7. Case G

A. Source Characterization

Case G is one of four hazardous waste incinerators selected for this analysis. Facility and source parameters used in the air dispersion modeling and risk assessment of this site are presented in Table A-7.1. Values listed in the table were obtained from facility-specific information provided by the EPA.

Table A-7.1. Facility and Source Parameters for Case G

Parameter	Case G
Facility type	Incinerator
Land-use w/in 5 km	Industrial
Terrain use	No
Operating hours (8,760/year possible)	6,920
Stack parameters	Stack 1
Stack height (m)	30.5
Diameter (m)	1.8
Total flow rate (dscfm) / (dscms)	44,800 / 21.1
Exit velocity (m/s)	14.4
Exit temperature (K)	331.4

B. Setting Characterization

Case G is located in the south-central United States in an area of flat terrain. Land use surrounding the site is industrial in all directions but the southeast. The Gulf Stream lies to the southeast of the facility.

Meteorologic data for the National Weather Service Station for Hobby Field in Houston, Texas, was purchased from National Climatic Data Center because it provided the most appropriate surface data for Case G. The proximity of Hobby Field to the facility and the similarity in the land use made the use of this meteorologic location superior to that of Houston Intercontinental, which was available from SCRAM. Upper air data from Lake Charles, Louisiana, and Victoria, Texas (from SCRAM), were paired with the surface data for air dispersion modeling. Five years of meteorologic data, for the years 1986-1990, were used to determine long-term average air dispersion and deposition estimates. Table A-7.2 lists the annual average meteorologic parameters, which were obtained from the International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992). Also listed in Table A-7.2 are the average evapotranspiration rate and annual runoff. These values were used with the precipitation rate to calculate a water balance for Case G. One-half of the average annual runoff value cited in the *Water Atlas* (Geraghty, et al., 1973) was used in the analysis. The adjustment was made to account for surface runoff only and not the subsurface inflows to surface waters. The evapotranspiration rate was calculated by assuming 70 percent of the precipitation evaporates.

Table A-7.2. Annual Average Meteorologic Parameters for Case G

Ave. annual evapotranspiration (cm/yr)	Ave. annual runoff [a] (cm/yr)	Ave. annual precipitation[b] (cm/yr)	Ambient air temperature[b] (K)	Mean annual windspeed[b] (m/s)
83.4	12.7	119.1	293.6	4.1

[a] *Water Atlas* (Geraghty et al., 1973).
[b] International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992).

C. Characterization of Exposed Populations

Table A-7.3 presents the locations of exposed populations identified for Case G. Information regarding the location of the residence and farms likely to be most impacted by Case G was obtained through telephone interviews with local planning offices and local agricultural extension agents. The local officials were asked to identify farms near the facility where subsistence activities would be likely. Farms identified by local officials were assessed to determine which would be most impacted by the facility emissions, and the maximally impacted farms were assumed to represent the location of the subsistence farmers.

Table A-7.3. Location of Receptors Identified for Case G

Receptor	Location (Distance (km)/Direction)	Source
Residence of home gardener	0.7 km southeast	City Planning and Development Department
Subsistence beef farm	5 km south-southeast[a]	City Engineering Department
Subsistence dairy farm	5 km south-southeast[a]	City Engineering Department
Subsistence poultry farm	5 km south-southeast[a]	City Engineering Department
Subsistence pork farm	5 km south-southeast[a]	City Engineering Department
Subsistence fisher location (inhalation and soil ingestion) San Jacinto River Trinity River Highlands Reservoir Shelton Reservoir	 4 km north 24 km northeast 11 km north-northeast 21 km north-northwest	Location of maximum air concentration of vapors within the watershed
Waterbody identified as surface drinking water source	Trinity River Lake Houston (San Jacinto River)	City Planning and Development Department

[a] Default assumption based on location of subsistence beef farmer.

The waterbodies were selected from USGS topographical maps as those that would be large enough to support fish yet would reflect the highest impact from the facility. Phone calls to local officials verified that individuals might consume fish caught in the selected waterbodies. The topographic maps were also used in identifying the watersheds associated with each waterbody and in estimating waterbody and watershed surface areas. Table A-7.4 lists the surface areas and other surface water parameters for Case G. References for the surface water parameters are also listed in the table.

The fraction of food contaminated was varied depending on the scenario. In this analysis, the fraction contaminated is defined as the fraction of what is consumed that is contaminated by facility emissions. The fraction contaminated is independent of the level of contamination. The level of contamination is dependent upon the production location. Contamination levels calculated for a subsistence farm located near the facility would be higher than those calculated for the typical farm (air concentrations and deposition rates averaged to 20 kilometers over the land only). The terms "subsistence level of contamination" and "typical level of contamination" are used to reflect the different levels.

Central tendency and high-end contaminated fractions were developed based on an economic analysis of regional production and processing capacity and the fraction home-produced recommendations from the *Exposure Factors Handbook* (U.S. EPA, 1990). The fractions were developed using data from counties within 50 kilometers of the site. The economic analysis is discussed in detail in Section II.E.2 of the main report. The commodity with the highest fraction locally produced was assumed to be the commodity produced by the typical farmer. Local agricultural production indicated that the typical farmer for Case G was a produce farmer. The fractions assumed to be locally produced and processed for Case G are as follows:

Beef	0.01	Pork	0.01
Dairy	0.05	Poultry	0.01
Produce	0.02	Eggs	0.01
Fish	0.01		

The subsistence farmers considered for Case G were beef, dairy, poultry, and pork farmers. The locations of the subsistence farmers, listed in Table A-7.3, were used for estimating exposures from direct inhalation and soil ingestion. The fraction contaminated is assumed to be 1 for the livestock the subsistence farmer is identified as producing. He was also assumed to grow all the fruits and vegetables he consumed. For example, the subsistence beef farmer was assumed to produce all the beef, vegetables, and fruits that he ingested and to purchase all other dietary items -- such as milk, pork, fish, etc. -- from local markets. The items raised on the subsistence farms had higher levels of contamination than what was available in the local market. The local items purchased in the market were contaminated at levels that reflected the average impact from the stack out to 20 kilometers over land from the facility. Subsistence farmers consuming fish from Trinity River were also assumed to drink contaminated water from Trinity River. Tables A-7.5 through A-7.8 list the locations of contamination and the contaminated fraction by pathway for the subsistence farm scenarios.

Table A-7.4. Surface Water Parameters for Case G

Waterbody	Surface Area (m^2)[a]	Watershed Area (m^2)[a]	Impervious Watershed Area (m^2)[b]	Average Volumetric Flow Rate[c] (m^3/yr)	Current Velocity[d] (m/s)	Depth of Water Column (m)[e]	USLE Rainfall/ Erosivity Factor[f]
Highlands Reservoir	2.0E+06	2.0E+06	4.0E+04	2.5E+05	NA	4	300
San Jacinto River / Lake Houston	5.4E+07	3.3E+08	2.3E+07	3.4E+09	0.66	2.1	300
Sheldon Reservoir	4.8E+06	1.9E+07	9.5E+04	2.4E+06	NA	6.1	300
Trinity River	4.0E+06	3.6E+08	1.8E+06	4.5E+07	0.1	1.0	300

[a] Surface areas for the watersheds and waterbodies were determined from the USGS 1.25 000-scale topographic 7.5 min X 15 min quadrangles.

[b] Impervious watershed areas were estimated from USGS quadrangles, site-specific land use, and a study of percent imperviousness for different land uses conducted by Camp, Dresser, and McKee (1989).

[c] The volumetric flow rate for the San Jacinto River was obtained from the REACH (U.S. EPA, 1995a) database. Flow rates for the other waterbodies were calculated from the watershed area and average annual surface runoff.

[d] Current velocity for the San Jacinto River was obtained from the REACH (U.S. EPA, 1995a) database. Current velocity for the Trinity River was estimated from its volumetric flow rate and cross-sectional area. Current velocities for lakes were not required and are listed as NA (Not Applicable).

[e] Depth for the San Jacinto River was calculated from the volumetric flow rates, the current velocity, and width. The remaining depths were assumed from defaults of 4 to 6 meters for lakes and 1 meter for rivers.

[f] USLE Erosivity/Rainfall Factor was obtained from Edwards (1993) and was used in the universal soil loss equation.

Table A-7.5. Exposure Scenario for Subsistence Beef Farmer, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (5 km south-southeast)	1.0
Soil ingestion	Location of subsistence beef farm (5 km south-southeast)	1.0
Belowground vegetables	Location of subsistence beef farm (5 km south-southeast)	1.0
Aboveground produce	Location of subsistence beef farm (5 km south-southeast)	1.0
Beef ingestion	Location of subsistence beef farm (5 km south-southeast)	1.0
Milk ingestion	Average over land to 20 km	0.05
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.01
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

Table A-7.6. Exposure Scenario for Subsistence Dairy Farmer and Child, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Soil ingestion	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Belowground vegetables	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Aboveground produce	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.01
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

Table A-7.7. Exposure Scenario for Subsistence Pork Farmer, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Soil ingestion	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Belowground vegetables	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Aboveground produce	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.05
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.01
Pork ingestion	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

Table A-7.8. Exposure Scenario for Subsistence Poultry Farmer, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Soil ingestion	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Belowground vegetables	Location of subsistence beef farm (5 km south-southeast) [a]	1.0
Aboveground produce	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.05
Chicken meat ingestion	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Egg ingestion	Location of subsistence beef farm (5 km south-southeast)[a]	1.0
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

A subsistence fisher was modeled for each watershed. The fish consumption rate for the subsistence fisher was 60 g/d, rather than the 1.64-g/d rate of the general population. The locations of the residences of the subsistence fishers were assumed to be the site of highest vapor air concentration within the affected watershed. The residence location was used for estimating exposures from direct inhalation and soil ingestion. All fish in the diet was assumed to be from the watershed where the subsistence fisher resided. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. The subsistence fisher consuming fish from Trinity River was also assumed to drink contaminated water from Trinity River. Table A-7.9 lists the locations of contamination and the contaminated fraction by pathway for the subsistence fisher scenario.

Table A-7.9. Exposure Scenario for Subsistence Fisher, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of maximum vapor air concentration in each watershed	1.0
Soil ingestion	Location of maximum vapor air concentration in each watershed	1.0
Belowground vegetables	Average over land to 20 km	0.02
Aboveground produce	Average over land to 20 km	0.02
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.05
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.01
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion (60 g/d)	Each watershed	1.0

The location of the home gardener and child was derived from the location of the closest actual residence to the facility. This residential location was used to estimate exposures from direct inhalation and soil ingestion. The fractions contaminated for the aboveground produce and belowground vegetables were determined by adding the fraction contaminated in the local market to the fraction that the gardener home-raised and consumed, as cited in the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.27 by adding the homegrown fraction of 0.25 to 2 percent of the remaining 0.75 purchased from local markets. All other dietary items were assumed purchased from local markets and to contain typical levels of contamination derived from air deposition and concentration estimates averaged over the surrounding land area to 20 kilometers from the facility. The home gardener consuming fish from Trinity River was also assumed to drink contaminated water from Trinity River. Table A-7.10 lists the locations of contamination and the contaminated fraction by pathway for the home gardener scenarios.

Table A-7.10. Exposure Scenario for Home Gardener and Child, Case G

Exposure Pathway	**Location for Calculating Contamination**	**Fraction Contaminated**	
Direct inhalation	Location of home gardener (0.7 km southeast)	1.0	
Soil ingestion	Location of home gardener (0.7 km southeast)	1.0	
Belowground vegetables	Location of home gardener (0.7 km southeast)	Central tendency	High end
		0.25 Typical farmer + 0.75 x Local market = 0.27	0.40 Typical farmer + 0.60 x Local market = 0.41
Aboveground produce	Location of home gardener (0.7 km southeast)	0.25 Typical farmer + 0.75 x Local market = 0.27	40% Typical farmer + 60% x Local market = 0.41
Beef ingestion	Average over land to 20 km	0.01	0.01
Milk ingestion	Average over land to 20 km	0.05	0.05
Chicken meat ingestion	Average over land to 20 km	0.01	0.01
Egg ingestion	Average over land to 20 km	0.01	0.01
Pork ingestion	Average over land to 20 km	0.01	0.01
Fish ingestion	Each watershed	0.01	0.01

The typical adult resident and child exposures were based on air concentrations and deposition rates averaged over the land surrounding the facility out to 20 kilometers. The averages were used for estimating exposures from direct inhalation and soil ingestion. All dietary items were assumed purchased from the local market and to contain typical levels of contamination. The typical resident consuming fish from Trinity River was also assumed to drink contaminated water from Trinity River. Table A-7.11 lists the locations of contamination and the contaminated fraction by pathway for the typical resident scenarios.

