Dispersion Modeling of Emissions from Hazardous Waste Combustion:

Veolia ES Technical Solutions, L.L.C., Sauget, Illinois

August 23, 2019

Prepared by:

Todd D. Ramaly, Environmental Scientist
Christopher Lambesis, Environmental Scientist

EPA Region 5
Land, Chemicals & Redevelopment Division

This page intentionally left blank.

Contents

Chapter 1 Executive Summary

As part of an Illinois Environmental Protection Agency (IEPA) Resource Conservation and Recovery Act (RCRA) permit appeal, the United States Environmental Protection Agency (EPA) updated the 2007 EPA Site-Specific Risk Assessment (SSRA) for the Veolia ES Technical Solutions, L.L.C. (Veolia) hazardous waste incineration facility in Sauget, Illinois. The 2007 EPA SSRA was used to support permit conditions in the RCRA permit issued by IEPA. The updated SSRA uses new air dispersion modeling results from current versions of preferred and recommended air dispersion models as described herein. Although the modeling effort is primarily for mercury, EPA also evaluated other possible emissions, such as dioxin/furans and other metals.

Specifically, EPA prepared and conducted stack gas dispersion modeling using EPA's latest version (18081) AERMOD model, described as a significant advance over ISCST3, the model used in the previous SSRA performed by EPA for IEPA in 2007. The AERMOD model requires different formatting for the meteorological data than for ISCST3 and includes several new and different subroutines requiring some site-specific parameters not used by ISCST3. EPA generally followed the approach described in EPA's 2005 *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* – HHRAP (U.S. EPA 2005a) but had to rerun the meteorological data and individual dispersion modeling runs. EPA used up-to-date information for these runs in keeping with the conceptual model in the HHRAP.

This page intentionally left blank.

Chapter 2 Facility Conditions

Veolia operates three waste-burning incinerators at its Sauget, Illinois facility (Units 2, 3 and 4). See Figure 2-1 for a map and aerial photo of the area surrounding the Veolia facility. Units 2 and 3 are fixed-hearth dual-chambered incinerators with spray dryer absorbers and fabric filters. Unit 4 is a rotary kiln with a secondary combustion chamber, tempering chamber, spray dryer absorbers, and fabric filters with carbon injection (Veolia 2014). Veolia recently installed activated carbon injection to Units 2 and 3 (Veolia 2019). Table 2-1 summarizes incinerator characteristics used in this analysis.

Stack heights and diameters were taken from a Risk Assessment submitted by Franklin Engineering for Veolia (Franklin 2017). Stack temperature was taken from the 2013 Comprehensive Performance Test (CPT) (Veolia 2014). Stack gas exit velocity was calculated from a one-year average of actual stack gas flowrates described by Veolia in the 2016 Confirmatory Performance Tests (CfPTs) (Veolia 2016a, 2016b, 2016c). EPA identified Universal Transverse Mercator (UTM) coordinates, Zone 15, for each stack from the internet-based geographic information system (GIS) Google Earth Pro (GEP). GEP is projected in the World Geodetic System of 1984 (WGS84) datum (the mathematical geoid used to represent the earth's surface). WGS84 is nearly identical to the North American Datum of 1983 (NAD83) datum which is used for most of the additional resources (terrain elevation maps, land use maps, etc.) needed to run the air dispersion model. Any locational data not in WGS84 or NAD83 will be converted before use. Base elevations for the stack were estimated using the *AERMAP* tool to import elevation data.

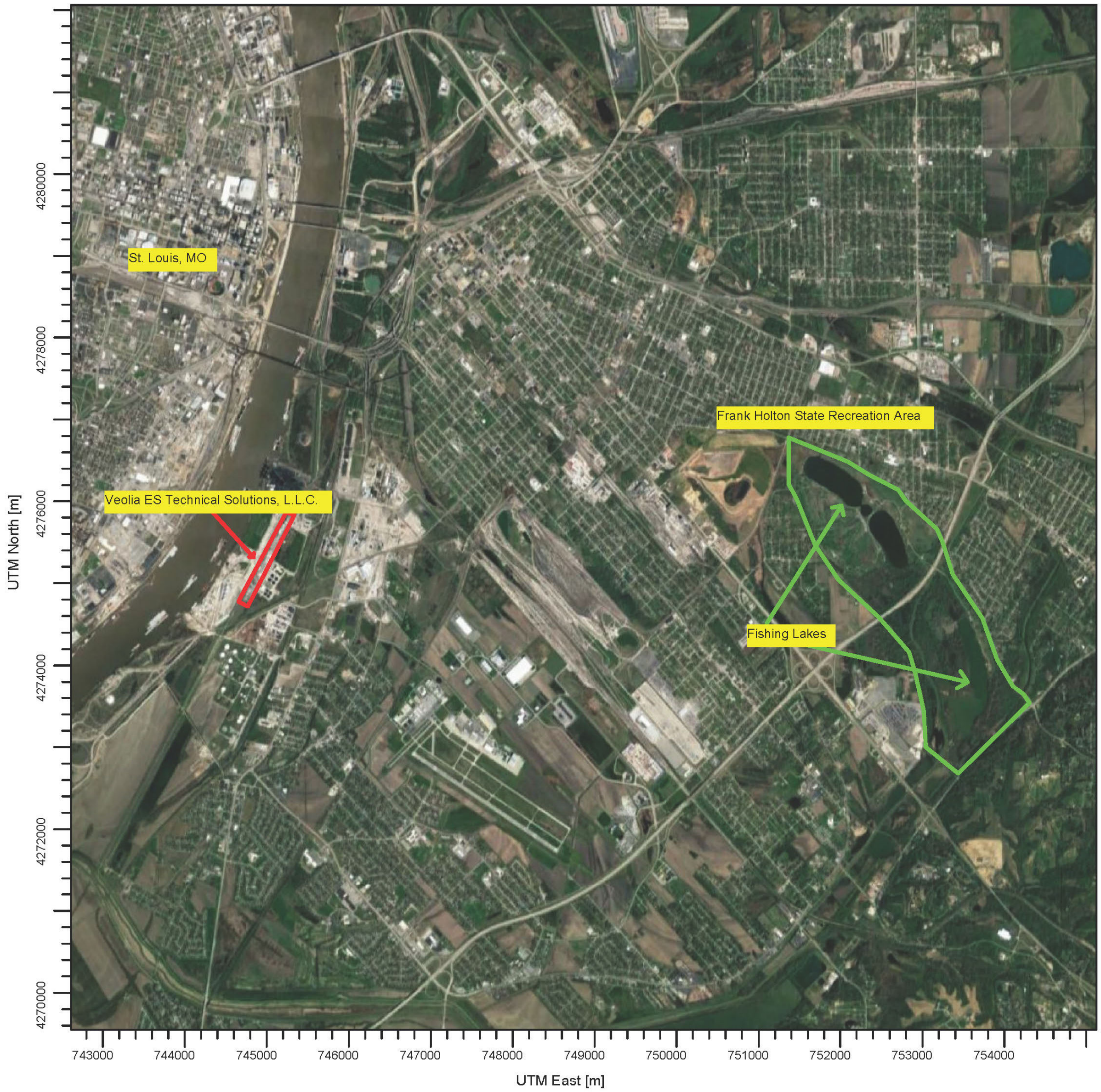
Table 2-1
Incinerator Characteristics

Unit	2	3	4
Thermal Input Rating (million British Thermal Units per hour)[1]	16	16	50
Stack UTM Northing (meters)[2]	4275918.17	4275964.87	4275207.53
Stack UTM Easting (meters)[2]	745302.11	745334.50	744975.55
Stack Height (meters)[2]	27.432	27.432	30.48
Stack Diameter (meters)[2]	0.686	0.686	1.219
Stack Gas Exit Velocity (meters per second)[3]	16.276	16.870	13.144
Stack Gas Temperature (degrees Fahrenheit)[1]	391	367	373
Base Elevation (meters above sea level)[4]	124.910	124.970	124.800

1 Veolia 2014
2 Franklin 2017
3 Veolia 2016a, 2016b, and 2016c
4 AERMAP

PROJECT TITLE:

Figure 2-1. Site Location Map
Veolia ES Technical Solutions, L.L.C., Sauget, IL



COMMENTS:	SOURCES:	COMPANY NAME:	
	3	U.S. EPA	
	RECEPTORS: 5233	MODELER: TDR	
		SCALE: 1:78,643 (0 – 3 km)	
		DATE: 5/25/2019	PROJECT NO.:

AERMOD View - Lakes Environmental Software

Chapter 3 Meteorological Data

Protocol

EPA processed five years of hourly surface and upper air meteorological data in accordance with EPA's *Regional Meteorological Data Processing Protocol, EPA Region 5 and States, August 2014 DRAFT* to prepare the data for AERMET, AERMOD's meteorological data processor (U.S. EPA 2014). The modeling protocol calls for five years of hourly meteorological data for facilities without an on-site weather station. EPA used five years of Integrated Surface Data files, 2011 through 2015, from the weather station at St. Louis, Lambert Field posted by the National Oceanic and Atmospheric Administration (NOAA) and obtained here: ftp://ftp.ncdc.noaa.gov/pub/data/noaa/.

EPA used GEP to confirm the location of the weather station tower. The location of the weather station tower appears to be approximately 900 meters west of the location reported in the facility's air-modeling files: 38.749ºN, 90.364°W (IEPA 2017). The location according to GEP is 38.752465°N, 90.373464°W. EPA applied the updated weather station tower location to AERMET and reported the true elevation of 162 meters above sea level. EPA found the 900-meter difference altered some of the surface parameters used by AERMET to process the meteorological data, so EPA used the more precise locational data from GEP for the weather station tower location (See AERSURFACE discussion below).

EPA obtained upper air data for the same years and corrected the data for Greenwich Mean Time. The upper air files were obtained for the KILX Logan Airport site in Lincoln, Illinois from the following website: http://esrl.noaa.gov/raobs/.

Upon completion of the adjustments described below, surface- and profile-files for each year were then combined into 5-year files, 2011-2015VS.SFC and 2011-2015VS.PFL. The facility's 2017 SSRA did not follow the regional protocol (Franklin 2017).

Surface Characteristics and AERSURFACE

EPA used the AERSURFACE tool to characterize the surface surrounding the St. Louis Lambert Field weather station and that of the Veolia stacks. This is an aid to AERMET that uses 1992 National Land Cover Data to estimate several surface characteristics needed for AERMOD (USGS 2000). The surface characteristics include *surface roughness* – a measure of the obstacles to wind flow such as trees and buildings – that is functionally equivalent to the height above the ground surface where the horizontal wind velocity drops to zero. The *bowen ratio* is a measure of surface moisture which affects heat transfer in the atmosphere. *Noon-time albedo* is a measure of reflectivity that impacts heat transfer in the atmosphere because of its relationship to the amount of solar radiation reflected or absorbed by the earth's surface. AERSURFACE also allows the user to model these characteristics by compass-point direction, season and month. Previous sensitivity analysis of the deposition algorithms conducted in the ISCST3 modeling suite showed that surface roughness has a significant impact on results (U.S. EPA 1997a). Since the deposition algorithms in AERMOD are based on the same studies used for ISCST3, EPA's sought the most representative surface characteristics for this updated modeling.

To evaluate any potential impact on the weather station tower locational data, EPA ran AERSURFACE using both locations and limited a comparison of the compass-point directions to those upwind from Veolia's stacks and from the downwind direction of lakes at Frank Holten State Recreation Area. The upwind fetch approaching the weather station represents the data used by the model to set up the wind profile for modeling dispersion from Veolia's facility in the direction of the lakes. The lakes are roughly between azimuths of 77.3° and 106.67° from the perspective of the stacks. Thus, the upwind fetch is between azimuths of 257.3° and 286.67°.

EPA compared annual values for surface roughness, bowen ratio, and noon-time albedo at both the more precise weather station tower location from GEP and the location used in the 2017 SSRA. Using the more precise location increased surface roughness by 9% and reduced bowen ration by 3% in the upwind fetch. The downwind range (between 77.3° and 106.67°) also showed differences with surface roughness increasing by 16% and bowen ratio decreasing by 3%. Noon-time albedo did not change between locations. EPA chose to use the locational data taken from GEP because it is more precise and produces different surface characteristics for AERMET than the location used in the 2017 SSRA.

Continuous Snow Cover and Annual Precipitation

The protocol also recommends adjusting the surface characteristics for wintertime with continuous snow cover (altering the reflectivity of solar radiation – noon time albedo) and for annual precipitation (dry, average, or wet – altering the bowen ratio). Therefore, EPA modified AERSURFACE results for each year with the adjustments summarized in Table 3-1.

Table 3.2 summarizes days of snow cover for all months for this project. EPA obtained snow cover data at https://www.ncdc.noaa.gov/qclcd/QCLCD. Tables 3-3 through 3-7 document adjustments for snow cover for each of 12 compass-point directions for each month of the project with snow cover. The facility's 2017 SSRA did not adjust AERSURFACE for snow cover (Franklin 2017).

EPA made the recommended adjustment for soil moisture (wet, dry, average) based on annual precipitation amounts obtained here:
https://www.weather.gov/media/lsx/climate/stl/precip/precip_stl_ranked_annual_amounts.pdf.

Table 3-8 shows adjustments EPA made for annual precipitation according to the protocol. EPA considered annual precipitation amounts greater than 43.487 inches (the 70th percentile of the 30-years of data through 2015) to be "wet" years in AERSURFACE. EPA considered annual precipitation amounts less than 34.508 inches (the 30th percentile of the 30-years of data through 2015) to be "dry" years in AERSURFACE. The facility's 2017 SSRA did not adjust AERSURFACE for annual precipitation (Franklin 2017).

Missing/Calm Hours and AERMINUTE 1-Minute Data

The protocol also addresses the number of reported wind speeds that are identified as missing or calm. The current National Weather Service (NWS) protocol is to record one-hour average wind speeds that are less than three knots as zero. This often results in an excessive proportion of missing and calm wind speeds which AERMOD will not process.

The protocol recommends using a data processing tool called AERMINUTE that converts two-minute wind speed and wind direction NWS data into hourly averages for use in AERMOD. The two-minute data from the National Weather Service is not limited by the three-knot convention; and lighter, nonzero winds are included. The two-minute data is available for the St. Louis Lambert Field station and was successfully integrated with the standard surface files to produce met data with no more than 0.97% missing and calm hours. EPA obtained the data from ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin/. The improvement in missing and/or calm hours data for each modeled year is as follows: 2011 (11.34% reduced to 0.34%), 2012 (14.21% reduced to 0.87%), 2013 (11.84% reduced to 0.46%), 2014 (12.53% reduced to 0.65%), and 2015 (12.61% reduced to 0.97%).

Figure 3-1 shows a wind rose generated from all five years of the adjusted met data.

The AERMET processor allows the user to specify a wind speed below which winds in the two-minute data will be considered calm. There is no default value, however a warning will be given if the value chosen is less than 0.5 m/s. The rationale behind setting the 0.5 m/s threshold is to make that value consistent with the minimum wind speed value set under current meteorological monitoring guidance for site-specific weather data towers. EPA used the 0.5 m/s minimum threshold wind speed option when preparing the data consistent with EPA guidance (U.S. EPA 2013).

EPA also enabled the ADJ_U* option in AERMET which adjusts the surface friction velocity (U*) under low-wind/stable conditions based on 2011 studies by Qian and Venkatram. The ADJ_U* option may be used as a regulatory option in AERMET with NWS data or with site-specific data that does not include turbulence (i.e., sigma-w and/or sigma-theta). This adjustment is applicable for releases relatively close to the surface (Qian and Venkatram, 2011).

While there is no set criterion for when to use ADJ_U*, when measured turbulence is not part of the meteorological data, this option improves model performance. Sources with smaller stacks in elevated terrain have the most model improvement (82 FR 5182, January 17, 2017). For taller stacks and/or cases where light winds/stable conditions are less important, model performance was largely unaffected. EPA's Regional Meteorologist, Randy Robinson, recommended this option for this project. The facility's 2017 SSRA did not adjust the surface friction velocity (U*) under low-wind/stable conditions (Franklin 2017).

