, moderate, and wet) against new data and other landfill gas models, and how they are applied to the percentage of the population assigned to these climate types. EPA will also assess the uncertainty factor applied to these k values in the Waste Model. A 30 percent uncertainty factor is applied to each k value in the Monte Carlo analysis, which is consistent with that recommended by the IPCC (2006).

Other Comments

EPA received 28 additional anonymous public comments³ as part of the public review of the draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016*. These comments can be found on the public docket. Example topics of comments included: production and impacts of rare earth metals, evaluation of various U.S. Federal Government regulations, extreme weather events and climate variation, wind and hydroelectric power, U.S. manufacturing and infrastructure needs, particulate matter air quality, and U.S. energy policy needs.

Response: These comments are noted but are out of scope of this review.

³ EPA docket IDs for these other comments include: EPA-HQ-OAR-2017-0729-0002; EPA-HQ-OAR-2017-0729-0003; EPA-HQ-OAR-2017-0729-0004; EPA-HQ-OAR-2017-0729-0005; EPA-HQ-OAR-2017-0729-0006; EPA-HQ-OAR-2017-0729-0007; EPA-HQ-OAR-2017-0729-0008; EPA-HQ-OAR-2017-0729-0009; EPA-HQ-OAR-2017-0729-0010; EPA-HQ-OAR-2017-0729-0011; EPA-HQ-OAR-2017-0729-0012; EPA-HQ-OAR-2017-0729-0013; EPA-HQ-OAR-2017-0729-0014; EPA-HQ-OAR-2017-0729-0015; EPA-HQ-OAR-2017-0729-0016; EPA-HQ-OAR-2017-0729-0017; EPA-HQ-OAR-2017-0729-0018; EPA-HQ-OAR-2017-0729-0020; EPA-HQ-OAR-2017-0729-0021; EPA-HQ-OAR-2017-0729-0022; EPA-HQ-OAR-2017-0729-0023; EPA-HQ-OAR-2017-0729-0024; EPA-HQ-OAR-2017-0729-0025; EPA-HQ-OAR-2017-0729-0026, EPA-HQ-OAR-2017-0729-0027; EPA-HQ-OAR-2017-0729-0028; EPA-HQ-OAR-2017-0729-0029; EPA-HQ-OAR-2017-0729-0030.