Table A-7.11. Exposure Scenario for Typical Adult Resident and Child, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average over land to 20 km	1.0
Soil ingestion	Average over land to 20 km	1.0
Belowground vegetables	Average over land to 20 km	0.02
Aboveground produce	Average over land to 20 km	0.02
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.05
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.01
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

The typical farmer for this site was assumed to be a produce farmer because the fraction of produce locally grown was higher than the fractions for the other commodities in the analysis. The typical produce farmer was assumed to produce a fraction of the vegetables and fruits he consumed and to purchase all other dietary items from the local market. The fractions contaminated for each pathway were determined by adding the fraction contaminated in the local market to the fraction that the farmer home-raised and consumed, as cited in the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.27 by adding the homegrown fraction of 0.25 to 2 percent of the remaining 0.75 purchased from local markets. Both the items raised on the typical farm and the items purchased from local markets had typical levels of contamination. The typical produce farmer's exposures from direct inhalation and soil ingestion were estimated to be at levels derived from air dispersion and deposition outputs averaged over the surrounding land out to 20 kilometers. The typical farmer consuming fish from Trinity River was also assumed to drink contaminated water from Trinity River. Table A-7.12 lists the locations of contamination and the contaminated fraction by pathway for the typical farmer scenario.

Table A-7.12. Exposure Scenario for Typical Farmer, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated	
Direct inhalation	Average over land to 20 km	1.0	
Soil ingestion	Average over land to 20 km	1.0	
		Central tendency	High-end
Belowground vegetables	Average over land to 20 km	0.25 Typical farmer + 0.75 x Local market = 0.27	0.40 Typical farmer + 0.60 x Local market = 0.41
Aboveground produce	Average over land to 20 km	0.25 Typical farmer + 0.75 x Local market = 0.27	40% Typical farmer + 60% x Local market = 0.41
Beef ingestion	Average over land to 20 km	0.01	0.01
Milk ingestion	Average over land to 20 km	0.05	0.05
Chicken meat ingestion	Average over land to 20 km	0.01	0.01
Egg ingestion	Average over land to 20 km	0.01	0.01
Pork ingestion	Average over land to 20 km	0.01	0.01
Fish ingestion	Each watershed	0.01	0.01

Recreational fishers were modeled for each waterbody by combining the typical resident scenario with an increased consumption of contaminated fish recreationally caught (30 g/d). The recreational fisher's exposures from direct inhalation and soil ingestion were derived from air dispersion and deposition outputs averaged over the surrounding land out to 20 kilometers. All fish in the diet was assumed to be from a single waterbody. For instance, the recreational fisher identified for the Sheldon Reservoir ate only fish caught in the Sheldon Reservoir. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. The recreational fisher consuming fish from Trinity River was also assumed to drink contaminated water from Trinity River. Table A-7.13 lists the location of contamination and the contaminated fraction by pathway for the recreational fisher scenario.

Table A-7.13. Exposure Scenario for Recreational Fisher, Case G

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average over land to 20 km	1.0
Soil ingestion	Average over land to 20 km	1.0
Belowground vegetables	Average over land to 20 km	0.02
Aboveground produce	Average over land to 20 km	0.02
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.05
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.01
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion (30 grams/day)	Each watershed	1.0

D. Air Modeling and Air Modeling Results

A test version of ISCSTDFT was the air dispersion and deposition model used to estimate air concentrations and deposition rates for Case G. Source inputs used in the modeling are listed in Table A-7.1. The meteorologic data required for the air modeling were created using PCRAMMET, DEPMET, and PMERGE preprocessors. Table A-7.14 lists site-specific data needed for the DEPMET preprocessor. The actual anemometer height was used as a DEPMET input. For the other inputs, recommendations from the DEPMET User's Guide (U.S. EPA, 1994b) based on the site-specific land use data were used. Land use information for Case G was obtained from telephone surveys and assessed through topographic maps.

The ISCSTDFT model was run using 5 years of meteorological data concatenated into a multiple-year meteorological file (U.S. EPA, 1995b). Therefore, results of the ISCSTDFT modeling conducted with this multiple-year meteorological file represent a 5-year average.

The ISCSTDFT model was run using the "default" model options. The terrain option was not used because this site is an area of flat terrain, and the effects of terrain on air dispersion would not be significant for this site. Additionally, the good engineering practices (GEP) stack height was calculated using EPA's Building Profile Input Program (BPIP) to determine if building downwash should be considered for this site. Inputs to BPIP -- site-specific information on the building height, width, and location -- were available for several buildings having the potential to influence the plume dispersion from the stack. Based on this site-specific information, the GEP stack height for Case G as calculated by BPIP was 65 meters. This value is greater than the actual stack height of 30.5 meters. The stack was located in the building's area of influence, which is defined as five times the lesser of the building height or the maximum projected width. Therefore, building downwash was used in the air dispersion modeling for Case G.

Specific receptor locations evenly spaced every 1,000 meters were identified for each watershed and waterbody using USGS topographic maps. The 5-year averages of air dispersions and deposition rates were then areally averaged over each specific watershed and waterbody.

The point of maximum combined deposition and the point of maximum vapor air concentration were used for "bounding" estimates. For a given scenario, the point of maximum concentration was used in calculating bounding risks for direct inhalation, while the maximum combined deposition or maximum concentration was used in estimating risks for other pathways. However, bounding exposure was considered only for the pathways involved in the subsistence activities for a given scenario. For example, bounding exposure for the subsistence poultry farmer was due to ingestion of soil, produce, poultry, and eggs (based on the point of maximum deposition) and to direct inhalation (based on the point of maximum concentration). The other exposure routes -- ingestion of beef, pork, milk, fish, and drinking water -- were not bounding but were, instead, based on the location of the subsistence poultry farmer. For the subsistence fisher scenario, a default watershed, which lies at the high end of the distribution of watersheds (Van der Leeden, 1990), was centered at the point of maximum combined deposition. Parameters for the bounding watershed are contained in the body of the document (Section II).

The ISCSTDFT air modeling results are presented in Figures A-7.1 through A-7.4. Figure A-7.1 shows the combined deposition of particles within 20 kilometers of Case G; Figure A-7.2 shows the air concentration of vapors within 20 kilometers of Case G; and Figures A-7.3 and A-7.4 show the wet and dry deposition of particles, respectively, within 3 kilometers of Facility G. The results are also presented in tabular form in Table A-7.15.

Table A-7.14. Air Modeling Inputs Used in ISCSTDFT Modeling

Meteorological location	
Surface / upper air	Houston, TX / Lake Charles, LA, and Victoria, TX
Anemometer height (m)	10.0
DEPMET Preprocessor Inputs	
Land use within 5 km	Industrial
Min. M-O length (m)	50.
Roughness height (m)	0.5[a]
Displacement height (m)	2.5
Noontime albedo (fraction)	0.21
Soil moisture available (fraction)	0.5
Net radiation absorbed in ground (fraction)	0.27
Anthropogenic heat flux (W/m^2)	0.0

[a] Based on a maximum roughness height of 1/20th of the anemometer height.

Table A-7.15. Results of ISCSTDFT Air Modeling for Case G[a]

Scenario	Location Distance (meters)/ Direction	Particles				Vapors	
		Combined Deposition (g/m²-yr)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Dry Deposition (g/m²-yr)/(g/s)	Air Concentration (μg/m³)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Air Concentration (μg/m³)/(g/s)
Point of maximum combined deposition	100/WNW	0.21	0.18	0.03	0.034	0.24	0.037
Point of maximum vapor concentration	1,000/NNW	0.11	0.0089	0.1	0.3	0.014	0.33
Home gardener (closest resident)	700/SE	0.03	0.006	0.024	0.056	0.0093	0.06
General population	--	0.0021	2.2E-4	0.0019	0.014	3.4E-04	0.015
Subsistence farmer - beef, pork, poultry, dairy	500/SSE	0.0071	6.0E-4	0.0065	0.026	1.0E-3	0.029
Subsistence fisher -San Jacinto River	4,000/N	0.022	--	--	0.11	0.0025	0.12
Subsistence fisher - Trinity River	24,000/NE	0.00024	--	--	0.004	0.000024	0.0042
Subsistence fisher - Highlands Reservoir	11,000/NNE	0.0011	--	--	0.01	0.00017	0.011
Subsistence fisher - Shelton Reservoir	21,000/NNW	0.0014	--	--	0.015	0.0001	0.016
		Averages over Watershed			**Averages over Waterbody**		
		Combined Deposition of Particles (g/m²-yr)/(g/s)	**Wet Deposition of Vapors (g/m²-yr)/(g/s)**	**Air Concentration of Vapors (μg/m³)/(g/s)**	**Combined Deposition of Particles (g/m²-yr)/(g/s)**	**Wet Deposition of Vapors (g/m²-yr)/(g/s)**	**Air Concentration of Vapors (μg/m³)/(g/s)**
San Jacinto River	--	0.0014	0.000098	0.014	0.002	0.00011	0.016
Trinity River	--	0.00011	0.0000082	0.002	0.0001	0.0000073	0.0019
Highlands Reservoir	--	0.00095	0.00015	0.0095	0.00095	0.00015	0.0095
Shelton Reservoir	--	0.0013	0.000097	0.016	0.0015	0.00012	0.018

[a] The air modeling results in the table are based on an emission rate of 1 g/s from the stack.

Figure A.7.1 Combined deposition of particles within 20 kilometers of Facility G. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.

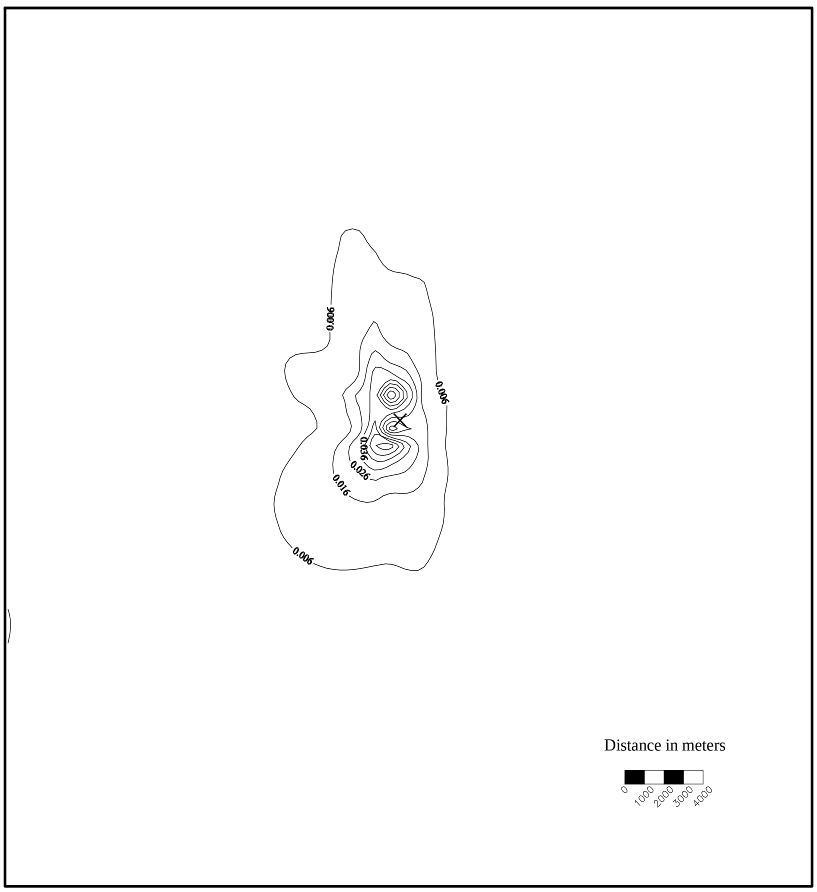


Figure A.7.2 Air concentration of vapors within 20 kilometers of Facility G. Air concentration in units of micrograms per cubic meter, resulting from a unit emission rate of 1 gram per second.