Table 3-1 AERSURFACE Adjustments			
Year	Tower Land Use	Annual Precipitation	Snow Cover
2011	Airport Site	Wet	Weighted for January, February, March, and December
2012	Airport Site	Dry	Weighted for January, February, and December
2013	Airport Site	Average	Weighted for January, February, March, and December
2014	Airport Site	Average	Weighted for January, February, March, and November
2015	Airport Site	Wet	Weighted for February and March

Table 3-2 Snow Cover				
Year	Month	days with 1" or more snow cover	total days	% with snow
2011	January	16	31	52%
2011	February	13	28	46%
2011	March	3	31	10%
2011	November	0	30	0%
2011	December	1	31	3%
2012	January	4	31	13%
2012	February	2	29	7%
2012	March	0	31	0%
2012	November	0	30	0%
2012	December	1	31	3%
2013	January	3	31	10%
2013	February	7	28	25%
2013	March	5	31	16%
2013	November	0	30	0%
2013	December	9	31	29%
2014	January	9	31	29%
2014	February	11	28	39%
2014	March	1	31	3%
2014	November	3	30	10%
2014	December	0	31	0%
2015	January	0	31	0%
2015	February	10	28	36%
2015	March	3	31	10%
2015	November	0	30	0%
2015	December	0	31	0%

https://www.ncdc.noaa.gov/qclcd/QCLCD

Table 3-3

Weighted Adjustments to Noon-time Albedo, Bowen Ratio, and Surface Roughness (z) for Days with Snow cover in 2011

		Without Snow Cover			With Snow Cover			Weighted for Snow Cover		
Sector	Month	Albedo	Bowen Ratio	z	Albedo	Bowen Ratio	z	Albedo	Bowen Ratio	z
1	January	0.18	0.67	0.05	0.44	0.5	0.044	0.31	0.58	0.047
1	February	0.18	0.67	0.05	0.44	0.5	0.044	0.30	0.59	0.047
1	March	0.17	0.54	0.054	0.44	0.5	0.044	0.20	0.54	0.053
1	December	0.18	0.67	0.05	0.44	0.5	0.044	0.19	0.66	0.050
2	January			0.041			0.034			0.037
2	February			0.041			0.034			0.038
2	March			0.046			0.034			0.045
2	December			0.041			0.034			0.041
3	January			0.018			0.011			0.014
3	February			0.018			0.011			0.015
3	March			0.024			0.011			0.023
3	December			0.018			0.011			0.018
4	January			0.027			0.018			0.022
4	February			0.027			0.018			0.023
4	March			0.035			0.018			0.033
4	December			0.027			0.018			0.027
5	January			0.026			0.018			0.022
5	February			0.026			0.018			0.022
5	March			0.032			0.018			0.031
5	December			0.026			0.018			0.026
6	January			0.042			0.035			0.038
6	February			0.042			0.035			0.039
6	March			0.047			0.035			0.046
6	December			0.042			0.035			0.042
7	January			0.044			0.037			0.040
7	February			0.044			0.037			0.041
7	March			0.049			0.037			0.048
7	December			0.044			0.037			0.044
8	January			0.035			0.027			0.031
8	February			0.035			0.027			0.031
8	March			0.041			0.027			0.040
8	December			0.035			0.027			0.035
9	January			0.049			0.043			0.046
9	February			0.049			0.043			0.046
9	March			0.055			0.043			0.054
9	December			0.049			0.043			0.049
10	January			0.025			0.017			0.021
10	February			0.025			0.017			0.021
10	March			0.032			0.017			0.031
10	December			0.025			0.017			0.025
11	January			0.042			0.034			0.038
11	February			0.042			0.034			0.038
11	March			0.048			0.034			0.047
11	December			0.042			0.034			0.042
12	January			0.044			0.037			0.040
12	February			0.044			0.037			0.041
12	March			0.049			0.037			0.048
12	December			0.044			0.037			0.044

Note: Only Surface Roughness (z) is adjusted for compass point direction.

Table 3-4

Adjustments to Noon-time Albedo, Bowen Ratio, and Surface Roughness (z) Weighted for Days with Snow cover in 2012

		Without Snow Cover			With Snow Cover			Weighted for Snow Cover		
Sector	Month	Albedo	Bowen Ratio	z	Albedo	Bowen Ration	z	Albedo	Bowen Ration	z
1	January	0.18	2.48	0.05	0.44	0.5	0.044	0.21	2.22	0.049
1	February	0.18	2.48	0.05	0.44	0.5	0.044	0.20	2.34	0.050
1	December	0.18	2.48	0.05	0.44	0.5	0.044	0.19	2.42	0.050
2	January			0.041			0.034			0.040
2	February			0.041			0.034			0.041
2	December			0.041			0.034			0.041
3	January			0.018			0.011			0.017
3	February			0.018			0.011			0.018
3	December			0.018			0.011			0.018
4	January			0.027			0.018			0.026
4	February			0.027			0.018			0.026
4	December			0.027			0.018			0.027
5	January			0.026			0.018			0.025
5	February			0.026			0.018			0.025
5	December			0.026			0.018			0.026
6	January			0.042			0.035			0.041
6	February			0.042			0.035			0.042
6	December			0.042			0.035			0.042
7	January			0.044			0.037			0.043
7	February			0.044			0.037			0.044
7	December			0.044			0.037			0.044
8	January			0.035			0.027			0.034
8	February			0.035			0.027			0.034
8	December			0.035			0.027			0.035
9	January			0.049			0.043			0.048
9	February			0.049			0.043			0.049
9	December			0.049			0.043			0.049
10	January			0.025			0.017			0.024
10	February			0.025			0.017			0.024
10	December			0.025			0.017			0.025
11	January			0.042			0.034			0.041
11	February			0.042			0.034			0.041
11	December			0.042			0.034			0.042
12	January			0.044			0.037			0.043
12	February			0.044			0.037			0.044
12	December			0.044			0.037			0.044

Note: Only Surface Roughness (z) is adjusted for compass point direction.

Table 3-5

Adjustments to Noon-time Albedo, Bowen Ratio, and Surface Roughness (z) Weighted for Days with Snow cover in 2013

		Without Snow Cover			With Snow Cover			Weighted for Snow Cover		
Sector	Month	Albedo	Bowen Ratio	z	Albedo	Bowen Ration	z	Albedo	Bowen Ration	z
1	January	0.18	1.08	0.05	0.44	0.5	0.044	0.21	1.02	0.049
1	February	0.18	1.08	0.05	0.44	0.5	0.044	0.25	0.94	0.049
1	March	0.17	0.81	0.054	0.44	0.5	0.044	0.21	0.76	0.052
1	December	0.18	1.08	0.05	0.44	0.5	0.044	0.26	0.91	0.048
2	January			0.041			0.034			0.040
2	February			0.041			0.034			0.039
2	March			0.046			0.034			0.044
2	December			0.041			0.034			0.039
3	January			0.018			0.011			0.017
3	February			0.018			0.011			0.016
3	March			0.024			0.011			0.022
3	December			0.018			0.011			0.016
4	January			0.027			0.018			0.026
4	February			0.027			0.018			0.025
4	March			0.035			0.018			0.032
4	December			0.027			0.018			0.024
5	January			0.026			0.018			0.025
5	February			0.026			0.018			0.024
5	March			0.032			0.018			0.030
5	December			0.026			0.018			0.024
6	January			0.042			0.035			0.041
6	February			0.042			0.035			0.040
6	March			0.047			0.035			0.045
6	December			0.042			0.035			0.040
7	January			0.044			0.037			0.043
7	February			0.044			0.037			0.042
7	March			0.049			0.037			0.047
7	December			0.044			0.037			0.042
8	January			0.035			0.027			0.034
8	February			0.035			0.027			0.033
8	March			0.041			0.027			0.039
8	December			0.035			0.027			0.033
9	January			0.049			0.043			0.048
9	February			0.049			0.043			0.048
9	March			0.055			0.043			0.053
9	December			0.049			0.043			0.047
10	January			0.025			0.017			0.024
10	February			0.025			0.017			0.023
10	March			0.032			0.017			0.030
10	December			0.025			0.017			0.023
11	January			0.042			0.034			0.041
11	February			0.042			0.034			0.040
11	March			0.048			0.034			0.046
11	December			0.042			0.034			0.040
12	January			0.044			0.037			0.043
12	February			0.044			0.037			0.042
12	March			0.049			0.037			0.047
12	December			0.044			0.037			0.042

Note: Only Surface Roughness (z) is adjusted for compass point direction.

Table 3-6 Adjustments to Noon-time Albedo, Bowen Ratio, and Surface Roughness (z) Weighted for Days with Snow cover in 2014										
		Without Snow Cover			With Snow Cover			Weighted for Snow Cover		
Sector	Month	Albedo	Bowen Ratio	z	Albedo	Bowen Ration	z	Albedo	Bowen Ration	z
1	January	0.18	1.08	0.05	0.44	0.5	0.044	0.26	0.91	0.048
1	February	0.18	1.08	0.05	0.44	0.5	0.044	0.28	0.85	0.048
1	March	0.17	0.81	0.054	0.44	0.5	0.044	0.18	0.80	0.054
1	November	0.17	1.08	0.054	0.44	0.5	0.044	0.20	1.02	0.053
2	January			0.041			0.034			0.039
2	February			0.041			0.034			0.038
2	March			0.046			0.034			0.046
2	November			0.046			0.034			0.045
3	January			0.018			0.011			0.016
3	February			0.018			0.011			0.015
3	March			0.025			0.011			0.025
3	November			0.018			0.011			0.017
4	January			0.027			0.018			0.024
4	February			0.027			0.018			0.023
4	March			0.035			0.018			0.034
4	November			0.036			0.018			0.034
5	January			0.026			0.018			0.024
5	February			0.026			0.018			0.023
5	March			0.032			0.018			0.032
5	November			0.032			0.018			0.031
6	January			0.042			0.035			0.040
6	February			0.042			0.035			0.039
6	March			0.047			0.035			0.047
6	November			0.047			0.035			0.046
7	January			0.044			0.037			0.042
7	February			0.044			0.037			0.041
7	March			0.049			0.037			0.049
7	November			0.05			0.037			0.049
8	January			0.035			0.027			0.033
8	February			0.035			0.027			0.032
8	March			0.041			0.027			0.041
8	November			0.042			0.027			0.041
9	January			0.049			0.043			0.047
9	February			0.049			0.043			0.047
9	March			0.055			0.043			0.055
9	November			0.055			0.043			0.054
10	January			0.025			0.017			0.023
10	February			0.025			0.017			0.022
10	March			0.032			0.017			0.032
10	November			0.032			0.017			0.031
11	January			0.042			0.034			0.040
11	February			0.042			0.034			0.039
11	March			0.048			0.034			0.048
11	November			0.048			0.034			0.047
12	January			0.044			0.037			0.042
12	February			0.044			0.037			0.041
12	March			0.049			0.037			0.049
12	November			0.049			0.037			0.048

Note: Only Surface Roughness (z) is adjusted for compass point direction.

Table 3-7 Adjustments to Noon-time Albedo, Bowen Ratio, and Surface Roughness (z) Weighted for Days with Snow cover in 2015										
		Without Snow Cover			With Snow Cover			Weighted for Snow Cover		
Sector	Month	Albedo	Bowen Ratio	z	Albedo	Bowen Ration	z	Albedo	Bowen Ration	z
1	February	0.18	0.67	0.05	0.44	0.5	0.044	0.27	0.61	0.048
1	March	0.17	0.54	0.054	0.44	0.5	0.044	0.20	0.54	0.053
2	February			0.041			0.034			0.039
2	March			0.046			0.034			0.045
3	February			0.018			0.011			0.016
3	March			0.025			0.011			0.024
4	February			0.027			0.018			0.024
4	March			0.035			0.018			0.033
5	February			0.026			0.018			0.023
5	March			0.032			0.018			0.031
6	February			0.042			0.035			0.040
6	March			0.047			0.035			0.046
7	February			0.044			0.037			0.042
7	March			0.049			0.037			0.048
8	February			0.035			0.027			0.032
8	March			0.041			0.027			0.040
9	February			0.049			0.043			0.047
9	March			0.055			0.043			0.054
10	February			0.025			0.017			0.022
10	March			0.032			0.017			0.031
11	February			0.042			0.034			0.039
11	March			0.048			0.034			0.047
12	February			0.044			0.037			0.042
12	March			0.049			0.037			0.048

Note: Only Surface Roughness (z) is adjusted for compass point direction.

Table 3-8

Annual Moisture/Precipitation Adjustment

Year	Precipitation (inches)	
2016	41.44	
2015	61.24	wet
2014	43.43	normal
2013	42.68	normal
2012	32.3	dry
2011	47.17	wet
2010	39.07	
2009	50.92	
2008	57.96	
2007	30.57	
2006	29.93	
2005	37.85	
2004	42.27	
2003	46.06	
2002	40.95	
2001	35.29	
2000	37.37	
1999	34.06	
1998	43.62	
1997	31.23	
1996	43.67	
1995	41.68	
1994	34.7	
1993	54.76	
1992	33.49	
1991	33.48	
1990	45.09	
1989	28.6	
1988	33.93	
1987	38.38	
1986	34.88	

	overall average for modeling period = 2011-2015	45.364	inches
	30-year average (1987-2016) =	40.44	inches
percentiles	30th	34.508	inches
	70th	43.487	inches

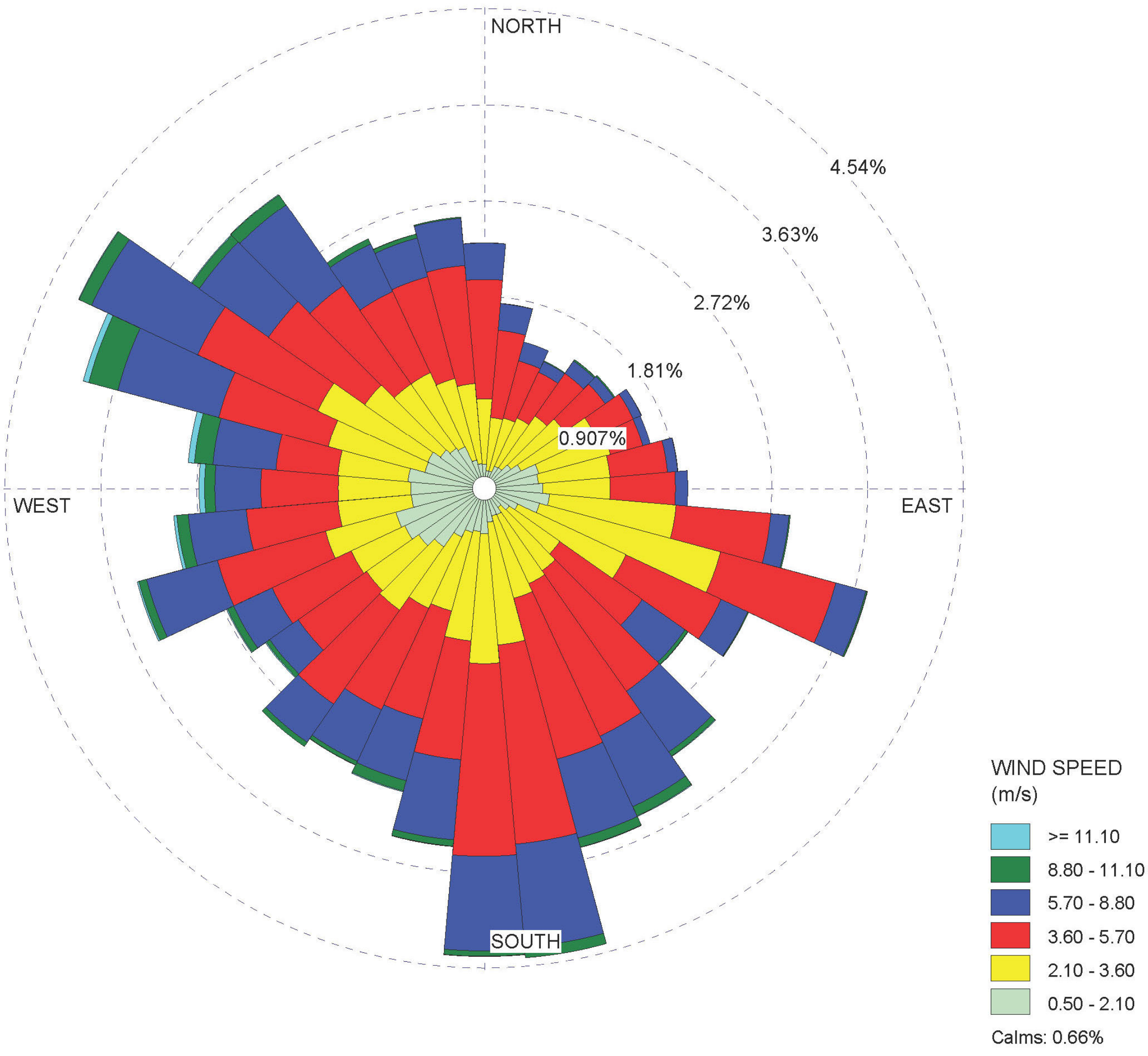
https://www.weather.gov/media/lsx/climate/stl/precip/precip_stl_ranked_annual_amounts.pdf

WIND ROSE PLOT:

Figure 3-1. Station #13994 - ST LOUIS/LAMBERT INT'L ARPT, MO

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 1/1/2011 - 00:00
End Date: 12/31/2015 - 23:59

COMPANY NAME:

U.S. EPA

MODELER:

TDR

CALM WINDS:

0.66%

TOTAL COUNT:

43783 hrs.

AVG. WIND SPEED:

4.05 m/s

DATE:

5/29/2019

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

This page intentionally left blank.

Chapter 4 *AERMOD*

EPA used version 9.6.5 of AERMOD-View (a proprietary version of AERMOD that adapts the unmodified program kernel of EPA's Build Number 18081 version of AERMOD into a graphical user interface) from Lakes Environmental Software of Waterloo, Ontario. This chapter follows the organizational structure of AERMOD's various input modules (called pathways).

Control Pathway

The control pathway sets various major modeling options including specifying options for dispersion modeling, terrain, and gas deposition as well as types of pollutants to be modeled. EPA evaluated dry and wet deposition of particles, particle bound compounds, and gasses from the Veolia emissions. EPA activated wet- and dry- plume depletion algorithms (to account for reductions in plume concentration from deposition that occurs closer to the stacks). EPA selected air concentration and deposition flux for both highest one-hour result and annual average for model output.

The model calculated gas deposition using default inputs. In default mode, the model estimated deposition velocity using default adjustments to leaf area indexes and a pollutant reactivity for divalent mercury of 1.0. The model set the pollutant reactivity for other vapors (organic compounds) at a default of zero. The facility's 2017 SSRA used a pollutant reactivity for divalent mercury of 0.0, referencing the HHRAP. However, the HHRAP does not recommend this value and AERMOD recommends using a value of 1.0 for divalent mercury.

EPA set seasonal categories to default values (winter is January and February, transitional spring is March through May, midsummer is June through August, autumn is September and October, and late autumn is November and December). EPA determined land use categories for gas deposition by extracting land use/land cover data from 2011 (USGS 2014) using ARCGIS (a geographical information system from ESRI of Redlands, California) and determining which land use type was most prominent within each 10-degree arc-slice surrounding the stack. Table 4-1 summarizes this information. The same analysis showed the overall land use around the facility to be 56% rural. AERMOD uses rural dispersion coefficients as default values.

Source Pathway

The characteristics of the sources were defined in Section 2 above. EPA delineated several buildings, tanks, and other structures as input for evaluating building downwash. EPA evaluated the dimensions of buildings near the stack for the potential to alter the plume with downwash effects by entering them into the model and using the BPIP tool to estimate building downwash effects. EPA used building dimensions and locational data from modeling files Veolia provided to the IEPA (IEPA 2017). Figure 4-1 and 4-2 show a three-dimensional depiction of the building layout. Table 4-2 summarizes the heights of buildings input into the model.

EPA entered gas and particle data for deposition under the Source pathway.

For divalent mercury deposition, EPA used the following parameter values.

Diffusivity in Air	0.0453 square centimeters per second (cm^2/s)	(U.S. EPA 2016)
Diffusivity in Water	5.25×10^{-6} cm^2/s	(U.S. EPA 2005a)
Cuticular Resistance	10^7 seconds per centimeter (s/cm)	(Wesely 2002)
Henry's Law Constant	2.37×10^{-5} Pascal cubic meters per mole ($Pa\cdot m^3/mole$)	(U.S. EPA 2016)

For organic vapor deposition, EPA used the following parameters reported in Wesely 2002 for generic vapor (as benzene):

Diffusivity in Air	0.08962 cm^2/s
Diffusivity in Water	1.04×10^{-5} cm^2/s
Cuticular Resistance	2.51×10^4 s/cm
Henry's Law Constant	557 $Pa\cdot m^3/mole$

For particulate matter deposition, EPA used site-specific particle-size data under AERMOD's Method 1 handling of particle data. This data is used for both particle-based pollutant dispersion, where the particle itself is expected to comprise the pollutant, and for particle-bound-based pollutant dispersion, where the pollutant is expected to be absorbed onto the surface of a particle. HHRAP assumes the amount of a particle-bound pollutant present on a given particle to be directly proportional to surface area since the contaminant is absorbed to the surface. To account for this, HHRAP recommends that the particle size distribution be adjusted for relative particle surface area assuming the particles are spherical.

In March of 2005, Veolia conducted stack testing on the Unit 4 rotary kiln and stack for particle size distribution. The stacks for Units 2 and 3, however, were not tested. On October 14, 2005, Veolia' submitted a detailed rationale for applying the Unit 4 stack particle data to the stacks for Units 2 and 3 based on similarities in air pollution control systems (Onyx 2005).

EPA considered the differences in the design and operation of the incinerators (rotary kiln versus dual-chamber/fixed hearth for example), in choosing to use the more conservative Unit 4 site-specific particle source data. EPA compared particle-bound deposition results for Units 2 and 3 using Unit 4 stack particle data to an example of particle data from HHRAP consistent with combustion facilities equipped with either electrostatic precipitators or fabric filters. The site-specific particle size distribution (adjusted for surface area) from the Unit 4 stack resulted in higher total deposition rates at the Lakes at Frank Holten State Recreation Area (the critical receptor location for mercury emissions) than the example particle size distribution in HHRAP. This testing was conducted during the previous iteration of modeling using the ISCST3 model. Since the particle deposition algorithms are based on the same studies for both AERMOD and ISCST3, EPA believes it is reasonable in the absence of stack-specific data for Units 2 and 3 to use the particle data which resulted in higher deposition at the lakes, the Unit 4 data, for the current round of modeling. EPA used the particle data from the Unit 4 test in part because it resulted in more conservative particle bound deposition. Table 4-3 summarizes the particle size distribution including fraction of total mass by mean diameter (for particle dispersion) and fraction of total surface area by mean particle diameter (for particle-bound dispersion). EPA recommends future stack-specific testing for particle size distribution for Units 2 and 3, especially since the facility recently modified the air pollution control devices.

Receptor Pathway

EPA used a multi-tier Cartesian receptor grid for the project with 100-meter (m) spacing out to three kilometers (km) and 500-m spacing from three km to 10 km from a centroid of the stack locations. EPA selected the elevated terrain option and imported land elevations for each of the 5,233 receptor grid-nodes. See Figure 4-3 for an illustration of the multi-tiered receptor grid.

Meteorology Pathway

EPA concatenated the AERMET files prepared as described in Section 2 of this report (for the years 2011 through 2015) into five-year files for both the surface file and the profile file. EPA selected the entire meteorological period for modeling. The weather station tower at St. Louis, Lambert Field, St. Louis, Missouri has a base elevation of 162 meters.

Terrain

EPA used the AERMOD tool AERMAP to import terrain elevations for the stacks, all entered buildings, and receptor grid nodes. Figure 4-4 shows the terrain elevations surrounding the facility. Elevated terrain near the stacks can have a significant impact on the results of air modeling. Veolia's stacks are located on Mississippi River bottomland with nearby bluffs rising as much as 150 feet (44 meters) above the top of Veolia's highest stack. To properly handle terrain effects, each receptor point must have a corresponding elevation.

EPA used United States Geological Survey (USGS) 7.5 Minute Digital Elevation Models (DEMs) with 30 x 30-meter samples (of elevation) to obtain the elevations. EPA downloaded these DEMs from the Agency's server in 2002 for the 2007 SSRA. The elevation data is expected to remain valid for the current modeling. EPA used the following specific DEMs: Cahokia, Illinois; Clayton, Missouri; French Village, Illinois; Granite City, Illinois; Monks Mound, Illinois; and Webster Grove, Illinois.

The Clayton, French Village, and Monks Mound DEMs are in a different projection than the default projection selected for the modeling (NAD83). EPA used ARCGIS version 8.3 to convert the DEMs from the 1927 North American Datum (NAD27) to NAD83. EPA used ARCGIS to ensure that elevation values in the DEMs were in the same units (meters). The model sampled the DEMs in ARCGIS to derive an elevation for each receptor point. ARCGIS combined the UTM coordinates of the receptor grid points with their respective elevations into a text file used to import elevations into the dispersion model.

Output

EPA selected the highest annual averages for concentration, and all combinations of deposition flux for output into contour plot files.

Emission Phase Partitioning

EPA modeled three types of emissions from the Veolia facility: vapor; particle; and particle-bound. Particle-bound differs from particle in that the mass fraction assigned to each particle-size range is further adjusted for surface area available for that particle-size range. Particle-bound is a separate run because certain types of contaminants are expected to be adsorbed to the surface of particulate emissions and surface area is a better predictor of mass fraction for these adsorbing contaminants than volume or weight. EPA performed a separate vapor model run for divalent mercury vapor.

EPA modeled emissions in AERMOD with a *unit emission rate*, meaning that the modeled emission rate for all sources and pollutants is one gram per second (g/s). This allows for the running of one generic set of vapor, particle, and particle-bound model runs that can be scaled to the actual emission rate by simple application of a factor to the results. EPA enters the emission rate factor in the risk assessment stage. Although divalent mercury vapor gets a special run due to its unique fate and transport characteristics, EPA still uses a *unit emission rate* so that it is compatible with the other runs.

Figures 4-5 through 4-12 present average annual air concentrations and total deposition flux for modeled emissions from Unit 2. Concentration and deposition contours for modeled emissions from Units 3 and 4 are similar in shape and magnitude to that of Unit 2. All plotfiles for this project are available in the electronic project archive.

Table 4-1

Land Use/Land Cover within 3 km by 10-Degree Arc

10-degree ARC (centered on (degrees)	AERMOD Land Use Categories for Gas Deposition	7 - Bodies of Water		none	6 - Suburban Areas, Forested		5 - Suburban Areas, Grassy		1 - Urban Land, No Vegetation			8 - Barren Land, Mostly Desert		4 - Forest					3 - Rangeland				2 - Agricultural Land		9 - Non-Forested Wetlands		Total Pixel Count	Highest Category - Percentage	Predominant Land Use Category
	2011 National Land Use/Land Cover Categories	11 - Open Water		12 - Perennial Snow and Ice	22 - Developed, Low Intensity		21 - Developed, Open Space		23 - Developed, Medium Intensity	24 - Developed, High Intensity		31 - Barren land (Rock/Sand/Clay)		41 - Deciduous Forest	42 - Evergreen Forest	43 - Mixed Forest	90 - Woody Wetlands		52 - Shrub/ Scrub	71 - Grassland/ Herbaceous	81 - Pasture/ Hay		82 - Cultivated Crops		95 - Emergent Herbaceous Wetlands				
10		176	19.86%	-	137	15.46%	71	8.01%	129	73	22.80%	0	0.00%	54	-	-	267	36.23%	-	-	2	0.23%	0	0.00%	5	0.56%	914	36%	forest
20		36	4.06%	-	213	24.04%	165	18.62%	130	69	22.46%	0	0.00%	37	-	-	201	26.86%	-	-	45	5.08%	0	0.00%	0	0.00%	896	27%	forest
30		3	0.34%	-	333	37.58%	119	13.43%	209	126	37.81%	0	0.00%	17	-	-	79	10.84%	-	-	0	0.00%	0	0.00%	0	0.00%	886	38%	urban
40		0	0.00%	-	397	44.81%	129	14.56%	208	137	38.94%	0	0.00%	0	-	-	13	1.47%	-	-	0	0.00%	0	0.00%	0	0.00%	884	45%	suburban forest
50		0	0.00%	-	388	43.79%	116	13.09%	131	217	39.28%	0	0.00%	0	-	-	0	0.00%	-	-	0	0.00%	18	2.03%	0	0.00%	870	44%	suburban forest
60		0	0.00%	-	308	34.76%	127	14.33%	184	235	47.29%	0	0.00%	0	-	-	1	0.11%	-	-	0	0.00%	23	2.60%	0	0.00%	878	47%	urban
70		0	0.00%	-	406	45.82%	122	13.77%	136	212	39.28%	0	0.00%	0	-	-	7	0.79%	-	-	0	0.00%	0	0.00%	0	0.00%	883	46%	suburban forest
80		59	6.66%	-	167	18.85%	111	12.53%	128	356	54.63%	0	0.00%	6	-	-	46	5.87%	-	-	0	0.00%	0	0.00%	0	0.00%	873	55%	urban
90		0	0.00%	-	149	16.82%	109	12.30%	259	302	63.32%	0	0.00%	0	-	-	68	7.67%	-	-	0	0.00%	3	0.34%	0	0.00%	890	63%	urban
100		0	0.00%	-	193	21.78%	156	17.61%	121	160	31.72%	0	0.00%	0	-	-	42	4.74%	-	-	20	2.26%	189	21.33%	0	0.00%	881	32%	urban
110		0	0.00%	-	184	20.77%	114	12.87%	158	141	33.75%	0	0.00%	0	-	-	8	0.90%	-	-	10	1.13%	270	30.47%	0	0.00%	885	34%	urban
120		0	0.00%	-	290	32.73%	157	17.72%	120	97	24.49%	0	0.00%	0	-	-	18	2.03%	-	-	0	0.00%	203	22.91%	0	0.00%	885	33%	suburban forest
130		0	0.00%	-	277	31.26%	167	18.85%	176	153	37.13%	0	0.00%	0	-	-	31	3.50%	-	-	0	0.00%	58	6.55%	0	0.00%	862	37%	urban
140		0	0.00%	-	377	42.55%	237	26.75%	195	54	28.10%	0	0.00%	0	-	-	0	0.00%	-	-	0	0.00%	33	3.72%	0	0.00%	896	43%	suburban forest
150		0	0.00%	-	418	47.18%	216	24.38%	91	70	18.17%	0	0.00%	0	-	-	13	1.47%	-	-	0	0.00%	95	10.72%	0	0.00%	903	47%	suburban forest
160		0	0.00%	-	389	43.91%	164	18.51%	190	109	33.75%	0	0.00%	0	-	-	0	0.00%	-	-	0	0.00%	60	6.77%	0	0.00%	912	44%	suburban forest
170		0	0.00%	-	300	33.86%	63	7.11%	232	163	44.58%	0	0.00%	0	-	-	0	0.00%	-	-	73	8.24%	85	9.59%	0	0.00%	916	45%	urban
180		4	0.45%	-	323	36.46%	136	15.35%	266	137	45.49%	0	0.00%	0	-	-	38	4.29%	-	-	0	0.00%	0	0.00%	0	0.00%	904	45%	urban
190		23	2.60%	-	366	41.31%	115	12.98%	200	75	31.04%	0	0.00%	0	-	-	53	5.98%	-	-	0	0.00%	82	9.26%	0	0.00%	914	41%	suburban forest
200		68	7.67%	-	107	12.08%	56	6.32%	64	76	15.80%	0	0.00%	6	-	-	103	12.30%	-	-	0	0.00%	376	42.44%	40	4.51%	896	42%	agricultural
210		31	3.50%	-	127	14.33%	192	21.67%	40	37	8.69%	0	0.00%	5	-	-	53	6.55%	-	-	23	2.60%	378	42.66%	0	0.00%	886	43%	agricultural
220		12	1.35%	-	147	16.59%	218	24.60%	297	147	50.11%	0	0.00%	0	-	-	28	3.16%	-	-	0	0.00%	35	3.95%	0	0.00%	884	50%	urban
230		399	45.03%	-	82	9.26%	96	10.84%	160	102	29.57%	0	0.00%	7	-	-	24	3.50%	-	-	0	0.00%	0	0.00%	0	0.00%	870	45%	open water
240		663	74.83%	-	36	4.06%	16	1.81%	59	71	14.67%	33	3.72%	0	-	-	0	0.00%	-	-	0	0.00%	0	0.00%	0	0.00%	878	75%	open water
250		242	27.31%	-	109	12.30%	3	0.34%	196	319	58.13%	14	1.58%	0	-	-	0	0.00%	-	-	0	0.00%	0	0.00%	0	0.00%	883	58%	urban
260		153	17.27%	-	98	11.06%	21	2.37%	165	418	65.80%	18	2.03%	0	-	-	0	0.00%	-	-	0	0.00%	0	0.00%	0	0.00%	873	66%	urban
270		111	12.53%	-	141	15.91%	27	3.05%	225	377	67.95%	8	0.90%	0	-	-	0	0.00%	-	-	0	0.00%	0	0.00%	0	0.00%	889	68%	urban
280		78	8.80%	-	134	15.12%	2	0.23%	281	387	75.40%	0	0.00%	0	-	-	0	0.00%	-	-	0	0.00%	0	0.00%	0	0.00%	882	75%	urban
290		79	8.92%	-	197	22.23%	12	1.35%	258	340	67.49%	0	0.00%	0	-	-	0	0.00%	-	-	0	0.00%	0	0.00%	0	0.00%	886	67%	urban
300		85	9.59%	-	152	17.16%	7	0.79%	278	351	70.99%	6	0.68%	0	-	-	0	0.00%	-	-	5	0.56%	0	0.00%	0	0.00%	884	71%	urban
310		75	8.47%	-	127	14.33%	3	0.34%	297	350	73.02%	2	0.23%	0	-	-	0	0.00%	-	-	8	0.90%	0	0.00%	0	0.00%	862	73%	urban
320		92	10.38%	-	63	7.11%	14	1.58%	277	437	80.59%	5	0.56%	0	-	-	0	0.00%	-	-	7	0.79%	0	0.00%	0	0.00%	895	81%	urban
330		120	13.54%	-	61	6.88%	5	0.56%	226	476	79.23%	0	0.00%	0	-	-	0	0.00%	-	-	14	1.58%	0	0.00%	0	0.00%	902	79%	urban
340		174	19.64%	-	4	0.45%	0	0.00%	118	595	80.47%	0	0.00%	0	-	-	0	0.00%	-	-	20	2.26%	0	0.00%	0	0.00%	911	80%	urban
350		313	35.33%	-	42	4.74%	19	2.14%	190	321	57.67%	11	1.24%	3	-	-	0	0.34%	-	-	15	1.69%	0	0.00%	0	0.00%	914	58%	urban
360		695	78.44%	-	41	4.63%	6	0.68%	55	62	13.21%	7	0.79%	6	-	-	27	3.72%	-	-	4	0.45%	0	0.00%	1	0.11%	904	78%	open water
		3691	11.52%	0	7283	22.74%	3291	10.27%	6449	7752	44.34% **55.66%**	104 **rural**	0.32%	141	0	0	1120	3.94%	0	0	246	0.77%	1908	5.96%	46	0.14%	32031		