Figure A.7.3 Wet deposition of particles within 3 kilometers of Facility G. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.

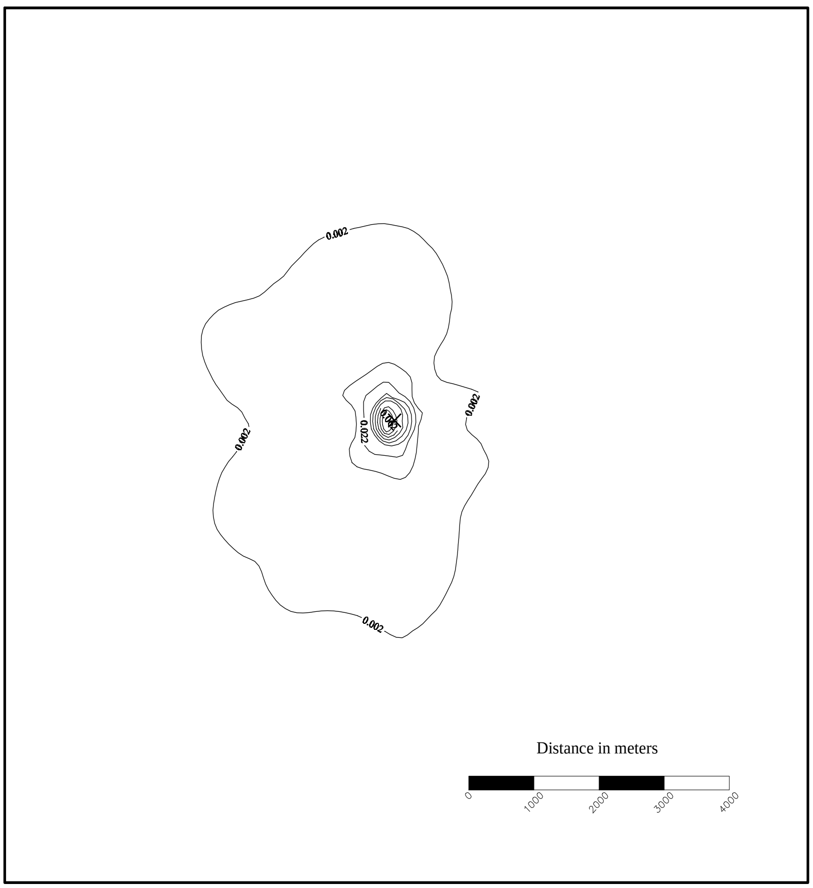
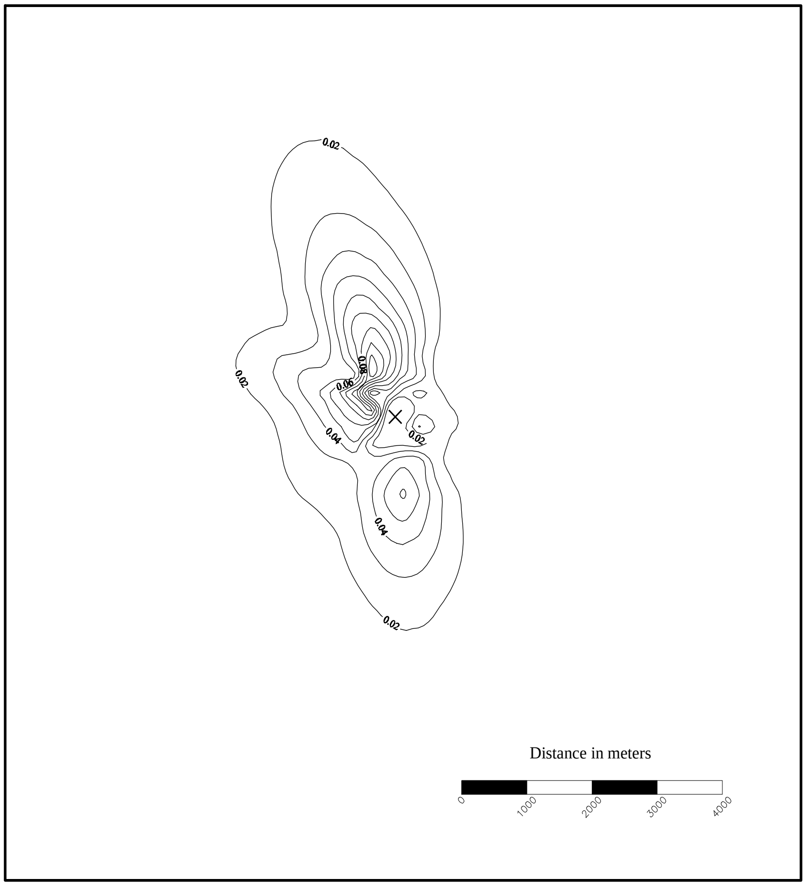


Figure A.7.4 Dry deposition of particles within 3 kilometers of Facility G. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.



8. Case H

A. Source Characterization

Case H is one of five cement kilns selected for this analysis. Facility and source parameters used in the air dispersion modeling and risk assessment of this site are presented in Table A-8.1. Values listed in the table were obtained from facility-specific information provided by EPA.

Table A-8.1. Facility and Source Parameters for Case H

Parameter	Case H	
Facility type	Cement kiln	
Land use w/in 5 km	Agricultural	
Terrain use	No	
Operating hours (8760/year possible)	7324	
Stack parameters	Stack 1	Stack 2
Stack height (m)	59.4	59.4
Diameter (m)	2.1	3.7
Total flow rate (dscfm) / (dscms)	195,900 / 92.4	
Exit velocity (m/s)	12.3	11.1
Exit temperature (K)	427	405

B. Setting Characterization

Case H is located in the northeastern United States, in an area of complex terrain. Land use surrounding the site is agricultural.

The National Weather Service Station at Allentown, Pennsylvania, provided the most appropriate surface data for Case H. Upper air data from Albany, New York, were paired with the surface data for air dispersion modeling. Five years of meteorologic data, for the years 1985 and 1987-1990, were used to determine long-term average air dispersion and deposition estimates. Table A-8.2 lists the annual average meteorologic parameters, which were obtained from the International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992). Also listed in Table A-8.2 are the average evapotranspiration rate and annual runoff. These values were used with the precipitation rate to calculate a water balance for Case H. One-half of the average annual runoff value cited in the *Water Atlas* (Geraghty, et al., 1973) was used in the analysis. The adjustment was made to account for surface runoff only and not the subsurface inflows to surface waters. The evapotranspiration rate was calculated by assuming 70 percent of the precipitation evaporates.

Table A-8.2. Annual Average Meteorologic Parameters for Case H

Ave. annual evapotranspiration (cm/yr)	Ave. annual runoff [a] (cm/yr)	Ave. annual precipitation[a] (cm/yr)	Ambient air temperature[b] (K)	Mean annual windspeed[b] (m/s)
78.6	22.2	112.3	284.1	5.1

[a] *Water Atlas* (Geraghty et al., 1973).
[b] International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992).

C. Characterization of Exposed Populations

Table A-8.3 presents the locations of exposed populations identified for Case H. Information regarding the location of the residence and farms likely to be most impacted by Case H was obtained through telephone interviews with local planning offices and local agricultural extension agents. The local officials were asked to identify farms where subsistence activities would be likely, near the facilities and in the direction of the maximum impact. These farms were assumed to be the maximum impacted subsistence farms.

Table A-8.3. Location of Receptors Identified for Case H

Receptor	Location (Distance (km)/Direction)	Source
Residence of home gardener	0.2 km east	Zoning Office
Subsistence beef farm	0.7 km southeast[a]	Cooperative Extension Agent
Subsistence dairy farm	0.7 km southeast	Cooperative Extension Agent
Subsistence poultry farm	0.7 km southeast[a]	Cooperative Extension Agent
Subsistence pork farm	0.7 km southeast[a]	Cooperative Extension Agent
Subsistence fisher location (inhalation and soil ingestion) Wild Creek Reservoir Lehigh River Monacacy Creek	 20 km northwest 2 km west 7 km northeast	Location of maximum air concentration of vapors within the watershed
Waterbody identified as surface drinking water source	Wild Creek Reservoir	Cooperative Extension Agent

[a] Default assumption based upon location of subsistence dairy farmer.

The waterbodies were selected from USGS topographical maps as those that would be large enough to support fish yet would reflect the highest impact from the facility. Phone calls to local officials verified that individuals might consume fish caught in the selected waterbodies. The topographic maps were also used in identifying the watersheds associated with each waterbody and in estimating waterbody and watershed surface areas. Table A-8.4 lists the surface areas and other surface water parameters for Case H. References for the surface water parameters are also listed in the table.

The fraction of food contaminated was varied depending on the scenario. In this analysis, the fraction contaminated is defined as the fraction of what is consumed that is contaminated by facility emissions. The fraction contaminated is independent of the level of contamination. The level of contamination is dependent upon the production location. Contamination levels calculated for a subsistence farm located near the facility would be higher than those calculated for the typical farm (air concentrations and deposition rates averaged to 20 kilometers). The terms "subsistence level of contamination" and "typical level of contamination" are used to reflect the different levels.

Central tendency and high-end contaminated fractions were developed based on an economic analysis of regional production and processing capacity and the fraction home-produced recommendations from the *Exposure Factors Handbook* (U.S. EPA, 1990). The fractions were developed using data from counties within 50 kilometers of the site. The economic analysis is discussed in detail in Section II.E.1 of the main report. The commodity with the highest fraction locally produced was assumed to be the commodity produced by the typical farmer. Local agricultural production indicated that the typical farmer for Case H was a dairy farmer. The fractions assumed to be locally produced and processed for Case H are as follows:

Beef	0.08	Pork	0.18
Dairy	0.71	Poultry	0.01
Produce	0.23	Eggs	0.01
Fish	0.01		

The subsistence farmers considered for Case H were beef, dairy, poultry, and pork farmers. The locations of the subsistence farmers, listed in Table A-8.3, were used for estimating exposures from direct inhalation and soil ingestion. The fraction contaminated is assumed to be 1 for the livestock the subsistence farmer is identified as producing. He was also assumed to grow all the fruits and vegetables he consumed. For example, the subsistence beef farmer was assumed to produce all the beef, vegetables, and fruits that he ingested and to purchase all other dietary items -- such as milk, pork, fish -- from local markets. The items raised on the subsistence farms had higher levels of contamination than did the items available in the local market. The local items purchased in the market were contaminated at levels that reflected the average impact from the unit out to 20 kilometers from the facility. Subsistence farmers consuming fish from Wild Creek Reservoir were also assumed to drink contaminated water from Wild Creek Reservoir. Tables A-8.5 through A-8.8 list the locations of contamination and the contaminated fraction by pathway for the subsistence farm scenarios.

Table A-8.4. Surface Water Parameters for Case H

Waterbody	Surface Area (m)[a]	Watershed Area (m)[a]	Impervious Watershed Area (m)[b]	Average Volumetric Flow Rate (m^3/yr)[c]	Current Velocity (m/s)[d]	Depth of Water Column (m)[e]	USLE Rainfall/ Erosivity Factor [f]
Lehigh River	9.7E+06	1.0E+09	1.0E+08	2.1E+09	0.84	1.1	175
Monacacy Creek	3.2E+05	1.09E+08	1.1E+06	2.4E+07	0.15	1	175
Wild Creek Reservoir	3.7E+06	5.2E+07	2.6E+05	1.2E+07	NA	4.5	175

[a] Surface areas for the watersheds and waterbodies were determined from the USGS 1.25 000-scale topographic 7.5 min X 15 min quadrangles.