Note: The assignment of 2011 Land Use/Land Cover categories to AERMOD gas-deposition categories was at the discretion of the modeler.

This page intentionally left blank.

Table 4-2 Building Elevations and Heights for Downwash				
Building ID	Description	Tier_Number	Base_Elevation [m]	Tier_Height [m]
AshStore	Ash Storage	1	125	6.90
2/3DirIn	Units 2 & 3 Direct Injection Building	1	125	6.25
ProdDock	Production Building Dock	1	125	5.23
NendPers	North End Personnel	1	125	5.23
SDA2	Spray Dryer Adsorber 2	1	125	24.16
BagHse2	Unit 2 Baghouse	1	125	15.36
SDA3	Spray Dryer Adsorber 3	1	125	24.16
BagHse3	Unit 3 Baghouse	1	125	15.36
SDA4	Spray Dryer Adsorber 4	1	124.9	25.40
BagHse4	Unit 4 Baghouse	1	124.9	4.11
SendPers	South End Personnel Building	1	124.9	6.10
BulkFeed	Bulk Feed Building	1	124.9	17.27
DrumStor	Drum Storage Building Unit 6	1	124.9	6.15

Data extracted from dispersion modeling input file, Veolia.PIP (IEPA 2017).

Table 4-3 Site-Specific Particle Size Distribution		
Geometric Mean Diameter (μm)	Fraction of Total Mass	Fraction of Total Surface Area
0.16	0.008	0.082
0.26	0.011	0.073
0.36	0.011	0.054
0.46	0.011	0.042
0.78	0.088	0.192
1.84	0.370	0.343
3.83	0.445	0.198
6.22	0.056	0.015

Onyx 2005

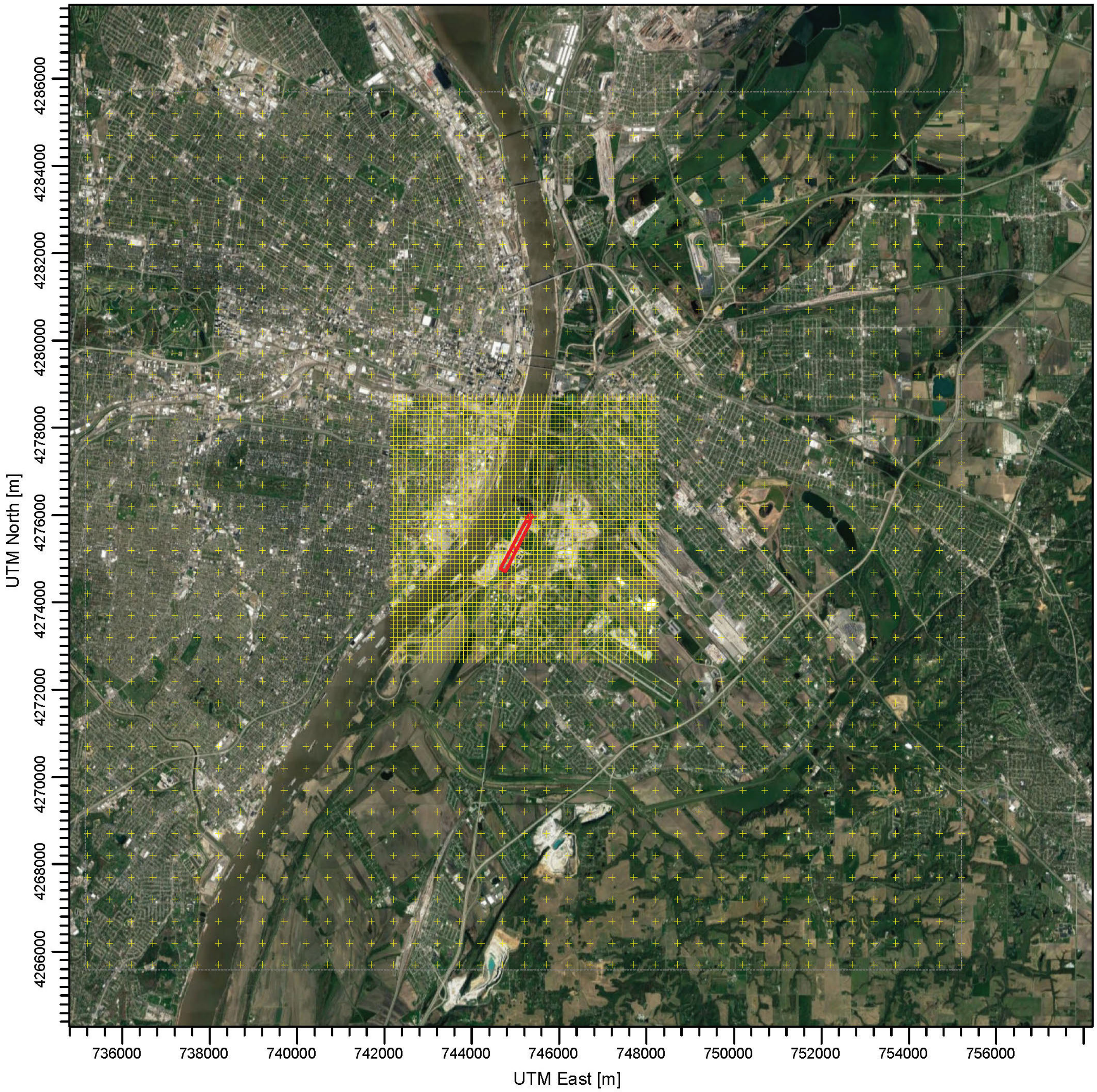
This page intentionally left blank.

Figure 4-1. 3-Dimensional Image of Buildings and Tanks (Building Downwash Tier 1 Buildings in Blue w/Unit 4 Stack in Red)

Figure 4-2. 3-Dimensional Image of Buildings and Tanks (Building Downwash Tier 1 Buildings in Blue w/Units 2 and 3 Stacks in Red)

PROJECT TITLE:

Figure 4-3. Receptor Grid
Veolia ES Technical Solutions, L.L.C., Sauget, IL

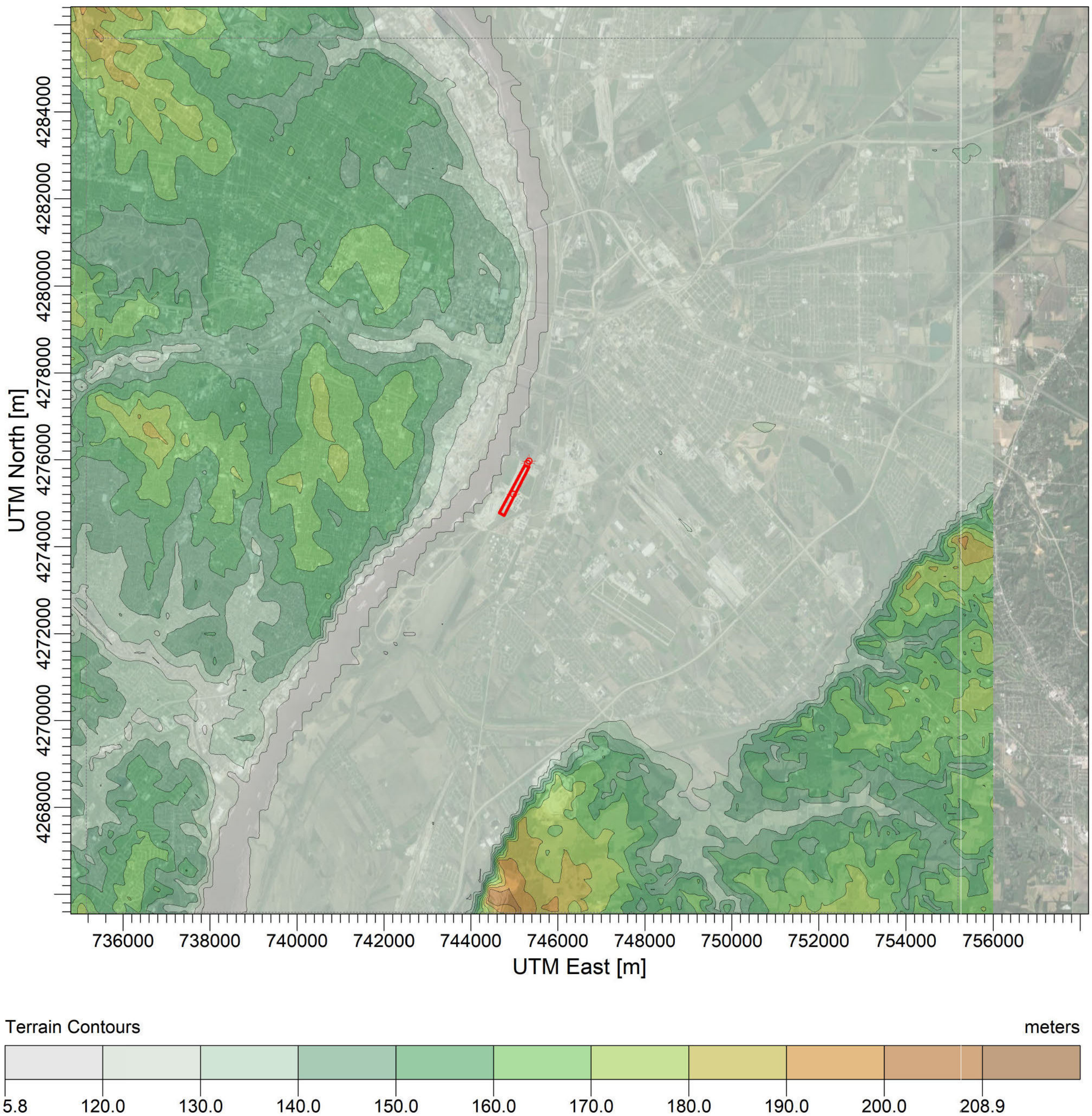


COMMENTS:	SOURCES: 3	COMPANY NAME: U.S. EPA	
	RECEPTORS: 5233	MODELER: TDR	
		SCALE: 1:147,222 (0 — 5 km)	
		DATE: 5/29/2019	PROJECT NO.:

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 4-4. Terrain Elevations
Veolia ES Technical Solutions, L.L.C., Sauget, IL

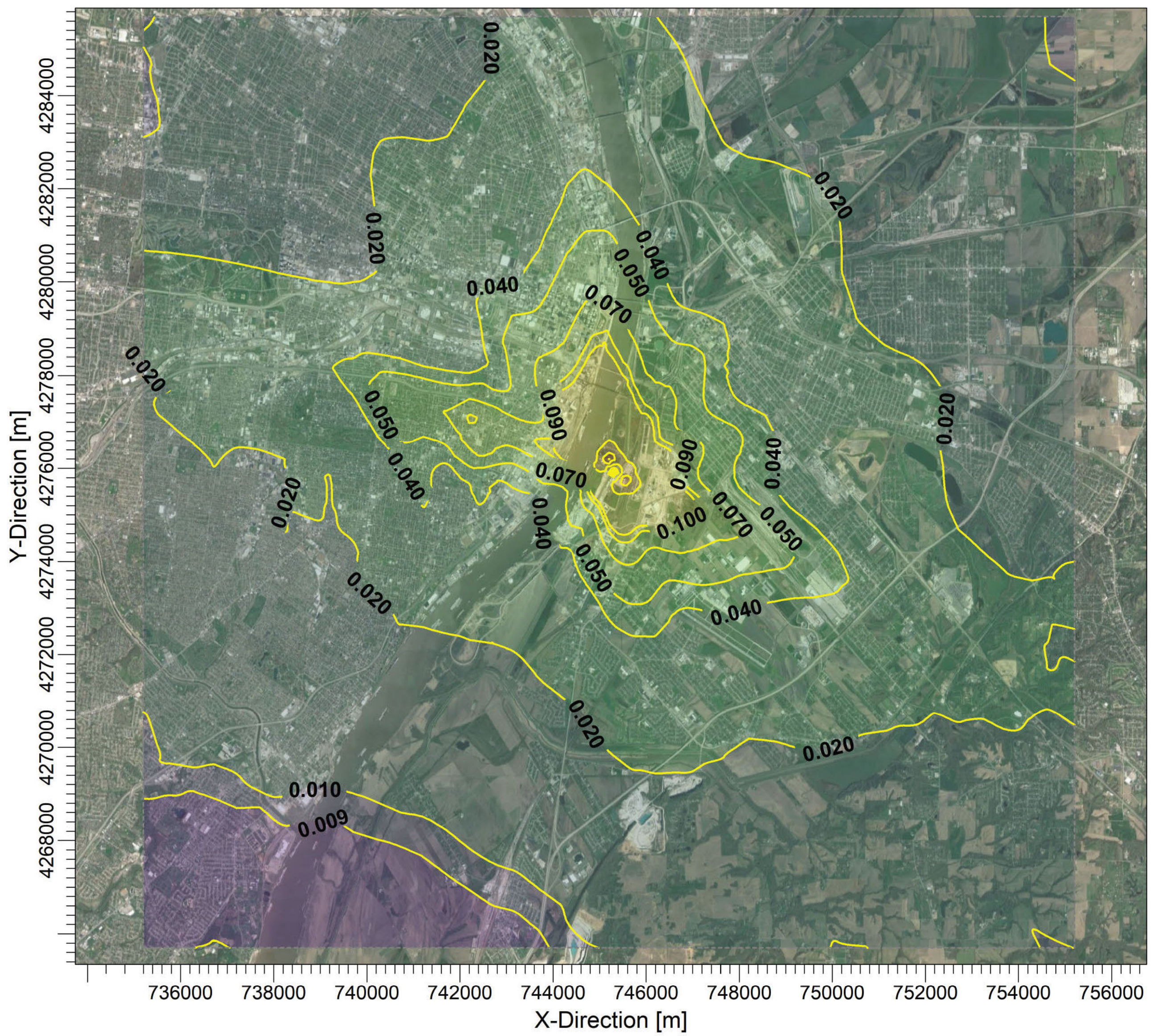


COMMENTS:	SOURCES: **3**	COMPANY NAME: **U.S. EPA**	
	RECEPTORS: **5233**	MODELER: **TDR**	
		SCALE: 1:147,032 (0 — 5 km)	
		DATE: **5/29/2019**	PROJECT NO.:

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 4-5. Veolia, Sauget, Illinois. Stack 2 - Divalent Mercury Vapor Concentration Plot File of Annual Values Averaged Across 5 Years



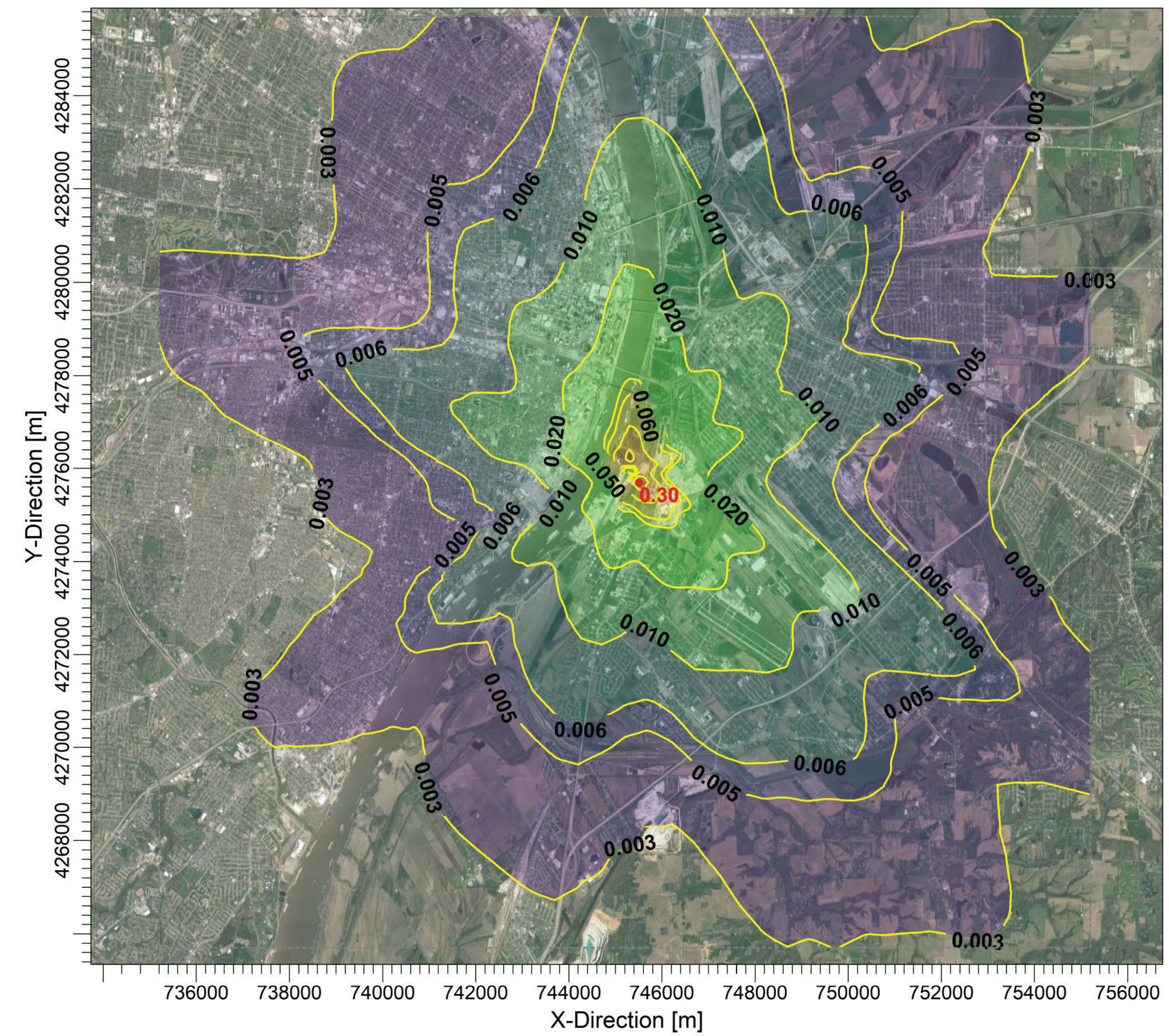
PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

0.006 0.009 0.010 0.020 0.040 0.050 0.070 0.090 0.100 0.300 0.500 0.600 0.605

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, NONDFAULT, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		**U.S. EPA**	
			MODELER: **TDR**	
	OUTPUT TYPE: **Concentration**	RECEPTORS: **5233**	SCALE: 1:144,679 (0 — 4 km)	
	MAX: **0.6049**	UNITS: **ug/m^3**	DATE: **6/2/2019**	PROJECT NO.:

PROJECT TITLE:

Figure 4-6. Veolia, Sauget, Illinois. Stack 2 - Divalent Mercury Vapor Total Deposition Plot File of Annual Values Averaged Across 5 Years



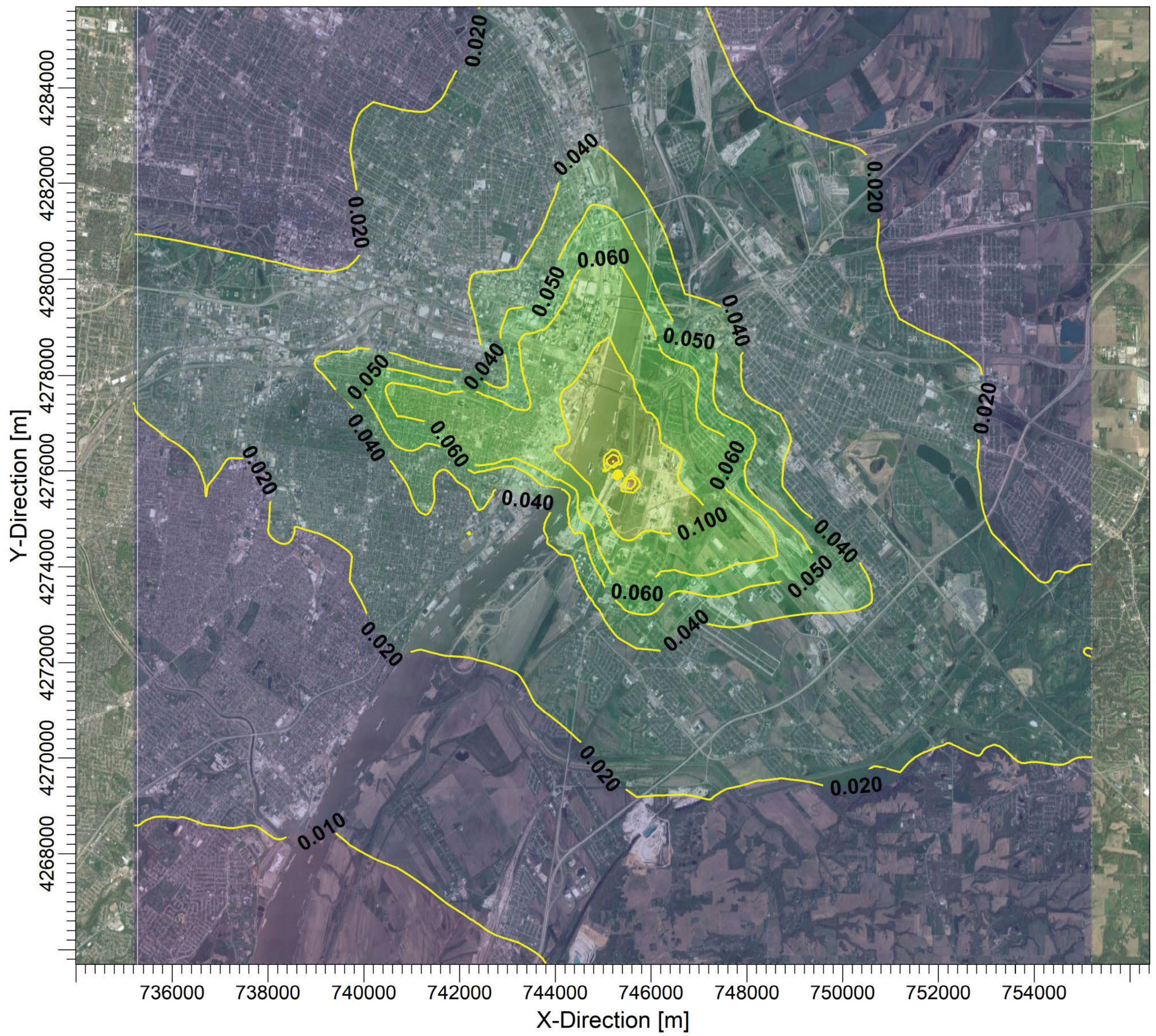
PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL g/m^2

0.003 0.005 0.006 0.010 0.020 0.050 0.060 0.100 0.200 0.297

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, NONDFAULT, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		**U.S. EPA**	
			MODELER: **TDR**	
	OUTPUT TYPE: **Total Depos.**	RECEPTORS: **5233**	SCALE: 1:144,679 (0 — 4 km)	
	MAX: **0.29678**	UNITS: **g/m^2**	DATE: **6/2/2019**	PROJECT NO.:

PROJECT TITLE:

Figure 4-7. Veolia, Sauget, Illinois. Stack 2 - Particle Bound Concentration
Plot File of Annual Values Averaged Across 5 Years



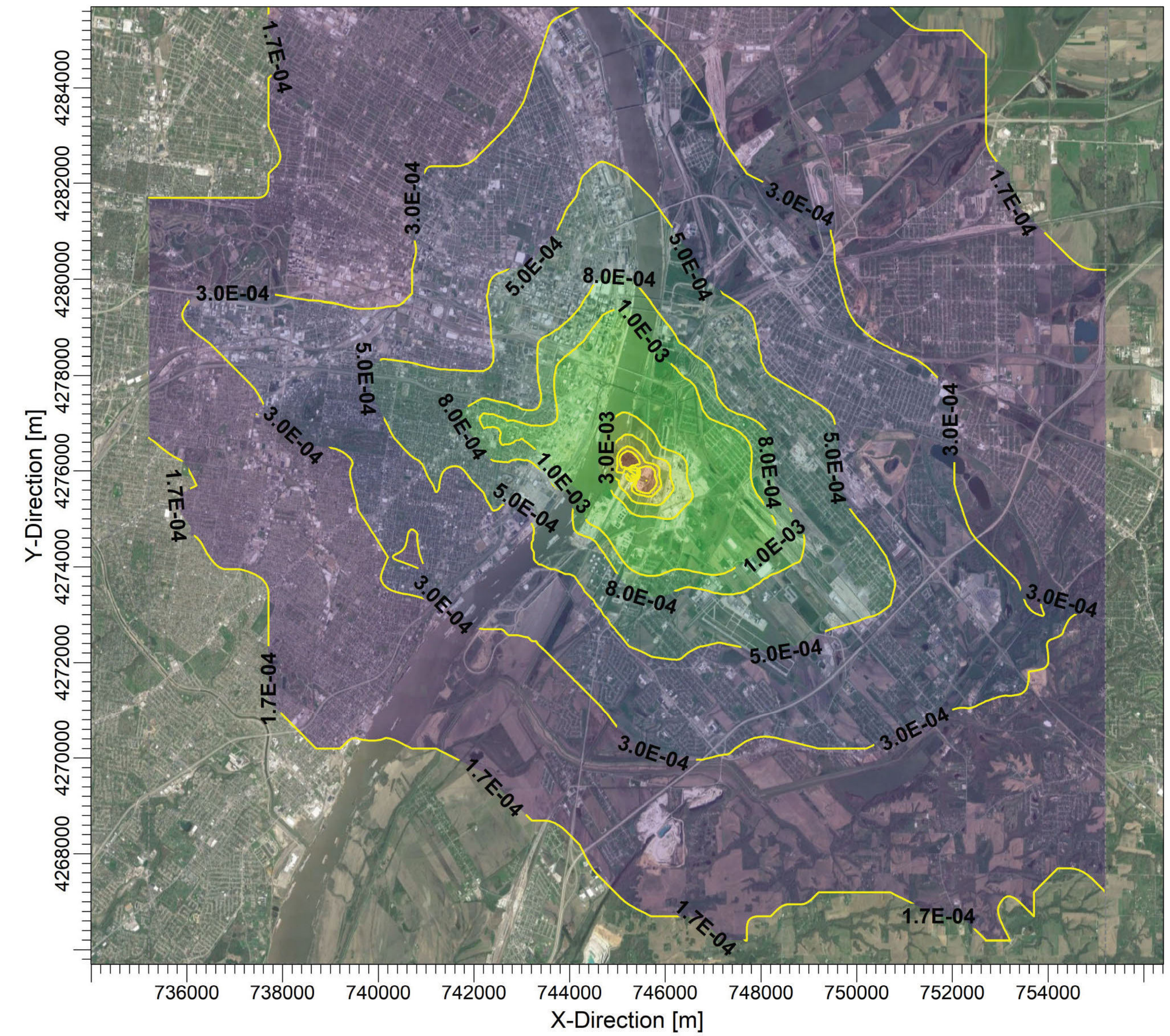
PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

0.006 0.010 0.020 0.040 0.050 0.060 0.100 0.400 0.500 0.600 0.606

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		**U.S. EPA**	
			MODELER: **TDR**	
	OUTPUT TYPE: **Concentration**	RECEPTORS: **5233**	SCALE: 1:140,901 (0 — 4 km)	
	MAX: **0.60624**	UNITS: **ug/m^3**	DATE: **6/2/2019**	PROJECT NO.:

PROJECT TITLE:

Figure 4-8. Veolia, Sauget, Ilinois. Stack 2 - Particle Bound Total Deposition
Plot File of Annual Values Averaged Across 5 Years



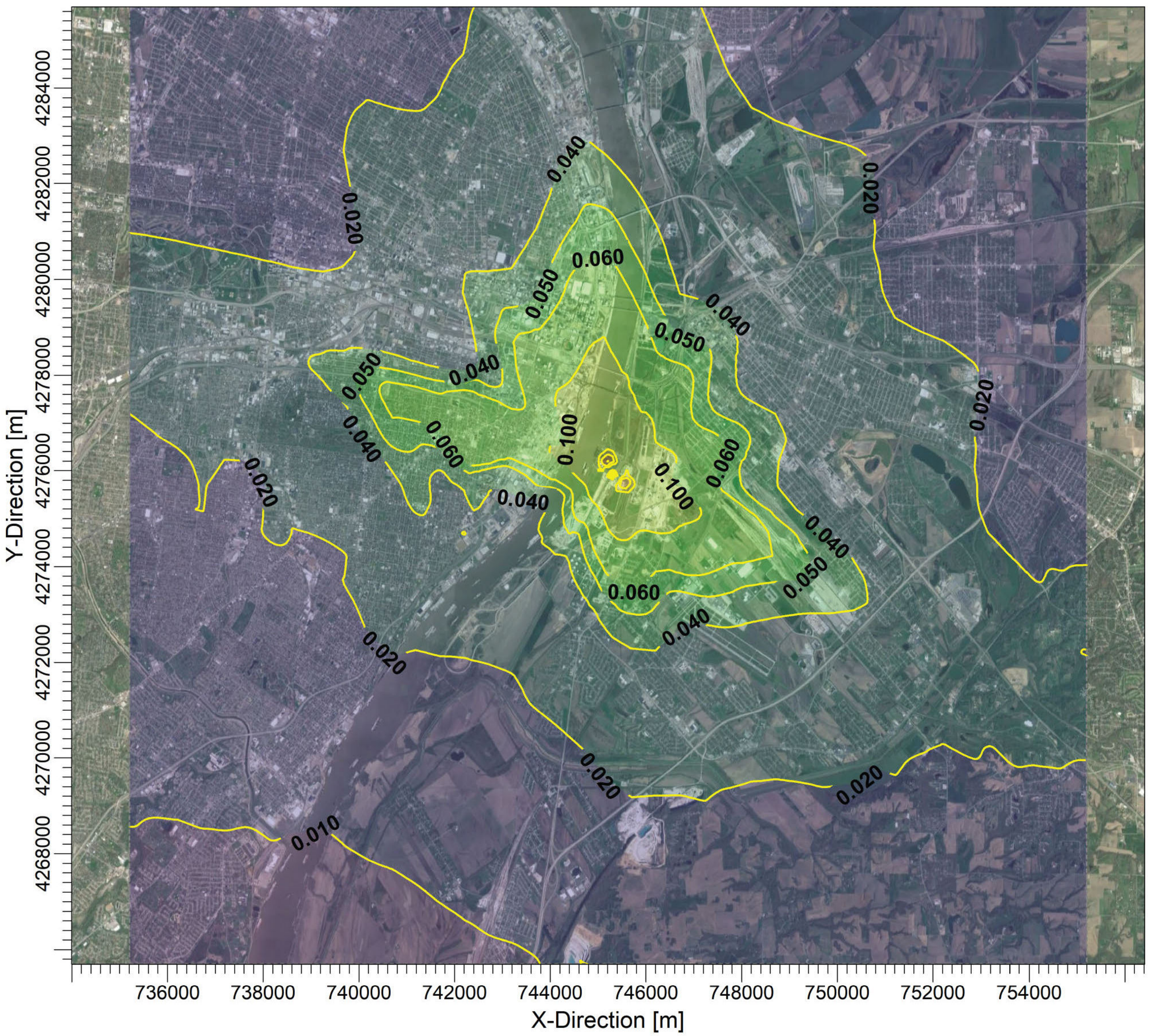
PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL g/m^2