[b] Impervious watershed areas were estimated from USGS quadrangles, site-specific land use, and a study of percent imperviousness for different land uses conducted by Camp, Dresser, and McKee (1989).

[c] The volumetric flow rate for the Lehigh River was obtained from the REACH (U.S. EPA, 1995a) database. Flow rates for the other waterbodies were calculated from the watershed area and average annual surface runoff.

[d] Current velocity for the Lehigh River was obtained from the REACH (U.S. EPA, 1995a) database. Current velocity for the Monacacy Creek was calculated from the volumetric flow rate and the cross-sectional area. Current velocities for lakes were not required and are listed as NA (Not Applicable).

[e] Depth for the Lehigh River was calculated from the volumetric flow rate, the velocity, and the width. Depths for the other waterbodies were assumed from a default of 4 to 6 meters for lakes and 1 meter for rivers.

[f] USLE Erosivity/Rainfall Factor was obtained from Edwards (1993) and was used in the universal soil loss equation (USLE).

Table A-8.5. Exposure Scenario for Subsistence Beef Farmer, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Soil ingestion	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Belowground vegetables	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Aboveground produce	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Beef ingestion	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Milk ingestion	Average to 20 km	0.71
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.18
Fish ingestion	Each watershed	0.01

[a] Default assumption based upon location of subsistence dairy farmer.

Table A-8.6. Exposure Scenario for Subsistence Dairy Farmer and Child, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (0.7 km southeast)	1.0
Soil ingestion	Location of subsistence beef farm (0.7 km southeast)	1.0
Belowground vegetables	Location of subsistence beef farm (0.7 km southeast)	1.0
Aboveground produce	Location of subsistence beef farm (0.7 km southeast)	1.0
Beef ingestion	Average to 20 km	0.01
Milk ingestion	Location of subsistence beef farm (0.7 km southeast)	1.0
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.18
Fish ingestion	Each watershed	0.01

Table A-8.7. Exposure Scenario for Subsistence Pork Farmer, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Soil ingestion	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Belowground vegetables	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Aboveground produce	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Beef ingestion	Average to 20 km	0.08
Milk ingestion	Average to 20 km	0.71
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Location of subsistence pork farm (1 km north)[a]	1.0
Fish ingestion	Each watershed	0.01

[a] Default assumption based upon location of subsistence dairy farmer.

Table A-8.8. Exposure Scenario for Subsistence Poultry Farmer, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Soil ingestion	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Belowground vegetables	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Aboveground produce	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Beef ingestion	Average to 20 km	0.08
Milk ingestion	Average to 20 km	0.71
Chicken meat ingestion	Location of subsistence beef farm (0.7 km southeast)[a]	1.0
Egg ingestion	Location of subsistence beef farm (0.7 km southeast)[a]	
Pork ingestion	Average to 20 km	0.18
Fish ingestion	Each watershed	0.01

[a] Default assumption based upon location of subsistence dairy farmer.

A subsistence fisher was modeled for each watershed. The fish consumption rate for the subsistence fisher was 60 g/d, rather than the 1.64-g/d rate of the general population. The locations of the residences of the subsistence fishers were assumed to be the site of highest vapor air concentration within the affected watershed. The residence location was used for estimating exposures from direct inhalation and soil ingestion. All fish in the diet was assumed to be from the watershed where the subsistence fisher resided. All other dietary items were assumed purchased from the local market and to contain typical levels of contamination. The subsistence fisher residing in Wild Creek Reservoir area and consuming fish from the reservoir was also assumed to drink contaminated water from Wild Creek Reservoir. Table A-8.9 lists the locations of contamination and the contaminated fraction by pathway for the subsistence fisher scenario.

Table A-8.9. Exposure Scenario for Subsistence Fisher, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of maximum vapor air concentration in each watershed	1.0
Soil ingestion	Location of maximum vapor air concentration in each watershed	1.0
Belowground vegetables	Average to 20 km	0.23
Aboveground produce	Average to 20 km	0.23
Beef ingestion	Average to 20 km	0.08
Milk ingestion	Average to 20 km	0.71
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.18
Fish ingestion (60 g/d)	Each watershed	1.0

The location of the home gardener and child was derived from the location of the closest actual residence to the facility. This residential location was used to estimate exposures from direct inhalation and soil ingestion. The fractions contaminated for the aboveground produce and root vegetables were determined by adding the fraction contaminated in the local market to the fraction that the gardener home-raised and consumed, as cited in the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.42 by adding the homegrown fraction of 0.25 to 23 percent of the remaining 0.75 purchased from local markets. All other dietary items were assumed to be purchased from local markets and to contain typical levels of contamination derived from average air dispersion and deposition estimates to 20 kilometers from the facility. The home gardener consuming fish from Wild Creek Reservoir was also assumed to drink contaminated water from Wild Creek Reservoir. Table A-8.10 lists the locations of contamination and the contaminated fraction by pathway for the home gardener scenarios.

Table A-8.10. Exposure Scenario for Home Gardener and Child, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated	
Direct inhalation	Location of closest residence (0.2 km east)	1.0	
Soil ingestion	Location of closest residence (0.2 km east)	1.0	
		Central tendency	**High-end**
Belowground vegetables	Location of closest residence (0.2 km east)	0.25 Typical farmer + 0.75 x Local market = 0.43	0.40 Typical farmer + 0.60 x Local market = 0.54
Aboveground produce	Location of closest residence (0.2 km east)	0.25 Typical farmer + 0.75 x Local market = 0.43	0.40 Typical farmer + 0.60 x Local market = 0.54
Beef ingestion	Average to 20 km	0.08	0.08
Milk ingestion	Average to 20 km	0.71	0.71
Chicken meat ingestion	Average to 20 km	0.01	0.01
Egg ingestion	Average to 20 km	0.01	0.01
Pork ingestion	Average to 20 km	0.18	0.18
Fish ingestion	Each watershed	0.01	0.01

The typical adult resident and child exposures were based on averages of air concentrations and deposition rates out to 20 km. The averages were used for estimating exposures from direct inhalation and soil ingestion. All dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. The typical resident consuming fish from Wild Creek Reservoir was also assumed to drink contaminated water from Wild Creek Reservoir. Table A-8.11 lists the locations of contamination and the contaminated fraction by pathway for the typical resident scenarios.

Table A-8.11. Exposure Scenario for Typical Adult Resident and Child, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average out to 20 km	1.0
Soil ingestion	Average out to 20 km	1.0
Belowground vegetables	Average out to 20 km	0.23
Aboveground produce	Average out to 20 km	0.23
Beef ingestion	Average out to 20 km	0.08
Milk ingestion	Average out to 20 km	0.71
Chicken meat ingestion	Average out to 20 km	0.01
Egg ingestion	Average out to 20 km	0.01
Pork ingestion	Average out to 20 km	0.18
Fish ingestion	Each watershed	0.01

The typical farmer for this site was assumed to be a dairy farmer because the fraction of dairy products locally produced was higher than the fractions for the other commodities in the analysis. The typical dairy farmer was assumed to produce a fraction of the dairy, vegetables, and fruits he consumed and to purchase all other dietary items from the local market. The fractions contaminated for each pathway were determined by adding the fraction contaminated in the local market to the fraction that the farmer home-raised and consumed from the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.42 by adding the homegrown fraction of 0.25 to 23 percent of the remaining 0.75 purchased from local markets. Both the items raised on the typical farm and the items purchased from local markets had typical levels of contamination. The typical dairy farmer's exposures from direct inhalation and soil ingestion were estimated to be at levels derived from averages of air dispersion and deposition outputs to 20 kilometers. The typical farmer consuming fish from Wild Creek Reservoir was also assumed to drink contaminated water from Wild Creek Reservoir. Table A-8.12 lists the locations of contamination and the contaminated fraction by pathway for the typical farmer scenario.

Table A-8.12. Exposure Scenario for Typical Farmer, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated	
Direct inhalation	Average to 20 km	1.0	
Soil ingestion	Average to 20 km	1.0	
		Central tendency	**High-end**
Belowground vegetables	Average to 20 km	0.25 Typical farmer + 0.75 x Local market = 0.43	0.40 Typical farmer + 0.60 x Local market = 0.54
Aboveground produce	Average to 20 km	0.25 Typical farmer + 0.75 x Local market = 0.43	0.40 Typical farmer + 0.60 x Local market = 0.54
Beef ingestion	Average to 20 km	0.08	0.08
Milk ingestion	Average to 20 km	0.40 Typical farmer + 0.60 x Local market = 0.83	0.75 Typical farmer + 0.25 x Local market = 0.93
Chicken meat ingestion	Average to 20 km	0.01	0.01
Egg ingestion	Average to 20 km	0.01	0.01
Pork ingestion	Average to 20 km	0.18	0.18
Fish ingestion	Each waterbody	0.01	0.01

Recreational fishers were modeled for each waterbody by combining the typical resident scenario with an increased consumption of contaminated fish recreationally caught (30 g/d). The recreational fisher's exposures from direct inhalation and soil ingestion were derived from averages of air dispersion and deposition output to 20 kilometers. All fish in the diet was assumed to be from a single waterbody. For instance, the recreational fisher identified for the Lehigh River ate only fish caught in the Lehigh River. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. The recreational fisher consuming fish from Wild Creek Reservoir was also assumed to drink contaminated water from Wild Creek Reservoir. Table A-8.13 lists the location of contamination and the contaminated fraction by pathway for the recreational fisher scenario.

Table A-8.13. Exposure Scenario for Recreational Fisher, Case H

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average to 20 km	1.0
Soil ingestion	Average to 20 km	1.0
Belowground vegetables	Average to 20 km	0.23
Aboveground produce	Average to 20 km	0.23
Beef ingestion	Average to 20 km	0.08
Milk ingestion	Average to 20 km	0.71
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.18
Fish ingestion (30 g/d)	Each watershed	1.0

D. Air Modeling and Air Modeling Results

A test version of ISCSTDFT was the air dispersion and deposition model used to estimate air concentrations and deposition rates for Case H. Source inputs used in the modeling are listed in Table A-8.1. The meteorologic data required for the air modeling were created using PCRAMMET, DEPMET, and PMERGE preprocessors. Table A-8.14 lists site-specific data needed for the DEPMET preprocessor. The actual anemometer height was used as a DEPMET input. For the other inputs, recommendations from the DEPMET User's Guide (U.S. EPA, 1994) based on the site-specific land use data were used. Land use information for Case H was obtained from telephone surveys and assessed through topographic maps.

The ISCSTDFT model was run using 5 years of meteorological data concatenated into a multiple-year meteorological file (U.S. EPA, 1995b). Therefore, results of the ISCSTDFT modeling conducted with this multiple-year meteorological file represent a 5-year average.

The ISCSTDFT model was run using the "default" model options. The terrain option was used because this facility is located in an area of complex terrain. An assessment of the good engineering practice (GEP) stack height for each building was provided for the facility. The information indicated that the stack was not located in the area of influence of any of the buildings. A building's area of influence on a stack is defined as five times the lesser of the building height or the maximum projected width, and it will vary for each building. Since the stack was not located in the area of influence for any buildings considered, downwash was not used in the air dispersion modeling for Case H.

Specific receptor locations evenly spaced every 1,000 meters were identified for each watershed and waterbody using USGS topographic maps. The 5-year averages of air dispersions and deposition rates were then areally averaged over each specific watershed and waterbody.

The point of maximum combined deposition and the point of maximum vapor air concentration were used for "bounding" estimates. For a given scenario, the point of maximum concentration was used in calculating bounding risks for direct inhalation while the maximum combined deposition or maximum air concentration was used in estimating risks for other pathways. However, bounding exposure was considered for only the pathways involved in the subsistence activities for a given scenario. For example, bounding exposure for the subsistence poultry farmer was due to ingestion of soil, produce, poultry, and eggs (based on the point of maximum deposition) and to direct inhalation (based on the point of maximum concentration). The other exposure routes -- ingestion of beef, pork, milk, fish, and drinking water -- were not bounding but were, instead, based on the location of the subsistence poultry farmer. For the subsistence fisher scenario, a default watershed, which lies at the high end of the distribution of watersheds (Van der Leeden, 1990) was centered at the point of maximum combined deposition. Parameters for the bounding watershed are contained in the body of the document (Section II).

The ISCSTDFT air modeling results are presented in Figures A-8.1 through A-8.4. Figure A-8.1 shows the combined deposition of particles within 20 kilometers of Case H; Figure A-8.2 shows the air concentration of vapors within 20 kilometers of Case H; and Figures A-8.3 and A-8.4 show the wet and dry deposition of particles, respectively, within 3 kilometers of Facility H. The results are also presented in tabular form in Table A-8.15.

Table A-8.14. Air Modeling Inputs Used in ISCSTDFT Modeling

Meteorologic location	
Surface / upper air	Allentown, PA / Albany, NY
Anemometer height (m)	6.1
DEPMET Preprocessor Inputs	
Land use within 5 km	Agricultural
Min. M-O length (m)	2.0
Roughness height (m)	0.31[a]
Displacement height (m)	1.53
Noontime albedo (fraction)	0.28
Soil moisture available (fraction)	0.5
Net radiation absorbed in ground (fraction)	0.15
Anthropogenic heat flux (W/m^2)	0.0

[a] Based on a maximum roughness height of 1/20th of the anemometer height.

Table A-8.15. Results of ISCSTDFT Air Modeling for Case H[a]

Scenario	Location Distance (m)/ Direction	Particles				Vapors	
		Combined Deposition (g/m²-yr)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Dry Deposition (g/m²-yr)/(g/s)	Air Concentration (µg/m³)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Air Concentration (µg/m³)/(g/s)
Point of maximum combined deposition	100/WSW	0.59	0.59	0	0	0.79	0
Point of maximum vapor concentration	2000/W	0.042	0.018	0.024	0.11	0.028	0.18
Home gardener (closest resident)	200/E	0.087	0.087	0	0	0.12	0
General population	--	0.0037	0.0016	0.0021	0.013	0.0022	0.014
Subsistence farmer - beef / dairy / pork / poultry	700/SE	0.018	0.015	0.0025	0.0077	0.027	0.0081
Subsistence fisher - Wild Creek Reservoir	20000/NW	0.00048	--	--	0.0044	1.9E-04	0.0046
Subsistence fisher - Lehigh River	2000/W	0.044	--	--	0.11	0.029	0.12
Subsistence fisher - Monacacy Creek	7000/NE	0.015	--	--	0.10	0.0024	0.11
		Averages over Watershed			Averages over Waterbody		
		Combined Deposition of Particles (g/m²-yr)/(g/s)	Wet Deposition of Vapors (g/m²-yr)/(g/s)	Air Concentration of Vapors (µg/m³)/(g/s)	Combined Deposition of Particles (g/m²-yr)/(g/s)	Wet Deposition of Vapors (g/m²-yr)/(g/s)	Air Concentration of Vapors (µg/m³)/(g/s)
Wild Creek Reservoir	--	2.9E-04	1.1E-04	0.0027	3.4E-04	1.24E-04	0.0032
Lehigh River	--	0.0069	0.0034	0.017	0.0022	0.0012	0.0085
Monacacy Creek	--	0.025	0.022	0.032	0.090	0.11	0.028

[a] The air modeling results in the table are based on an emission rate of 1 g/s from each of the two stacks at Site H, for a total emission rate of 2 g/s.

Figure A-8.1 Combined deposition of particles within 20 kilometers of Facility H. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second from each stack.

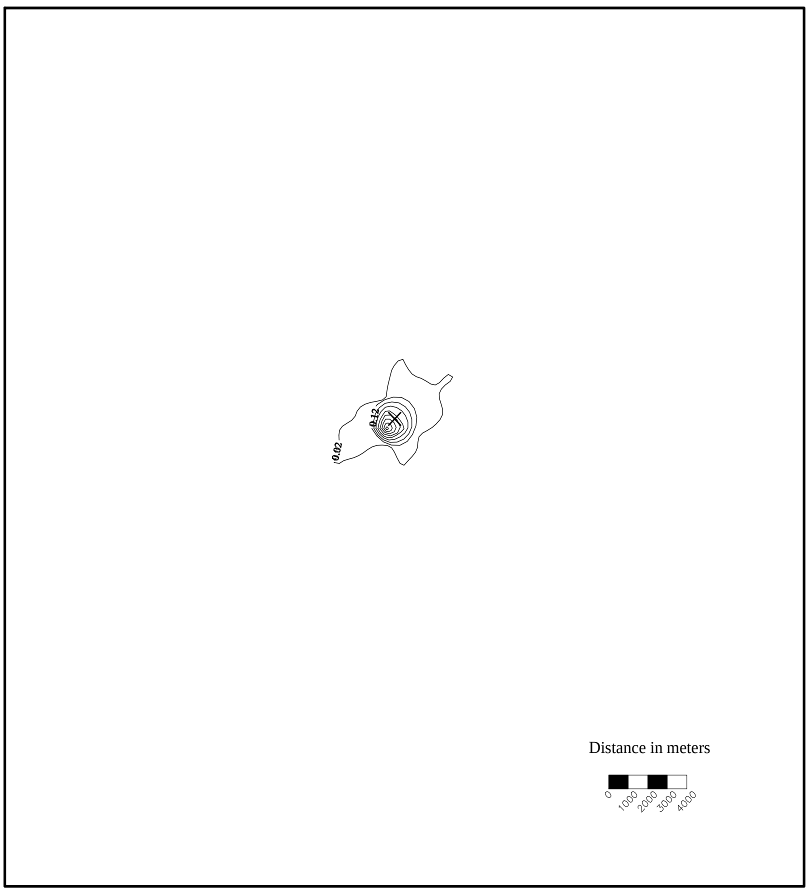


Figure A-8.2 Air concentration of vapors within 20 kilometers of Facility H. Air concentration in units of micrograms per cubic meter, resulting from a unit emission rate of 1 gram per second from each stack.

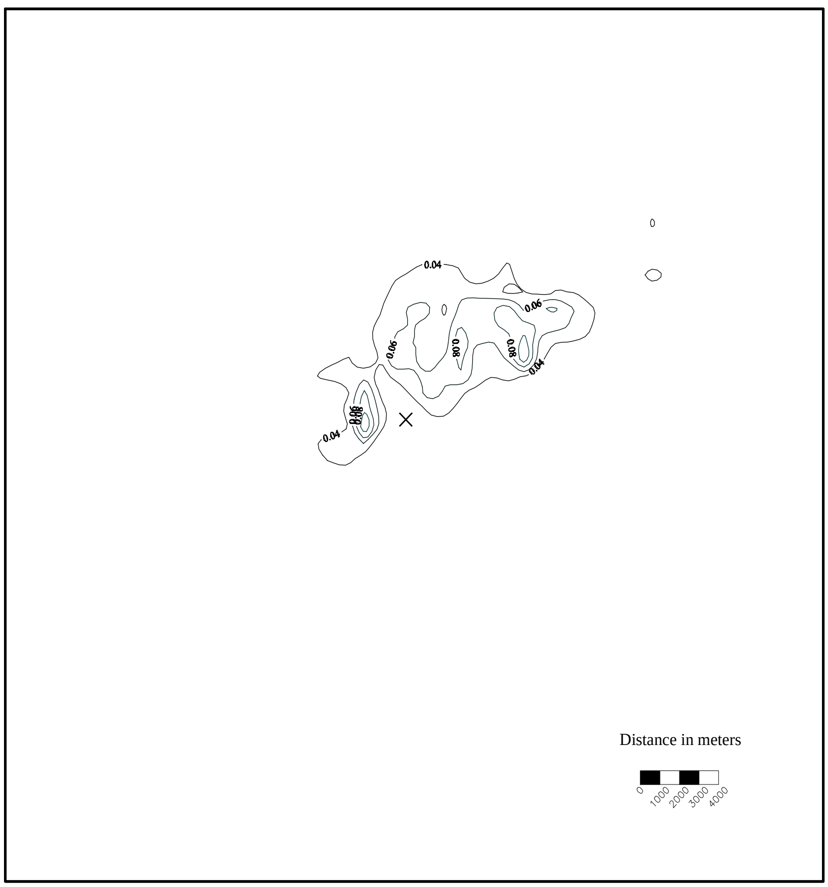


Figure A-8.3 Wet deposition of particles within 3 kilometers of Facility H. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second from each stack.

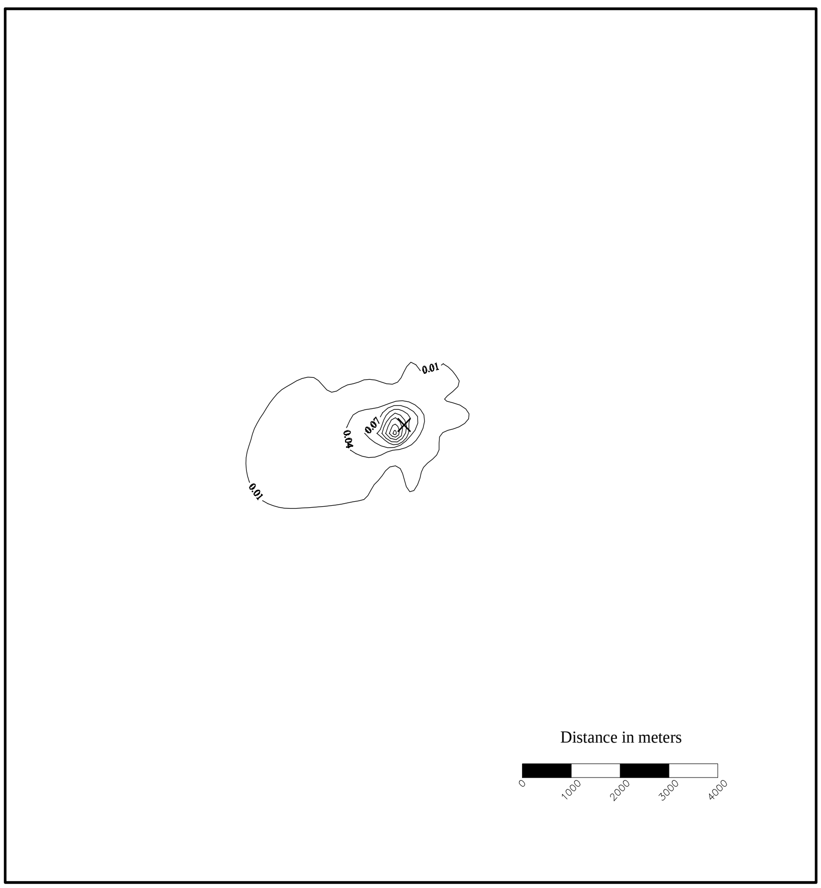
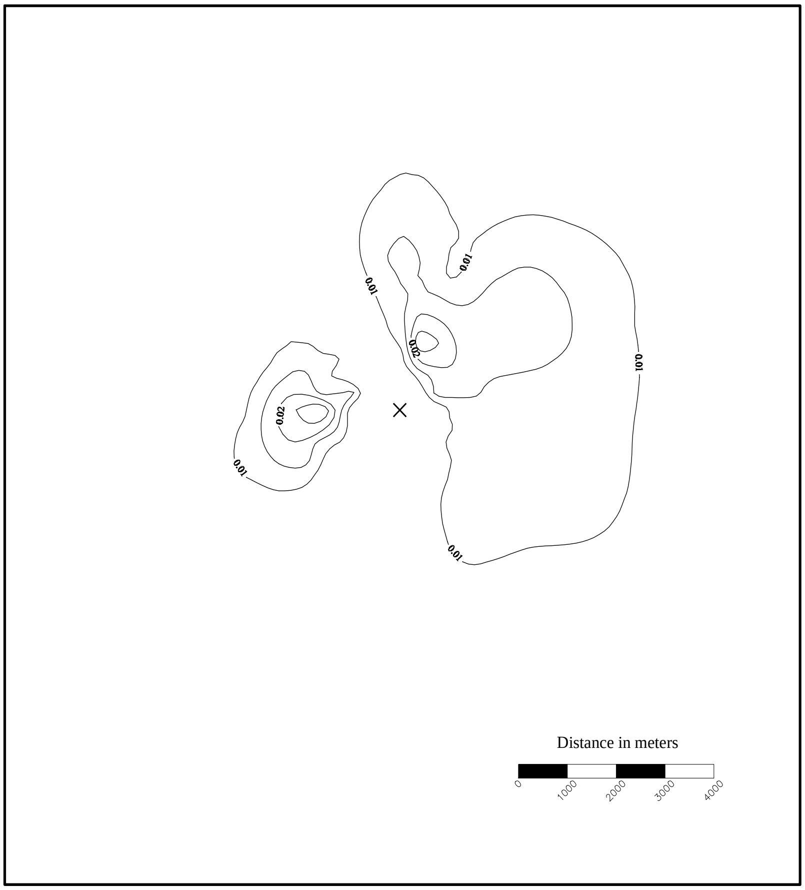


Figure A-8.4 Dry deposition of particles within 3 kilometers of Facility H. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second from each stack.