1.7E-04 3.0E-04 5.0E-04 8.0E-04 1.0E-03 3.0E-03 5.0E-03 8.0E-03 1.0E-02 1.8E-02

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		**U.S. EPA**	
			MODELER: **TDR**	
	OUTPUT TYPE: **Total Depos.**	RECEPTORS: **5233**	SCALE: 1:140,901 (0 — 4 km)	
	MAX: **0.0176**	UNITS: **g/m^2**	DATE: **6/2/2019**	PROJECT NO.:

PROJECT TITLE:

Figure 4-9. Veolia, Sauget, Illinois, Stack 2 - Particle Concentration Plot File of Annual Values Averaged Across 5 Years



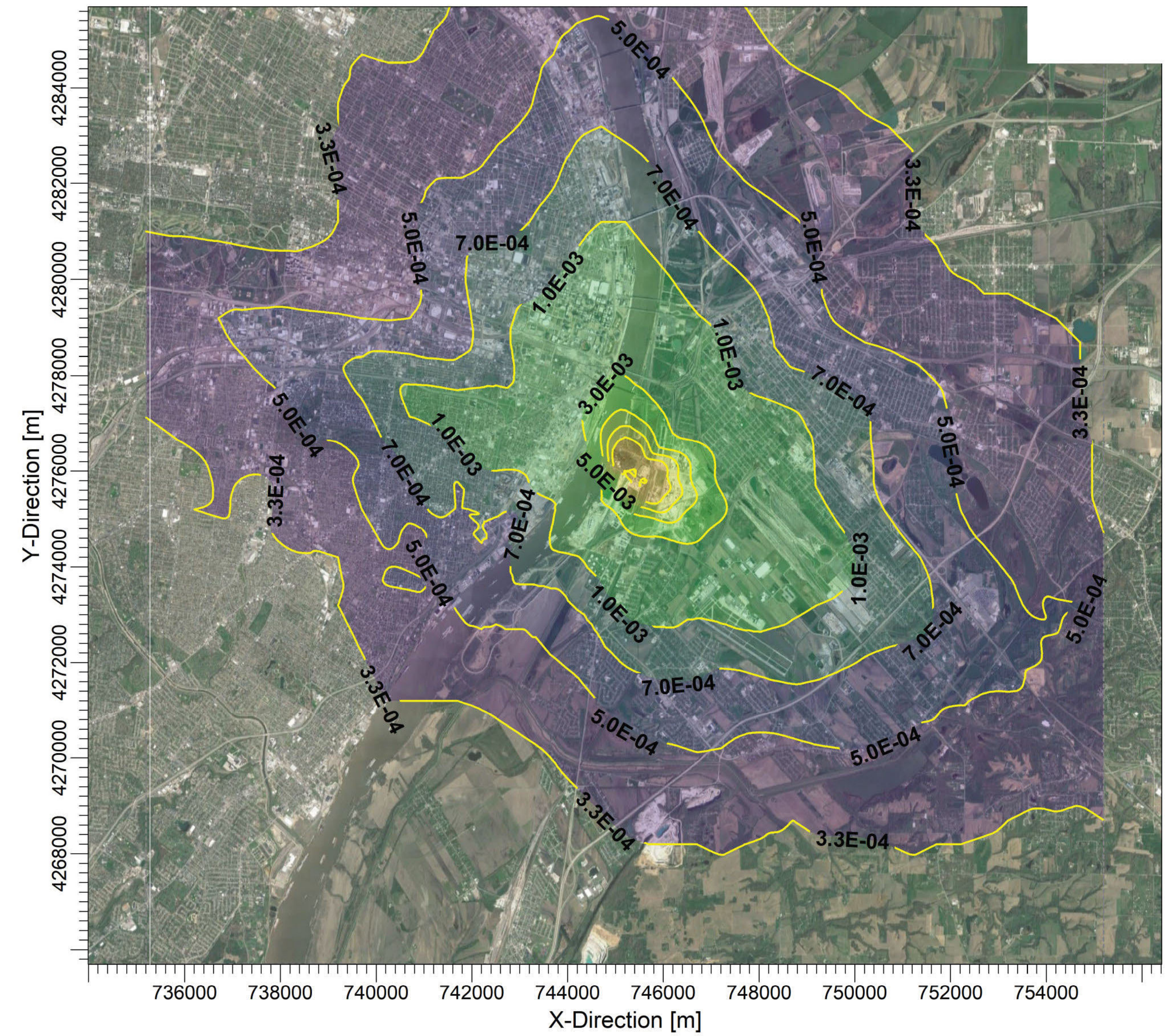
PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

0.006 0.010 0.020 0.040 0.050 0.060 0.100 0.400 0.500 0.600 0.607

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		U.S. EPA	
			MODELER: TDR	
	OUTPUT TYPE: Concentration	RECEPTORS: 5233	SCALE: 1:140,901 (0 — 4 km)	
	MAX: 0.60665	UNITS: ug/m^3	DATE: 6/2/2019	PROJECT NO.:

PROJECT TITLE:

Figure 4-10. Veolia, Sauget, Illinois. Stack 2 - Particle Total Deposition Plot File of Annual Values Averaged Across 5 Years



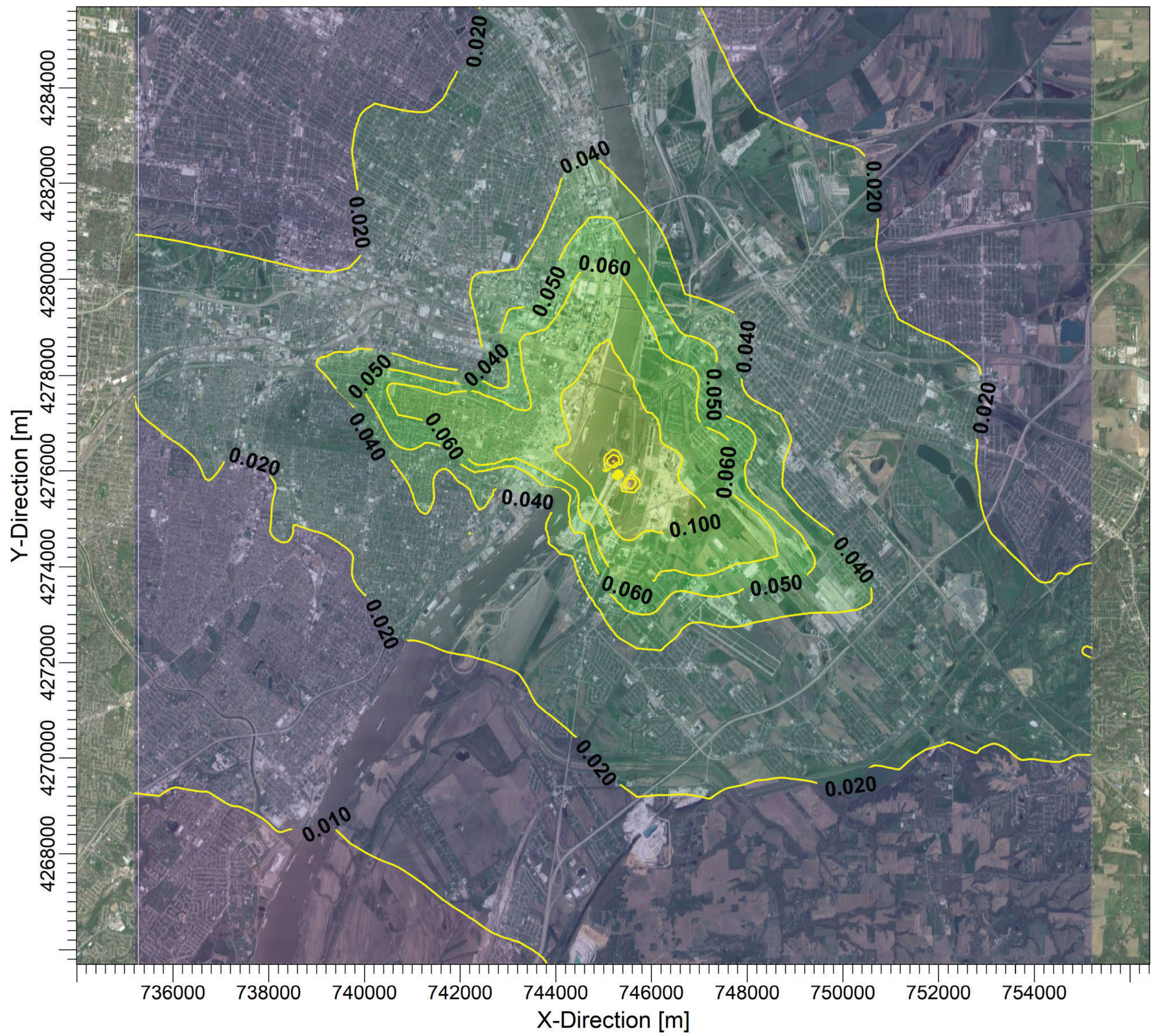
PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL g/m^2

3.3E-04 5.0E-04 7.0E-04 1.0E-03 3.0E-03 5.0E-03 7.0E-03 1.0E-02 3.0E-02 3.3E-02

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		U.S. EPA	
			MODELER: TDR	
	OUTPUT TYPE: Total Depos.	RECEPTORS: 5233	SCALE: 1:140,901 (0 — 4 km)	
	MAX: 0.03323	UNITS: g/m^2	DATE: 6/2/2019	PROJECT NO.:

PROJECT TITLE:

Figure 4-11. Veolia, Sauget, Illinois. Stack 2 - Vapor Concentration Plot File of Annual Values Averaged Across 5 Years



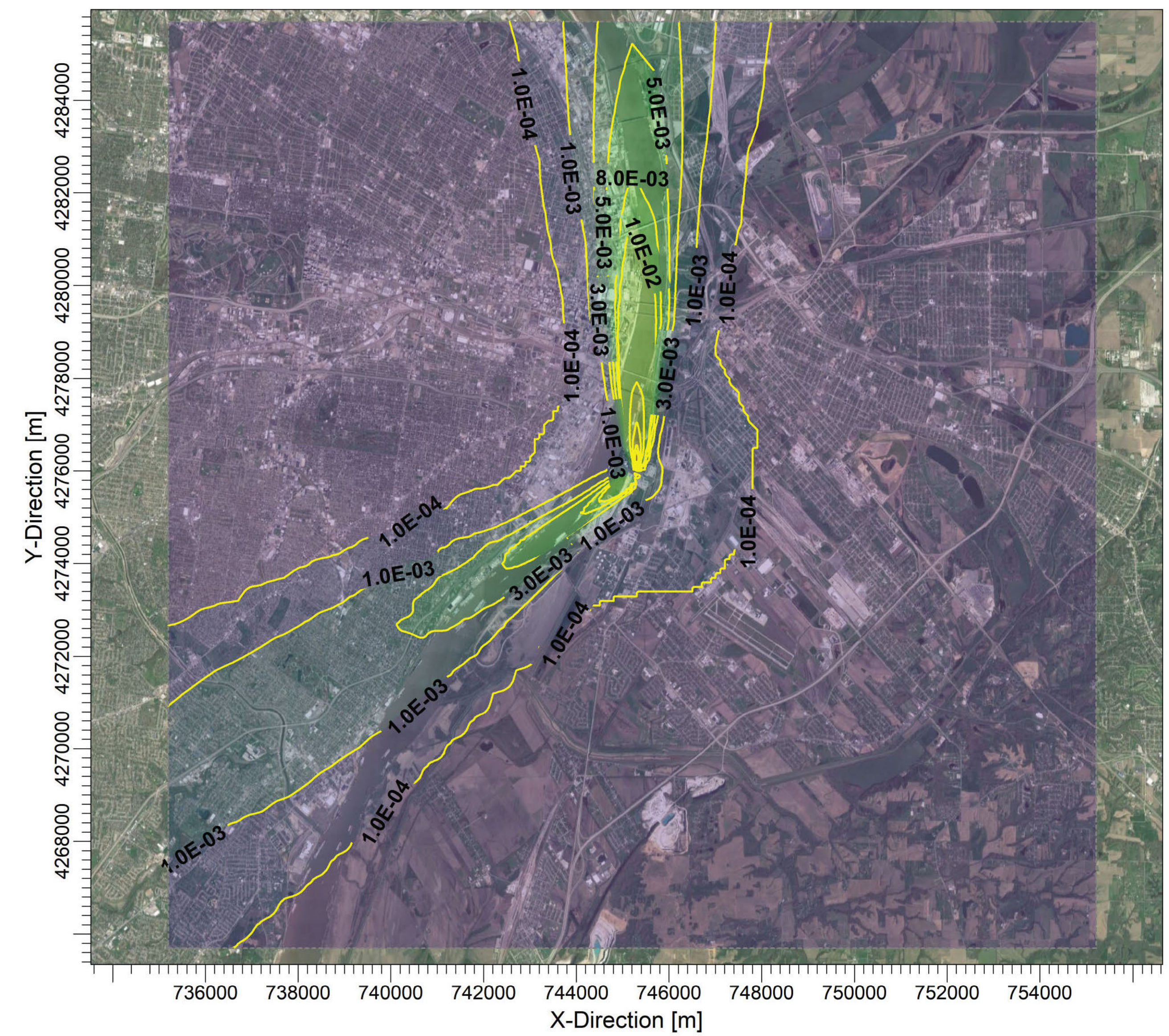
PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

0.006 0.010 0.020 0.040 0.050 0.060 0.100 0.400 0.500 0.600 0.606

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, NONDFAULT, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		**U.S. EPA**	
			MODELER: **TDR**	
	OUTPUT TYPE: **Concentration**	RECEPTORS: **5233**	SCALE: 1:140,901 (0 — 4 km)	
	MAX: **0.60578**	UNITS: **ug/m^3**	DATE: **6/2/2019**	PROJECT NO.:

PROJECT TITLE:

Figure 4-12. Veolia, Sauget, Illinois. Stack 2 - Vapor Total Deposition Plot File of Annual Values Averaged Across 5 Years



PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL g/m^2

0.000 0.000 0.001 0.003 0.005 0.008 0.010 0.030 0.050 0.080 0.100 0.140

COMMENTS:	MODELING OPTIONS:		COMPANY NAME:	
	MODELING, OPTIONS, USED:, NONDFAULT, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT, RURAL, ADJ_U*		**U.S. EPA**	
			MODELER: **TDR**	
	OUTPUT TYPE: **Total Depos.**	RECEPTORS: **5233**	SCALE: 1:145,251 (0 — 4 km)	
	MAX: **0.14039**	UNITS: **g/m^2**	DATE: **6/2/2019**	PROJECT NO.:

Chapter 5 Emission Rates at the MACT Standard

To estimate emission rates, EPA combined the stack gas flow rate with the Clean Air Act Maximum Achievable Control Technology (MACT) standards. The MACT standards applicable to incinerators were promulgated as stack concentrations and not as emission rates. At a constant stack concentration, an increase in stack gas flowrate would increase emission rates. The SSRA results are wholly dependent on emission rates. To estimate emission rates, we must determine the stack gas flowrate and combine it with the MACT standard. EPA calculated MACT emissions using the stack gas flowrates from the 2013 CPT, Table Summaries of Isokinetic Sampling, 3-3, 3-4, and 3-5 (Veolia 2014). One objective of the 2013 CPT test runs was to determine maximum stack gas flowrate. EPA averaged these maximum measured flowrates from the CPT to estimate the emission rate at the MACT. Veolia has operated at higher stack gas flowrates for each of its units in the past and stack gas flowrates higher than the values given here will increase the allowable emissions under the MACT and result in higher modeled risks to the community. EPA separately evaluated actual measured emissions from the 2013 CPT (Veolia 2014) for comparison.