9. Case I

A. Source Characterization

Case I is one of four hazardous waste incinerators selected for this analysis. Facility and source parameters used in the air dispersion modeling and risk assessment of this site are presented in Table A-9.1. Values listed in the table were obtained from facility-specific information provided by EPA.

Table A-9.1. Facility and Source Parameters for Case I

Parameter	Case I
Facility type	Incinerator
Land use w/in 5 km	Industrial / residential
Terrain use	Yes
Operating hours (8760/year possible)	7,560
Stack parameters	Stack 1
Stack height (m)	33
Diameter (m)	1.4
Total flow rate (dscfm) / (dscms)	24,600 / 11.6
Exit velocity (m/s)	13.3
Exit temperature (K)	354.3

B. Setting Characterization

Case I is located in the Pacific Coast of the United States in an area of complex terrain. The land use surrounding the site is industrial /residential to the east and west. The site lies near a large expanse of water to the north and south.

Because of the unique terrain surrounding Case I, surface winds and temperature were taken from a nearby regional air quality monitoring station (Bay Area Air Quality Management District) and used with other required surface data from Oakland, California. Upper air data from Oakland, California, were paired with the surface data for air dispersion modeling. Meteorologic data from 1993 were used to determine long-term average air dispersion and deposition estimates. Table A-9.2 lists the annual average meteorologic parameters, which were obtained from the International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992). Also listed in Table A-9.2 are the average evapotranspiration rate and annual runoff. These values were used with the precipitation rate to calculate a water balance for Case I. One-half of the average annual runoff value cited in the *Water Atlas* (Geraghty, et al., 1973) was used in the analysis. The adjustment was made to account for surface runoff only and not the subsurface inflows to surface waters. The potential evapotranspiration rate was calculated by assuming 70 percent of the precipitation evaporates.

Table A-9.2. Annual Average Meteorologic Parameters for Case I

Ave. annual evapotranspiration (cm/yr)	Ave. annual runoff [a] (cm/yr)	Ave. annual precipitation[b] (cm/yr)	Ambient air temperature[b] (K)	Mean annual windspeed[b] (m/s)
34.3	1.3	49	286.9	6.2

[a] *Water Atlas* (Geraghty et al., 1973).
[b] International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992).

C. Characterization of Exposed Populations

Table A-9.3 presents the locations of exposed populations identified for Case I. Information regarding the location of the residence and farms likely to be most impacted by Case I was obtained through telephone interviews with local planning offices and local agricultural extension agents. The local officials were asked to identify farms near the facility where subsistence activities would be likely. Farms identified by local officials were assessed to determine which would be most impacted by the facility emissions, and the maximally impacted farms were assumed to represent the location of the subsistence farmers.

Table A-9.3. Location of Receptors Identified for Case I

Receptor	Location (Distance (km)/Direction)	Source
Residence of home gardener	0.1 km east-southeast	City Planning Office
Subsistence beef farm	11 km northeast	Agricultural Weights and Measures
Subsistence dairy farm	5 km northeast[a]	Agricultural Weights and Measures
Subsistence poultry farm	5 km northeast	Agricultural Weights and Measures
Subsistence pork farm	5 km northeast[a]	Agricultural Weights and Measures
Subsistence fisher location (inhalation and soil ingestion) North Reservoir San Pablo Reservoir Lafayette Reservoir	 4 km northeast 3 km northeast 19 km east	Location of maximum air concentration of vapors within the watershed
Waterbody identified as surface drinking water source	San Pablo Reservoir	City Government Office

[a] Default assumption based on location of subsistence poultry farmer.

The waterbodies were selected from USGS topographical maps as those that would be large enough to support fish yet would reflect the highest impact from the facility. Phone calls to local officials verified that individuals might consume fish caught in the selected waterbodies. The topographic maps were also used in identifying the watersheds associated with each waterbody and in estimating waterbody and watershed surface areas. Table A-9.4 lists the surface areas and other surface water parameters for Case I. References for the surface water parameters are also listed in the table.

The fraction of food contaminated was varied depending on the scenario. In this analysis, the fraction contaminated is defined as the fraction of what is consumed that is contaminated by facility emissions. The fraction contaminated is independent of the level of contamination. The level of contamination is dependent upon the production location. Contamination levels calculated for a subsistence farm location near the facility would be higher than those calculated for the typical farm (air concentrations and deposition rates averaged to 20 kilometers over the land only). The terms "subsistence level of contamination" and "typical level of contamination" are used to reflect the different levels.

Central tendency and high-end contaminated fractions were developed based on an economic analysis of regional production and processing capacity and the fraction home-produced recommendations from the *Exposure Factors Handbook* (U.S. EPA, 1990). The fractions were developed using data from counties within 50 kilometers of the site. The economic analysis is discussed in detail in Section II.E.2. The commodity with the highest fraction locally produced was assumed to be the commodity produced by the typical farmer. Local agricultural production indicated that the typical farmer for Case I was a produce farmer. The fractions assumed to be locally produced and processed for Case I are as follows:

Beef	0.01
Dairy	0.31
Produce	1.00
Fish	0.01
Pork	0.01
Poultry	0.01
Eggs	0.02

The subsistence farmers considered for Case I were beef, dairy, poultry, and pork farmers. The locations of the subsistence farmers, listed in Table A-9.3, were used for estimating exposures from direct inhalation and soil ingestion. The fraction contaminated is assumed to be 1 for the livestock the subsistence farmer is identified as producing. He was also assumed to grow all the fruits and vegetables he consumed. For example, the subsistence beef farmer was assumed to produce all the beef, vegetables, and fruits that he ingested and to purchase all other dietary items -- such as milk, pork, fish -- from local markets. The items raised on the subsistence farms had higher levels of contamination than items available in the local market.

Table A-9.4. Surface Water Parameters for Case I

Waterbody	Surface Area (m^2)	Watershed Area (m^2)	Impervious Watershed Area (m^2)	Average Volumetric Flow Rate (m^3/yr)	Current Velocity (m/s)	Depth of Water Column (m)	USLE Rainfall/ Erosivity Factor
North Reservoir	7.2E+04	1.0E+06	2.5E+05	1.3E+04	NA	4.0	510
San Pablo Reservoir	3.6E+06	3.50E+07	1.8E+05	4.6E+05	NA	6.1	510
Lafayette Reservoir	5.7E+05	6.0E+06	2.4E+05	7.8E+04	NA	6.1	510

[a] Surface areas for the watersheds and waterbodies were determined from the USGS 1.25 000-scale topographic 7.5 min X 15 min quadrangles.

[b] Impervious watershed areas were estimated from USGS quadrangles, site-specific land use, and a study of percent imperviousness for different land uses conducted by Camp, Dresser, and McKee (1989).

[c] Flow rates for the waterbodies were calculated from the watershed area and average annual surface runoff.

[d] Current velocities for lakes were not required and are listed as NA (Not Applicable).

[e] Depths for the lakes were assumed from a default range of 4 to 6 meters.

[f] USLE Erosivity/Rainfall Factor was obtained from Edwards (1993) and was used in the universal soil loss equation (USLE).

The local items purchased in the market were contaminated at levels that reflected the average impact from the stack out to 20 kilometers over land from the facility. Subsistence farmers consuming fish from the San Pablo Reservoir were also assumed to drink contaminated water from the San Pablo Reservoir. Tables A-9.5 through A-9.8 list the locations of contamination and the contaminated fraction by pathway for the subsistence farm scenarios.

Table A-9.5. Exposure Scenario for Subsistence Beef Farmer, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (11 km northeast)	1.0
Soil ingestion	Location of subsistence beef farm (11 km northeast)	1.0
Belowground vegetables	Location of subsistence beef farm (11 km northeast)	1.0
Aboveground produce	Location of subsistence beef farm (11 km northeast)	1.0
Beef ingestion	Location of subsistence beef farm (11 km northeast)	1.0
Milk ingestion	Average over land to 20 km	0.31
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.02
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

Table A-9.6. Exposure Scenario for Subsistence Dairy Farmer and Child, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence dairy farm (5 km northeast)[a]	1.0
Soil ingestion	Location of subsistence dairy farm (5 km northeast)[a]	1.0
Belowground vegetables	Location of subsistence dairy farm (5 km northeast)[a]	1.0
Aboveground produce	Location of subsistence dairy farm (5 km northeast)[a]	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Location of subsistence dairy farm (5 km northeast)[a]	1.0
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.02
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence poultry farmer.

Table A-9.7. Exposure Scenario for Subsistence Pork Farmer, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence pork farm (5 km northeast)[a]	1.0
Soil ingestion	Location of subsistence pork farm (5 km northeast)[a]	1.0
Belowground vegetables	Location of subsistence pork farm (5 km northeast)[a]	1.0
Aboveground produce	Location of subsistence pork farm (5 km northeast)[a]	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.31
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.02
Pork ingestion	Location of subsistence pork farm (5 km northeast)[a]	1.0
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence poultry farmer.

Table A-9.8. Exposure Scenario for Subsistence Poultry Farmer, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence poultry farm (5 km northeast)	1.0
Soil ingestion	Location of subsistence poultry farm (5 km northeast)	1.0
Belowground vegetables	Location of subsistence poultry farm (5 km northeast)	1.0
Aboveground produce	Location of subsistence poultry farm (5 km northeast)	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.31
Chicken meat ingestion	Location of subsistence poultry farm (5 km northeast)	1.0
Egg ingestion	Location of subsistence poultry farm (5 km northeast)	1.0
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

A subsistence fisher was modeled for each watershed. The fish consumption rate for the subsistence fisher was 60 g/d, rather than the 1.64-g/d rate of the general population. The locations of the residences of the subsistence fishers were assumed to be the site of highest vapor air concentration within the affected watershed. The residence location was used for estimating exposures from direct inhalation and soil ingestion. All fish in the diet was assumed to be from the watershed where the subsistence fisher resided. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. The subsistence fisher residing in the San Pablo Reservoir and consuming fish from the reservoir was also assumed to drink contaminated water from the San Pablo Reservoir. Table A-9.9 lists the locations of contamination and the contaminated fraction by pathway for the subsistence fisher scenario.

Table A-9.9. Exposure Scenario for Subsistence Fisher, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of maximum vapor air concentration in each watershed	1.0
Soil ingestion	Location of maximum vapor air concentration in each watershed	1.0
Belowground vegetables	Average over land to 20 km	1.0
Aboveground produce	Average over land to 20 km	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.31
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.02
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion (60 g/d)	Each watershed	1.0

The location of the home gardener and child was derived from the location of the closest actual residence to the facility. This residential location was used to estimate exposures from direct inhalation and soil ingestion. The fractions contaminated for the aboveground produce and belowground vegetables were determined by adding the fraction contaminated in the local market to the fraction that the gardener home-raised and consumed, as cited in the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 1.0 by adding the homegrown fraction of 0.25 to 100 percent of the remaining 0.75 purchased from local markets. All other dietary items were assumed to be purchased from local markets and to contain typical levels of contamination derived from air concentrations and deposition rates averaged over the land out to 20 kilometers from the facility. The home gardener consuming fish from the San Pablo Reservoir was also assumed to drink contaminated water from the San Pablo Reservoir. Table A-9.10 lists the locations of contamination and the contaminated fraction by pathway for the home gardener scenarios.

Table A-9.10. Exposure Scenario for Home Gardener and Child, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated	
Direct inhalation	Location of closest residence (0.1 km east-southeast)	1.0	
Soil ingestion	Location of closest residence (0.1 km east-southeast)	1.0	
		Central tendency	**High end**
Belowground vegetables	Location of closest residence (0.1 km east-southeast)	0.25 Typical farmer + 0.75 x Local market = 1.0	0.40 Typical farmer + 0.60 x Local market = 1.0
Aboveground produce	Location of closest residence (0.1 km east-southeast)	0.25 Typical farmer + 0.75 x Local market = 1.0	0.40 Typical farmer + 0.60 x Local market = 1.0
Beef ingestion	Average over land to 20 km	0.01	0.01
Milk ingestion	Average over land to 20 km	0.31	0.31
Chicken meat ingestion	Average over land to 20 km	0.01	0.01
Egg ingestion	Average over land to 20 km	0.02	0.02
Pork ingestion	Average over land to 20 km	0.01	0.01
Fish ingestion	Each watershed	0.01	0.01

The typical adult resident and child exposures were based on air concentrations and deposition rates averaged over the land out to 20 km. The averages were used for estimating exposures from direct inhalation and soil ingestion. All dietary items were assumed purchased from the local market and to contain typical levels of contamination. The typical resident consuming fish from the San Pablo Reservoir was also assumed to drink contaminated water from the San Pablo Reservoir. Table A-9.11 lists the locations of contamination and the contaminated fraction by pathway for the typical resident scenarios.

Table A-9.11. Exposure Scenario for Typical Adult Resident and Child, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average over land to 20 km	1.0
Soil ingestion	Average over land to 20 km	1.0
Belowground vegetables	Average over land to 20 km	1.0
Aboveground produce	Average over land to 20 km	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.31
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.02
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion	Each watershed	0.01

The typical farmer for this site was assumed to be a produce farmer because the fraction of produce locally grown was higher than the fractions for the other commodities in the analysis. The typical produce farmer was assumed to produce a fraction of the vegetables and fruits he consumed and to purchase all other dietary items from the local market. The fractions contaminated for each pathway were determined by adding the fraction contaminated in the local market to the fraction that the farmer home-raised and consumed from the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 1.0 by adding the homegrown fraction of 0.25 to 100 percent of the remaining 0.75 purchased from local markets. Both the items raised on the typical farm and the items purchased from local markets had typical levels of contamination. The typical produce farmer's exposures from direct inhalation and soil ingestion were estimated to be at levels derived from air concentrations and deposition rate averaged over the land out to 20 kilometers. The typical farmer consuming fish from the San Pablo Reservoir was also assumed to drink contaminated water from the San Pablo Reservoir. Table A-9.12 lists the locations of contamination and the contaminated fraction by pathway for the typical farmer scenario.

Table A-9.12. Exposure Scenario for Typical Farmer, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated	
Direct inhalation	Average over land to 20 km	1.0	
Soil ingestion	Average over land to 20 km	1.0	
Belowground vegetables	Average over land to 20 km	**Central tendency**	**High-end**
		0.25 Typical farmer + 0.75 x Local market = 1.0	0.40 Typical farmer + 0.60 x Local market = 1.0
Aboveground produce	Average over land to 20 km	0.25 Typical farmer + 0.75 x Local market = 1.0	0.40 Typical farmer + 0.60 x Local market = 1.0
Beef ingestion	Average over land to 20 km	0.01	0.01
Milk ingestion	Average over land to 20 km	0.31	0.31
Chicken meat ingestion	Average over land to 20 km	0.01	0.01
Egg ingestion	Average over land to 20 km	0.02	0.02
Pork ingestion	Average over land to 20 km	0.01	0.01
Fish ingestion	Each Watershed	0.01	0.01

Recreational fishers were modeled for each waterbody by combining the typical resident scenario with an increased consumption of contaminated fish recreationally caught (30 g/d). The recreational fisher's exposures from direct inhalation and soil ingestion were derived from air concentrations and deposition rates averaged over land out to 20 kilometers. All fish in the diet was assumed to be from a single waterbody. For instance, the recreational fisher identified for the North Reservoir ate only fish caught in the North Reservoir. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. The recreational fisher consuming fish from the San Pablo Reservoir was also assumed to drink contaminated water from the San Pablo Reservoir. Table A-9.13 lists the location of contamination and the contaminated fraction by pathway for the recreational fisher scenario.

Table A-9.13. Exposure Scenario for Recreational Fisher, Case I

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average over land to 20 km	1.0
Soil ingestion	Average over land to 20 km	1.0
Belowground vegetables	Average over land to 20 km	1.0
Aboveground produce	Average over land to 20 km	1.0
Beef ingestion	Average over land to 20 km	0.01
Milk ingestion	Average over land to 20 km	0.31
Chicken meat ingestion	Average over land to 20 km	0.01
Egg ingestion	Average over land to 20 km	0.02
Pork ingestion	Average over land to 20 km	0.01
Fish ingestion (30 g/d)	Each watershed	1.0

D. Air Modeling and Air Modeling Results

A test version of ISCSTDFT was the air dispersion and deposition model used to estimate air concentrations and deposition rates for Case I. Source inputs used in the modeling are listed in Table A-9.1. The meteorologic data required for the air modeling were created using PCRAMMET, DEPMET, and PMERGE preprocessors. Table A-9.14 lists site-specific data needed for the DEPMET preprocessor. The actual anemometer height was used as a DEPMET input. For the other inputs, recommendations from the DEPMET User's Guide (U.S. EPA, 1994b) based on the site-specific land use data were used. Land use information for Case I was obtained from telephone surveys and assessed through topographic maps.

One year of on-site meteorological data were used for the ISCSTDFT air modeling. The ISCSTDFT model was run using the "default" model options. The terrain option was used because this site is located in an area of complex terrain. Additionally, the good engineering practices (GEP) stack height was calculated using EPA's Building Profile Input Program (BPIP) to determine if building downwash should be considered for this site. Inputs to BPIP -- site-specific information on the building height, width, and location -- were available for several buildings with the potential to influence the plume dispersion from the stack. Based on this site-specific information, GEP stack height for Case I as calculated by BPIP was 65 meters. This value is greater than the actual stack height of 34.1 meters. The stack was also located in the building's area of influence, which is defined as five times the lesser of the building height or the maximum projected width. Therefore, building downwash was used in the air dispersion modeling for Case I.

Specific receptor locations evenly spaced every 1,000 meters were identified for each watershed and waterbody using USGS topographic maps. The air dispersions and deposition rates were then areally averaged over each specific watershed and waterbody.

The point of maximum combined deposition and the point of maximum vapor air concentration were used for "bounding" estimates. For a given scenario, the point of maximum concentration was used in calculating bounding risks for direct inhalation, while the maximum combined deposition or maximum concentration was used in estimating risks for other pathways. However, bounding exposure was considered only for the pathways involved in the subsistence activities for a given scenario. For example, bounding exposure for the subsistence poultry farmer was due to ingestion of soil, produce, poultry, and eggs (based on the point of maximum deposition) and to direct inhalation (based on the point of maximum concentration). The other exposure routes -- ingestion of beef, pork, milk, fish, and drinking water -- were not bounding but were, instead, based on the location of the subsistence poultry farmer. For the subsistence fisher scenario, a default watershed, which lies at the high end of the distribution of watersheds (Van der Leeden, 1990), was centered at the point of maximum combined deposition. Parameters for the bounding watershed are contained in the body of the document (Section II).

The ISCSTDFT air modeling results are presented in Figures A-9.1 through A-9.4. Figure A-9.1 shows the combined deposition of particles within 20 kilometers of Case I; Figure A-9.2 shows the air concentration of vapors within 20 kilometers of Case I; and Figures A-9.3 and A-9.4 show the wet and dry deposition of particles, respectively, within 3 kilometers of Facility I. The results are also presented in tabular form in Table A-9.15.

Table A-9.14. Air Modeling Inputs Used in ISCSTDFT Modeling

Meteorological location	
Surface / upper air	Oakland, CA & BAAWMD Winds / Oakland, CA
Anemometer height (m)	10.0
DEPMET Preprocessor Inputs	
Land use within 5 km	Industrial / Rural
Min. M-O length (m)	50.
Roughness height (m)	0.5[a]
Displacement height (m)	2.5
Noontime albedo (fraction)	0.21
Soil moisture available (fraction)	0.5
Net radiation absorbed in ground (fraction)	0.27
Anthropogenic heat flux (W/m^2)	21.0

[a] Based on a maximum roughness height of 1/20th of the anemometer height

Table A-9.15. Results of ISCSTDFT Air Modeling for Site I[a]

Scenario	Location Distance (m)/ Direction	Particles				Vapors	
		Combined Deposition (g/m²-yr)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Dry Deposition (g/m²-yr)/(g/s)	Air Concentration (μg/m³)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Air Concentration (μg/m³)/(g/s)
Point of maximum combined deposition	100/SW	0.25	0.22	0.023	0.086	0.3	0.091
Point of maximum vapor concentration	1000/WSW	0.021	0.005	0.016	0.029	0.0084	0.3
Home gardener (closest resident)	100/ESE	0.057	0.057	0	0	0.078	0
General population	--	4.7E-04	4.0E-05	4.3E-04	0.018	6.4E-05	0.019
Subsistence farmer - beef	11,000/NE	0.0024	9.0E-05	0.0023	0.015	1.7E-04	0.017
Subsistence farmer - pork, poultry, dairy	5,000/NE	0.0081	2.6E-04	0.0078	0.044	4.6E-04	0.048
Subsistence fisher - North Reservoir	4000/NE	0.0082	--	--	0.032	0.00038	0.036
Subsistence fisher - San Pablo Reservoir	3000/NE	0.019	--	--	0.091	0.00088	0.1
Subsistence fisher - Lafayette Reservoir	19000/E	0.00089	--	--	0.0095	0.00005	0.0093
		Averages over Watershed			**Averages over Waterbody**		
		Combined Deposition of Particles (g/m²-yr)/(g/s)	**Wet Deposition of Vapors (g/m²-yr)/(g/s)**	**Air Concentration of Vapors (μg/m³)/(g/s)**	**Combined Deposition of Particles (g/m²-yr)/(g/s)**	**Wet Deposition of Vapors (g/m²-yr)/(g/s)**	**Air Concentration of Vapors (μg/m³)/(g/s)**
North Reservoir	--	0.011	0.0006	0.066	0.012	0.00062	0.066
San Pablo Reservoir	--	0.0033	0.00021	0.024	0.0029	0.00014	0.023
Lafayette Reservoir	--	0.00073	0.000048	0.0079	0.00068	0.00004	0.0076

[a] The air modeling results listed in the table are based on an emission rate of 1 g/s for the stack.

Figure A.9.1 Combined deposition of particles within 20 kilometers of Facility I. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.