Table 5-1 summarizes the maximum stack gas flowrates EPA used to estimate emission rates at the MACT standard. Tables 5-2 describes emission rates for dioxins and furans at the MACT standard. Note that the MACT standard for dioxin and furan emissions was promulgated as a single value based on the relative toxicity of individual dioxin and furan congeners to 2,3,7,8-tetrachloro-dibenzo-dioxin, known as toxicity equivalence (TEQ). Tables 5-3 through 5-5 summarize emission rates for heavy metals at their respective MACT standards.

Table 5-1

Maximum Stack Gas Flowrate

Unit	Dry Standard Cubic Feet per Minute (dscfm)	Dry Standard Cubic Meters per Second (dscms)
2	5,235	2.47
3	5,459	2.58
4	16,471	7.77

Dioxin/Furans

Table 5-2

Dioxin/Furan Emission Rates

Unit	2013 CPT Stack Flowrate (dscms)	Dioxin MACT Standard (ng TEQ/dscm)	MACT Standard Dioxin Emission Rate (ng TEQ/s)	MACT Standard Dioxin Emission Rate (g TEQ/s)	Average 2013 CPT Dioxin Emission Rate (g TEQ/s)
2	2.47	0.2	0.494	4.94×10^{-10}	1.77×10^{-11}
3	2.58	0.2	0.515	5.15×10^{-10}	2.12×10^{-12}
4	7.77	0.4	3.109	3.11×10^{-9}	6.55×10^{-10}

Metals

Table 5-3 Mercury Emission Rates					
Unit	2013 CPT Stack Flowrate (dscms)	Mercury MACT Standard (ug/dscm)	MACT Standard Mercury Emission Rate (ug/s)	MACT Standard Mercury emission rate (g/s)	Average 2013 CPT Mercury Emission Rate (g/s)
2	2.47	130	321	3.21×10^{-4}	1.87×10^{-4}
3	2.58	130	335	3.35×10^{-4}	8.51×10^{-5}
4	7.77	130	1,010	1.01×10^{-3}	4.95×10^{-5}

Table 5-4 Semi Volatile Metals (SVM) – Cadmium and Lead – Emission Rates					
Unit	2013 CPT Stack Flowrate (dscms)	SVM MACT Standard (ug/dscm)	MACT Standard SVM Emission Rate (ug/s)	MACT Standard SVM Emission Rate (g/s)	Average 2013 CPT SVM Emission Rate (g/s)
2	2.47	230	568	5.68×10^{-4}	1.77×10^{-6}
3	2.58	230	593	5.93×10^{-4}	2.70×10^{-5}
4	7.77	230	1,790	1.79×10^{-3}	3.87×10^{-5}

Table 5-5 Low Volatile Metals (LVM) – Arsenic, Beryllium, and Chromium – Emission Rates					
Unit	2013 CPT Stack Flowrate (dscms)	LVM MACT Standard (ug/dscm)	MACT Standard LVM Emission Rate (ug/s)	MACT Standard LVM Emission Rate (g/s)	Average 2013 CPT LVM Emission Rate (g/s)
2	2.47	92	227	2.27×10^{-4}	4.76×10^{-6}
3	2.58	92	237	2.37×10^{-4}	1.69×10^{-5}
4	7.77	92	715	7.15×10^{-4}	4.76×10^{-5}

Chapter 6 Metals Speciation and Loss to Global Cycle

EPA adjusted emission rates for different species of mercury and chromium expected to be present in the emissions. The different species vary greatly in fate, transport, and toxicity characteristics. Mercury is also adjusted for expected loss to global cycle by which a fraction of mercury emitted does not deposit locally.

EPA estimated mercury speciation from stack testing. Mercury can be emitted not only in different phases (vapor and particle-bound) but also in different species that affect how mercury is dispersed and deposited. The primary species of concern are elemental mercury and divalent mercury. Veolia did not conduct separate stack testing for mercury speciation during the last three CPTs. Mercury speciation can be estimated from the stack testing Method 29 results as follows (U.S. EPA 2005a):

- Mercury found in the probe rinse and filter can be assumed to be particle or particle-bound mercury.
- Mercury found in the nitric acid/hydrogen peroxide impinger and rinse is expected to be divalent mercury vapor.
- Mercury found in the potassium permanganate impinger and rinse is expected to be elemental mercury vapor.

According to the Mercury Study Report to Congress (U.S. EPA 1997b), the greatest degree of local deposition in consideration of loss to global cycle (where some of the mercury is assumed to leave the study area without depositing) is associated with divalent mercury vapor emissions (68% depositing locally).

The fraction of a pollutant that remains in the vapor phase in the surrounding area is identified in the model as F_v. This parameter tells the model how to partition the pollutant between the various phases. Since the "loss to global cycle" assumptions ultimately affect how the mercury species deposit, F_v must be individually calculated for the species of mercury and entered into the model. Table 6-1 summarizes the MACT standard emission rates for different mercury species and includes adjustments for global loss. Table 6-2 summarizes the emission rates for different mercury species at the average emission rate from the 2013 CPT and includes adjustments for global loss.

The diagrams in Figures 6-1, 6-2, and 6-3 show how the speciation of mercury and the estimates for "loss to global cycle" are factored into the emission rates at the MACT standard. The diagrams in Figures 6-4, 6-5, and 6-6 show how the speciation of mercury and the estimates for "loss to global cycle" are factored into the average 2013 CPT reported emission rates. The diagrams also show how EPA calculates F_v for both elemental and divalent mercury. Divalent mercury is modeled as mercuric chloride. These factors combined to scale the dispersion and deposition results from the "unit" emission model to site-specific air concentrations and deposition fluxes for the different species and phases of mercury. EPA then used the scaled results as the contaminant source for fate and transport of mercury through the environment to exposure scenarios.

Chromium is emitted as either the hexavalent species or as the trivalent species. Hexavalent chromium is more toxic than trivalent. EPA does not have site-specific sampling data documenting the fractions of each chromium species in Veolia's stack emissions. In the absence of site-specific data, the HHRAP recommends apportioning them evenly - 50% and 50% (EPA 2005a). Table 6-3 summarizes chomium emissions by species at both the MACT standard and at the average emission from the 2013 CPT (Veolia 2014).

Table 6-1 Speciated Mercury Emission Rates at the MACT Standard Emission					
			Modeled		Modeled
Unit	MACT Standard Mercury emission rate (g/s)	Divalent Mercury Emission Rate (divalent vapor and particle bound) (g/s)	Divalent Mercury Emission Rate with Loss to Global Cycle (g/s)	Elemental Mercury Emission Rate (g/s)	Elemental Mercury Emission Rate with Loss to Global Cycle (g/s)
2	3.21×10^{-4}	2.80×10^{-4}	1.94×10^{-4}	4.11×10^{-5}	4.11×10^{-7}
3	3.35×10^{-4}	3.05×10^{-4}	2.07×10^{-4}	2.97×10^{-5}	2.97×10^{-7}
4	1.01×10^{-3}	9.81×10^{-4}	6.65×10^{-4}	2.97×10^{-5}	2.97×10^{-7}

Table 6-2 Speciated Mercury Emission Rates at the 2013 CPT Emission Rate					
			Modeled		Modeled
Unit	Average 2013 CPT Mercury Emission Rate (g/s)	Divalent Mercury Emission Rate (divalent vapor and particle bound) (g/s)	Divalent Mercury Emission Rate with Loss to Global Cycle (g/s)	Elemental Mercury Emission Rate (g/s)	Elemental Mercury Emission Rate with Loss to Global Cycle (g/s)
2	1.87×10^{-4}	1.63×10^{-4}	1.11×10^{-4}	2.39×10^{-5}	2.39×10^{-7}
3	8.51×10^{-5}	7.86×10^{-5}	5.27×10^{-5}	7.55×10^{-6}	7.55×10^{-8}
4	4.95×10^{-5}	4.81×10^{-5}	3.26×10^{-5}	1.45×10^{-6}	1.45×10^{-8}

Table 6-3 Speciated Chromium Emission Rates at MACT Standard Emission Rate and at 2013 CPT Emission Rate				
Unit	MACT Standard Chromium Emission Rate as Hexavalent Chromium (g/s)	MACT Standard Chromium Emission Rate as Chromium (trivalent) (g/s)	Average 2013 CPT Chromium Emission Rate as Hexavalent Chromium (g/s)	Average 2013 CPT Chromium Emission Rate as Chromium (trivalent) (g/s)
2	1.14×10^{-4}	1.14×10^{-4}	2.38×10^{-6}	2.38×10^{-6}
3	1.19×10^{-4}	1.19×10^{-4}	8.45×10^{-6}	8.45×10^{-6}
4	3.58×10^{-4}	3.58×10^{-4}	2.38×10^{-5}	2.38×10^{-5}

Figure 6-1

Phase Allocation and Speciation of Mercury for Veolia 2019 EPA RIsk Assessment at MACT Standard Emission Rate
Stack 2 - 2013 Method 29 Results

Total Mercury Emmissions			Site-Specific Stack Speciation Results			Mercury Report to Congress Global Loss Fractions		Deposited (g/s)	Lost to Global Cycle (g/s)
into Air	3.21E-04	g/s	% Elemental Mercury Vapor 12.80%	4.11E-05	g/s	1%	Deposited as elemental mercury vapor	4.11E-07	
converted from MACT						99%	Lost to global cycle		4.07E-05
% Vapor Phase 99.95%	3.21E-04	g/s	% Divalent Mercury Vapor 87.2%	2.80E-04	g/s	68%	Deposited as divalent mercury vapor	1.90E-04	
						32%	Lost to global cycle		8.95E-05
% Particle Bound Phase 0.045%	1.46E-07	g/s	% Divalent Mercury Particle Bound 0.045%	1.46E-07	g/s	36%	deposited as divalent mercury particulate	5.25E-08	
						64%	Lost to global cycle as divalent mercury particulate		9.33E-08

Site-Specific Overall Fraction Global Loss

	Total Deposited	Total Lost
	1.91E-04	1.30E-04
Percent of Total	59.409%	40.591%

Summary with Consideration of Loss to Global Cycle

Total mercury emitted deposited as divalent mercury

Deposited as divalent mercury vapor + Deposited as divalent mercury particulate
= 1.90E-04 g/s
or 59.281% of total mercury emitted

Total mercury deposited as elemental vapor

Deposited elemental mercury vapor = 4.11E-07 g/s
0.1280% of total mercury emitted

Method 29 Hg Speciation

	2013 Hg-Speciation	R1	R2	R3	Average			
particulate Hg	Probe Rinse and Filter	0.08	0.08	0.08	0.08	Particulate	0.08	0.045%
		ND	ND	ND				
HgCl2	nitric and peroxide	84.2	182	142	136.06667			
HgCl2	empty rinse	51.6	0.57	0.15	17.44	Divalent	153.50667	87.2%
				ND				
elemental Hg	permanganate	31.136	0.5	3.4	11.678667			
		ND						
elemental Hg	HCl rinse	1.1	17.2	14.3	10.866667	Elemental	22.545333	12.8%
						Total	176.132	

Vapor Fraction (Fv) of Deposited Mercury (for partitioning between vapor and particle bound deposition fluxes)

Fv (divalent mercury)= total deposited as divalent mercury vapor divided by total divalent mercury deposited
Fv (divalent mercury)= 0.999724173

Fv (elemental mercury)= total deposited as elemental mercury vapor divided by total elemental mercury deposited
Fv (elemental mercury)= 1

Figure 6-2

Phase Allocation and Speciation of Mercury for Veolia 2019 EPA RIsk Assessment at MACT Standard Emission Rate
Stack 3 - 2013 Method 29 Results

Total Mercury Emmissions into Air 3.35E-04 g/s converted from MACT

% Vapor Phase	99.88%	3.35E-04 g/s
% Particle Bound Phase	0.116%	3.89E-07 g/s

Site-Specific Stack Speciation Results

% Elemental Mercury Vapor	8.87%	2.97E-05 g/s
% Divalent Mercury Vapor	91.0%	3.05E-04 g/s
% Divalent Mercury Particle Bound	0.116%	3.89E-07 g/s

Mercury Report to Congress Global Loss Fractions

		Deposited (g/s)	Lost to Global Cycle (g/s)
1%	Deposited as elemental mercury vapor	2.97E-07	
99%	Lost to global cycle		2.94E-05
68%	Deposited as divalent mercury vapor	2.07E-04	
32%	Lost to global cycle		9.76E-05
36%	deposited as divalent mercury particulate	1.40E-07	
64%	Lost to global cycle as divalent mercury particulate		2.49E-07

Site-Specific Overall Fraction Global Loss

	Total Deposited	Total Lost
	2.08E-04	1.27E-04
Percent of Total	62.02%	37.981%

Summary with Consideration of Loss to Global Cycle

Total mercury emitted deposited as divalent mercury

Deposited as divalent mercury vapor + Deposited as divalent mercury particulate
= 2.07E-04 g/s
or 61.930% of total mercury emitted

Total mercury deposited as elemental vapor

Deposited elemental mercury vapor = 2.97E-07 g/s
0.089% of total mercury emitted

Method 29 Hg Speciation

	2013 Hg-Speciation	R1	R2	R3	Average			
particulate Hg	Probe Rinse and Filter	0.08	0.08	0.08	0.08	Particulate	0.08	0.116%
		ND	ND	ND				
HgCl2	nitric and peroxide	81	52.2	54	62.4			
HgCl2	empty rinse	0.29	0.25	0.18	0.24	Divalent	62.64	91.0%
elemental Hg	permanganate	0.21	0.048	0.16	0.1393333			
			ND					
elemental Hg	HCl rinse	2.5	2.6	12.8	5.9666667	Elemental	6.106	8.9%
						Total	68.826	

Vapor Fraction (Fv) of Deposited Mercury (for partitioning between vapor and particle bound deposition fluxes)

Fv(divalent mercury)= total deposited as divalent mercury vapor divided by total divalent mercury deposited
Fv(divalent mercury)= 0.999324324

Fv(elemental mercury)= total deposited as elemental mercury vapor divided by total elemental mercury deposited
Fv(elemental mercury)= 1

Figure 6-3

Phase Allocation and Speciation of Mercury for Veolia 2019 EPA RIsk Assessment at MACT Standard Emission Rate
Stack 4 - 2013 Method 29 Results

Total Mercury Emmissions into Air		
	1.01E-03	g/s
	converted from MACT	
% Vapor Phase		
99.41%	1.00E-03	g/s
% Particle Bound Phase		
0.590%	5.96E-06	g/s

Site-Specific Stack Speciation Results

% Elemental Mercury Vapor	2.93%	2.97E-05 g/s
% Divalent Mercury Vapor	96.5%	9.75E-04 g/s
% Divalent Mercury Particle Bound	0.590%	5.96E-06 g/s

Mercury Report to Congress Global Loss Fractions

		Deposited (g/s)	Lost to Global Cycle (g/s)
1%	Deposited as elemental mercury vapor	2.97E-07	
99%	Lost to global cycle		2.94E-05
68%	Deposited as divalent mercury vapor	6.63E-04	
32%	Lost to global cycle		3.12E-04
36%	deposited as divalent mercury particulate	2.15E-06	
64%	Lost to global cycle as divalent mercury particulate		3.81E-06

Site-Specific Overall Fraction Global Loss

	Total Deposited	Total Lost
	6.65E-04	3.45E-04
Percent of Total	65.845%	34.155%

Summary with Consideration of Loss to Global Cycle

Total mercury emitted deposited as divalent mercury

Deposited as divalent mercury vapor + Deposited as divalent mercury particulate
= 6.65E-04 g/s
or 65.816% of total mercury emitted

Total mercury deposited as elemental vapor

Deposited elemental mercury vapor = 2.97E-07 g/s
0.0293% of total mercury emitted

Vapor Fraction (Fv) of Deposited Mercury (for partitioning between vapor and particle bound deposition fluxes)

Fv (divalent mercury)= total deposited as divalent mercury vapor divided by total divalent mercury deposited
Fv (divalent mercury)= 0.996774097

Fv (elemental mercury)= total deposited as elemental mercury vapor divided by total elemental mercury deposited
Fv (elemental mercury)= 1

Method 29 Hg Speciation

	2013 Hg-Speciation	R1	R2	R3	Average			
particulate Hg	Probe Rinse and Filter	0.08	0.08	0.08	0.08	Particulate	0.08	0.590%
		ND	ND	ND				
HgCl2	nitric and peroxide	9	10.4	19.5	12.966667			
HgCl2	empty rinse	0.12	0.12	0.12	0.12	Divalent	13.086667	96.5%
		ND	ND	ND				
elemental Hg	permanganate	0.048	0.047	0.047	0.0473333			
		ND	ND	ND				
elemental Hg	HCl rinse	0.22	0.082	0.75	0.3506667	Elemental	0.398	2.9%
			ND					
						Total	13.564667	

Figure 6-4

Phase Allocation and Speciation of Mercury for Veolia 2019 EPA RIsk Assessment at 2013 CPT Emission Rate
Stack 2 - 2013 Method 29 Results

Total Mercury Emmissions into Air	1.87E-04	g/s
Average emission from 2013 CPT		
% Vapor Phase		
99.95%	1.87E-04	g/s
% Particle Bound Phase		
0.045%	8.49E-08	g/s

Site-Specific Stack Speciation Results

% Elemental Mercury Vapor 12.80%	2.39E-05	g/s
% Divalent Mercury Vapor 87.2%	1.63E-04	g/s
% Divalent Mercury Particle Bound 0.045%	8.49E-08	g/s

Mercury Report to Congress
Global Loss Fractions

		Deposited (g/s)	Lost to Global Cycle (g/s)
1%	Deposited as elemental mercury vapor	2.39E-07	
99%	Lost to global cycle		2.37E-05
68%	Deposited as divalent mercury vapor	1.11E-04	
32%	Lost to global cycle		5.22E-05
36%	deposited as divalent mercury particulate	3.06E-08	
64%	Lost to global cycle as divalent mercury particulate		5.44E-08

Site-Specific Overall Fraction Global Loss

	Total Deposited	Total Lost
	1.11E-04	7.59E-05
Percent of Total	59.409%	40.591%

Summary with Consideration of Loss to Global Cycle

Total mercury emitted deposited as divalent mercury

Deposited as divalent mercury vapor + Deposited as divalent mercury particulate
= 1.11E-04 g/s
or 59.281% of total mercury emitted

Total mercury deposited as elemental vapor

Deposited elemental mercury vapor = 2.39E-07 g/s
0.1280% of total mercury emitted

Vapor Fraction (Fv) of Deposited Mercury (for partitioning between vapor and particle bound deposition fluxes)

Fv (divalent mercury)= total deposited as divalent mercury vapor divided by total divalent mercury deposited
Fv (divalent mercury)= 0.999724173

Fv (elemental mercury)= total deposited as elemental mercury vapor divided by total elemental mercury deposited
Fv (elemental mercury)= 1

Method 29 Hg Speciation

	2013 Hg-Speciation	R1	R2	R3	Average			
particulate Hg	Probe Rinse and Filter	0.08	0.08	0.08	0.08	Particulate	0.08	0.045%
		ND	ND	ND				
HgCl2	nitric and peroxide	84.2	182	142	136.06667			
HgCl2	empty rinse	51.6	0.57	0.15	17.44	Divalent	153.50667	87.2%
				ND				
elemental Hg	permanganate	31.136	0.5	3.4	11.678667			
		ND						
elemental Hg	HCl rinse	1.1	17.2	14.3	10.866667	Elemental	22.545333	12.8%
						Total	176.132	

Figure 6-5

Phase Allocation and Speciation of Mercury for Veolia 2019 EPA RIsk Assessment at 2013 CPT Emission Rate
Stack 3 - 2013 Method 29 Results

Total Mercury Emmissions into Air: 8.51E-05 g/s
Average emission from 2013 CPT

% Vapor Phase: 99.88% 8.50E-05 g/s

% Particle Bound Phase: 0.116% 9.89E-08 g/s

Site-Specific Stack Speciation Results

% Elemental Mercury Vapor	8.87%	7.55E-06	g/s
% Divalent Mercury Vapor	91.0%	7.75E-05	g/s
% Divalent Mercury Particle Bound	0.116%	9.89E-08	g/s

Mercury Report to Congress Global Loss Fractions

		Deposited (g/s)	Lost to Global Cycle (g/s)
1%	Deposited as elemental mercury vapor	7.55E-08	
99%	Lost to global cycle		7.47E-06
68%	Deposited as divalent mercury vapor	5.27E-05	
32%	Lost to global cycle		2.48E-05
36%	deposited as divalent mercury particulate	3.56E-08	
64%	Lost to global cycle as divalent mercury particulate		6.33E-08

Site-Specific Overall Fraction Global Loss

	Total Deposited	Total Lost
	5.28E-05	3.23E-05
Percent of Total	62.02%	37.981%

Summary with Consideration of Loss to Global Cycle

Total mercury emitted deposited as divalent mercury

Deposited as divalent mercury vapor + Deposited as divalent mercury particulate
= 5.27E-05 g/s
or 61.930% of total mercury emitted

Total mercury deposited as elemental vapor

Deposited elemental mercury vapor = 7.55E-08 g/s
0.089% of total mercury emitted

Vapor Fraction (Fv) of Deposited Mercury (for partitioning between vapor and particle bound deposition fluxes)

Fv(divalent mercury)= total deposited as divalent mercury vapor divided by total divalent mercury deposited
Fv(divalent mercury)= 0.999324324

Fv(elemental mercury)= total deposited as elemental mercury vapor divided by total elemental mercury deposited
Fv(elemental mercury)= 1

Method 29 Hg Speciation

	2013 Hg-Speciation	R1	R2	R3	Average			
particulate Hg	Probe Rinse and Filter	0.08	0.08	0.08	0.08	Particulate	0.08	0.116%
		ND	ND	ND				
HgCl2	nitric and peroxide	81	52.2	54	62.4			
HgCl2	empty rinse	0.29	0.25	0.18	0.24	Divalent	62.64	91.0%
elemental Hg	permanganate	0.21	0.048	0.16	0.1393333			
			ND					
elemental Hg	HCl rinse	2.5	2.6	12.8	5.9666667	Elemental	6.106	8.9%
						Total	68.826	

Figure 6-6

Phase Allocation and Speciation of Mercury for Veolia 2019 EPA RIsk Assessment at 2013 CPT Emission Rate
Stack 4 - 2013 Method 29 Results

Emissions			Site-Specific Stack Speciation Results				Mercury Report to Congress Global Loss Fractions		Deposited (g/s)	Lost to Global Cycle (g/s)
Total Mercury Emmissions into Air	4.95E-05	g/s	% Elemental Mercury Vapor 2.93%	1.45E-06	g/s		1%	Deposited as elemental mercury vapor	1.45E-08	
Average emission from 2013 CPT							99%	Lost to global cycle		1.44E-06
% Vapor Phase 99.41%	4.92E-05	g/s	% Divalent Mercury Vapor 96.5%	4.78E-05	g/s		68%	Deposited as divalent mercury vapor	3.25E-05	
							32%	Lost to global cycle		1.53E-05
% Particle Bound Phase 0.590%	2.92E-07	g/s	% Divalent Mercury Particle Bound 0.590%	2.92E-07	g/s		36%	deposited as divalent mercury particulate	1.05E-07	
							64%	Lost to global cycle as divalent mercury particulate		1.87E-07

Site-Specific Overall Fraction Global Loss

	Total Deposited	Total Lost
	3.26E-05	1.69E-05
Percent of Total	65.845%	34.155%

Summary with Consideration of Loss to Global Cycle

Total mercury emitted deposited as divalent mercury

Deposited as divalent mercury vapor + Deposited as divalent mercury particulate
= 3.26E-05 g/s
or 65.816% of total mercury emitted

Total mercury deposited as elemental vapor

Deposited elemental mercury vapor = 1.45E-08 g/s
0.0293% of total mercury emitted

Method 29 Hg Speciation

	2013 Hg-Speciation	R1	R2	R3	Average			
particulate Hg	Probe Rinse and Filter	0.08	0.08	0.08	0.08	Particulate	0.08	0.590%
		ND	ND	ND				
HgCl2	nitric and peroxide	9	10.4	19.5	12.966667			
HgCl2	empty rinse	0.12	0.12	0.12	0.12	Divalent	13.086667	96.5%
		ND	ND	ND				
elemental Hg	permanganate	0.048	0.047	0.047	0.0473333			
		ND	ND	ND				
elemental Hg	HCl rinse	0.22	0.082	0.75	0.3506667	Elemental	0.398	2.9%
			ND					
						Total	13.564667	

Vapor Fraction (Fv) of Deposited Mercury (for partitioning between vapor and particle bound deposition fluxes)

Fv (divalent mercury)= total deposited as divalent mercury vapor divided by total divalent mercury deposited
Fv (divalent mercury)= 0.996774097

Fv (elemental mercury)= total deposited as elemental mercury vapor divided by total elemental mercury deposited
Fv (elemental mercury)= 1

This page intentionally left blank.

Chapter 7 Uncertainty

EPA used the AERMOD dispersion model for this SSRA. AERMOD is a steady-state plume model that assumes Gaussian distributions in the vertical and horizontal dimensions for stable conditions, and in the horizontal for convective conditions. Vertical concentration distributions in convective conditions are from a bi-Gaussian probability density function of the vertical velocity. Unlike ISCST3, AERMOD includes updated treatments of boundary layer theory, an understanding of turbulence and dispersion, and handling of terrain interactions (U.S. EPA 2003). In 2005, EPA determined that AERMOD is appropriate for point sources with elevated continuous releases of toxic air emissions in rural or urban areas of simple and complex terrain with receptors up to 50 km from the source (U.S. EPA 2005b).

Studies of model accuracy described in the EPA Revision to the Guideline on Air Quality Models (70 FR 68218) for models such as AERMOD show that "models are more reliable for estimating longer time-averaged concentrations" (such as the annual averages used in this risk assessment) and that "the models are reasonably reliable in estimating the magnitude of highest concentrations." Furthermore, model evaluation studies showed a notable improvement in accuracy over the dispersion model ISCST3, which was used in previous SSRAs (U.S. EPA 2005b).

EPA chose a 20- by 20-kilometer grid centered on the facility to model air dispersion for this SSRA. HHRAP recommends this configuration as described in Chapter 4: "experience has shown us that most significant deposition occurs within a 10-km radius" (U.S. EPA 2005a). EPA determined that configuration is appropriate in this situation.

Table 7-1 summarizes site-specific data used to refine the air-modeling. Site-specific data is of greater certainty than default or estimated values. There will be some uncertainty with models such as AERMOD; and it is important to note that actual concentrations could be higher or lower.

Table 7-1 Air-Dispersion Modeling Site-Specific Parameter Sources	
Parameter	Source
Stack Location	Google Earth Pro
Stack Height	Franklin 2017
Stack Diameter	Franklin 2017
Stack Gas Exit Velocity	Veolia 2016a, 2016b, 2016c
Stack Gas Temperature	Veolia 2014
Stack Base Elevations and Terrain Data for Study Area	AERMAP
Surface and Upper Air Hourly and Climatic Data from 2011-2015	NOAA ftp://ftp.ncdc.noaa.gov/pub/data/noaa/ http://esrl.noaa.gov/raobs/ https://www.ncdc.noaa.gov/qclcd/QCLCD https://www.weather.gov/media/lsx/climate/stl/ precip/precip_stl_ranked_annual_amounts.pdf ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin
Local Land Use/Land Cover Data for Wind Profile and Deposition	USGS 2000, 2014
Location and Dimensions of Facility Building, Tanks, and Structures for Building Downwash Evaluation	IEPA 2017
Site-specific Test Data for Particle Size Distribution	Onyx 2005

Chapter 8 References

Franklin 2017, *Veolia Environmental Services Rotary Kiln and Fixed Hearth Incinerators Human Health Risk Assessment Report*, Franklin Engineering Group, Inc., Franklin, TN, December 22, 2017.

IEPA 2017, electronic message from S. Suthar, IEPA to T. Ramaly, U.S. EPA, regarding dispersion modeling files provided to IEPA by Veolia ES Technical Solutions, L.L.C., including attachments, June 28, 2017.

Onyx, 2005, Correspondence with T. Ramaly, U.S. EPA via electronic mail with attached document *Determination of Appropriate Particle Size Distribution and Mercury Speciation to be Utilized for the Fixed Hearth and Rotary Kiln Incinerators*, David Klarich, Onyx Environmental Services, Inc., October 14.

Qian, W., and A. Venkatram, 2011: "Performance of Steady-State Dispersion Models Under Low Wind-Speed Conditions", Boundary Layer Meteorology, 138, 475-491. Schulman, L.L., D.G. Strimaitis, and J.S. Scire, 1980: Buoyant line and point source (BLP) dispersion model user's guide. Prepared for The Aluminum Association, Inc. P-7304B. July 1980

U.S. EPA 1997a, *Model Parameter Sensitivity Analysis,* U.S. EPA Region 6 Center for Combustion Science and Engineering, Dallas, TX, May 23, 1997.

U.S. EPA 1997b, *Mercury Study Report to Congress, Volume III: Fate and Transport of Mercury in the Environment,* EPA-452/R-97-005, OAQPS and ORD, U.S. EPA, Washington DC, December 1997.

U.S. EPA 2003, *AERMOD: Latest Features and Evaluation Results*, EPA-454/R-03-003, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, June 2003.

U.S. EPA 2005a, *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities,* Office of Solid Waste and Emergency Response, EPA530-R-05-006, September 2005.

U.S. EPA 2005b, *Revision to the Guidance on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions, Final Rule*, Federal Register Volume 70, number 216, November 9, 2005.

U.S. EPA 2013, *MEMORANDUM - Use of ASOS meteorological data in AERMOD dispersion modeling*, Office of Air Quality Planning and Standards, Air Quality Modeling Group, Research Triangle Park, NC, March 8, 2013.

U.S. EPA 2014, *DRAFT Regional Meteorological Data Processing Protocol, EPA Region 5 and States,* U.S. EPA, Chicago, IL, August 2014.

U.S. EPA 2016, *Memorandum to File, RE: Review of the Literature for Gas Deposition Parameters for Divalent Mercury Vapor for Use in Air-dispersion and Risk Assessment Modeling, T. Ramaly and C. Lambesis*, U.S. EPA Region 5, Land and Chemicals Division, Chicago, IL, September 13, 2016.

USGS 2000, *NLCD 1992 Land Cover Conterminous United States*, U.S. Geologic Survey, Sioux Falls, SD, October 10, 2000.

USGS 2014, *NLCD 2011 Land Cover (2011 Edition),* U.S. Geologic Survey, March 31, 2014.

Veolia 2014, *Comprehensive Performance Test Report - Fixed Hearth Incinerator - Unit 2 Fixed Hearth Incinerator - Unit 3, Rotary Kiln Incinerator - Unit 4,* Veolia ES Technical Solutions L.L.C., Sauget, IL, January 28, 2014.

Veolia 2016a, *Confirmatory Performance Test Plan for the Unit 2 Fixed Hearth Incinerator*, Veolia ES Technical Solutions, L.L.C., Sauget, IL, January 7, 2016.

Veolia 2016b, *Confirmatory Performance Test Plan for the Unit 3 Fixed Hearth Incinerator*, Veolia ES Technical Solutions, L.L.C., Sauget, IL, January 7, 2016.

Veolia 2016c, *Confirmatory Performance Test Plan for the Unit 4 Rotary Kiln Incinerator*, Veolia ES Technical Solutions, L.L.C., Sauget, IL, January 7, 2016.

Veolia 2019, *Comprehensive Performance Test Report for Fixed Hearth Incinerator – Unit 2, Fixed Hearth Incinerator – Unit 3, Rotary Kiln Incinerator – Unit 4*, Prepared for: Veolia ES Technical Solutions, L.L.C., Sauget, IL, January 23, 2019.

Wesely, M.L., Doskey, P.V., and Shannon, J.D., 2002, *Deposition Parameterizations for the Industrial Source Complex (ISC3) Model*, Environmental Research Division, Argonne National Laboratory, Argonne, IL, June 2002.