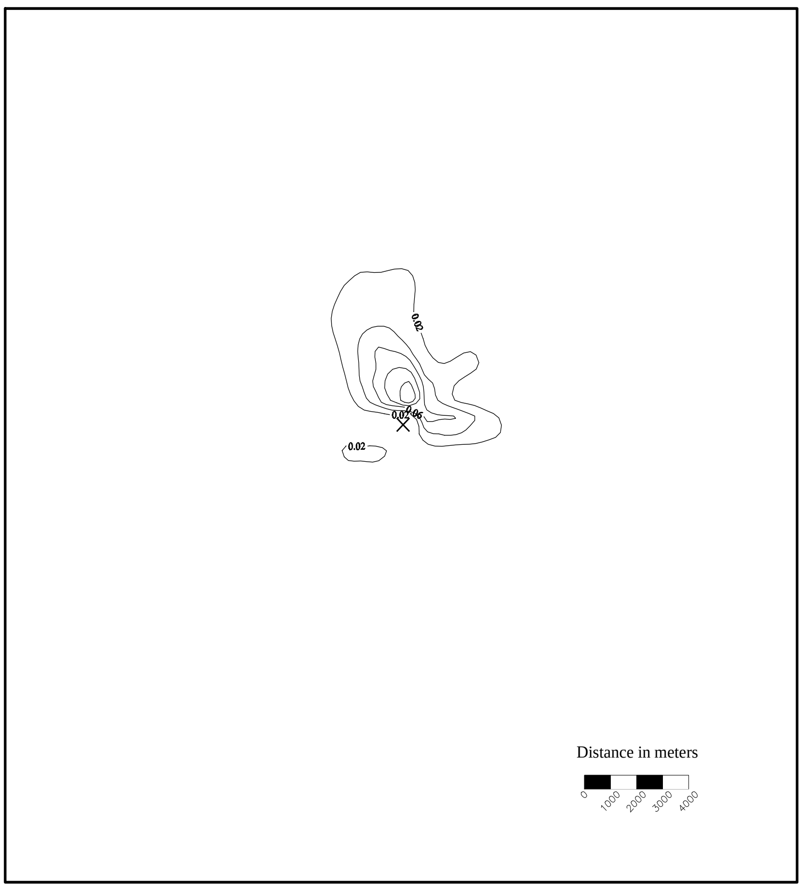


Figure A.9.2 Air concentration of vapors within 20 kilometers of Facility I. Air concentration in units of micrograms per cubic meter, resulting from a unit emission rate of 1 gram per second.

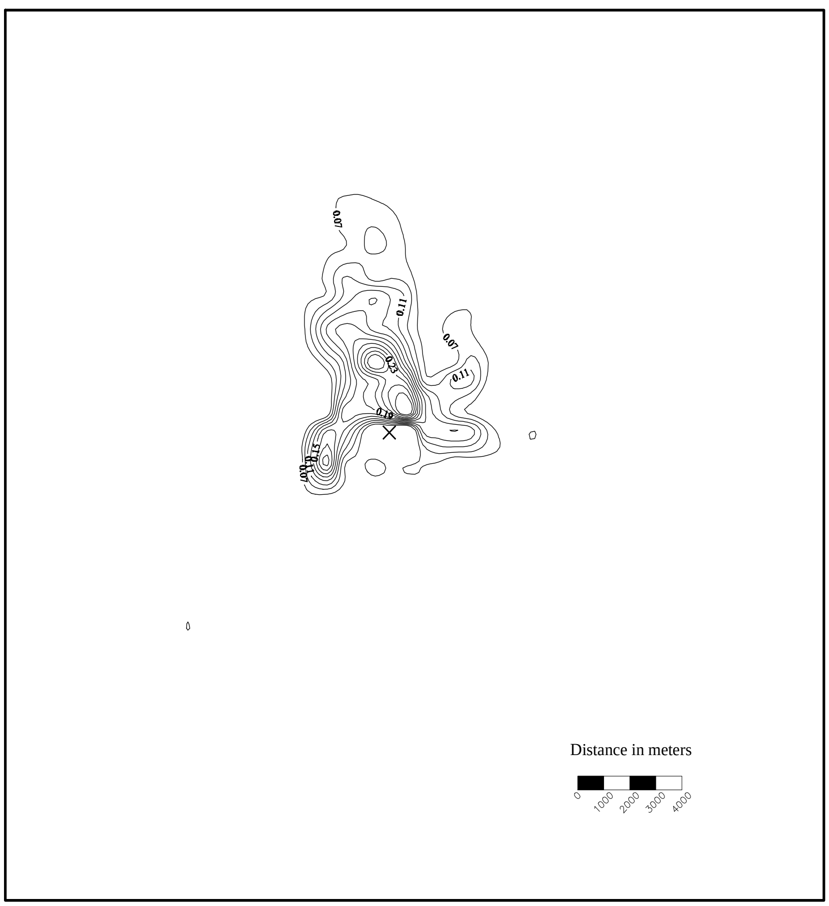


Figure A.9.3 Wet deposition of particles within 3 kilometers of Facility I. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.

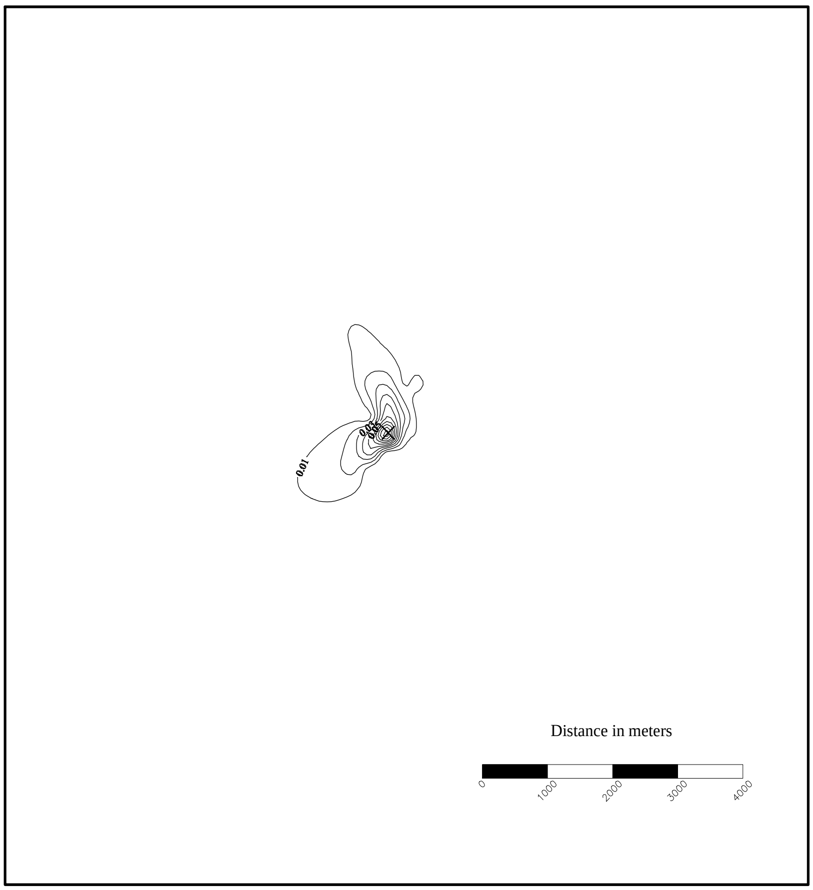
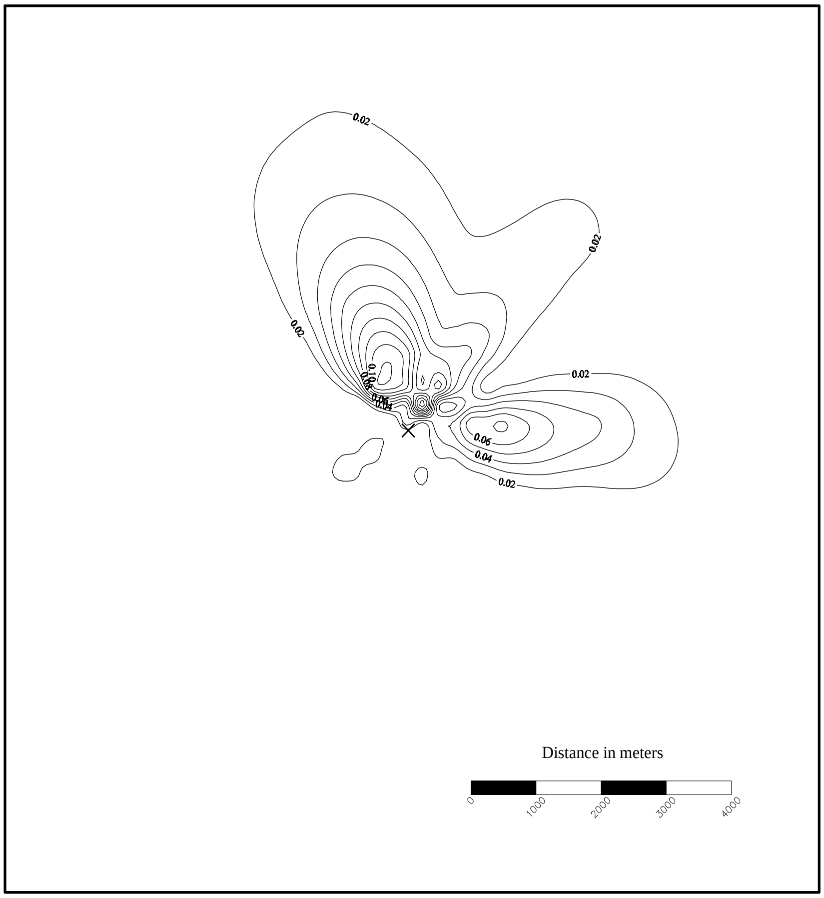


Figure A.9.4 Dry deposition of particles within 3 kilometers of Facility I. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.



10. Case J

A. Source Characterization

Case J is one of two lightweight aggregate kilns selected for this analysis. Facility and source parameters used in the air dispersion modeling and risk assessment of this site are presented in Table A-10.1. Values listed in the table were obtained from facility-specific information provided by EPA.

Table A-10.1. Facility and Source Parameters for Case J

Parameter	Case J
Facility type	Lightweight aggregate kiln
Land use w/in 5 km	Suburban / rural
Terrain use	Yes
Operating hours (8,760/year possible)	7,884
Stack parameters	Stack 1
Stack height (m)	36.6
Diameter (m)	1.2
Total flow rate (dscfm) / (dscms)	24,538 / 11.6
Exit velocity (m/s)	19.8
Exit temperature (K)	331.5

B. Setting Characterization

Case J is located in the northeastern United States in an area of complex terrain. Land use immediately surrounding the site is suburban, but the land use becomes more rural to the north.

The National Weather Service Station at Albany, New York, provided the most appropriate meteorologic data for Case J. Upper air data, also from Albany, were paired with the surface data for air dispersion modeling. Five years of meteorologic data, for the years 1985 and 1987-1990, were used to determine long-term average air dispersion and deposition estimates. Table A-10.2 lists the annual average meteorologic parameters, which were obtained from the International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992). Also listed in Table A-10.2 are the average evapotranspiration rate and annual runoff. These values were used with the precipitation rate to calculate a water balance for Case J. One-half of the average annual runoff value cited in the *Water Atlas* (Geraghty et al., 1973) was used in the analysis. The adjustment was made to account for surface runoff only and not the subsurface inflows to surface waters. The evapotranspiration rate was calculated by assuming 70 percent of the precipitation evaporates.

Table A-10.2. Annual Average Meteorologic Parameters for Case J

Ave. annual evapotranspiration (cm/yr)	Ave. annual runoff [a] (cm/yr)	Ave. annual precipitation [b] (cm/yr)	Ambient air temperature[b] (K)	Mean annual windspeed[b] (m/s)
63.6	25.4	90.9	282	5.1

a *Water Atlas* (Geraghty et al., 1973).
b International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992).

C. *Characterization of Exposed Populations*

Table A-10.3 presents the locations of exposed populations identified for Case J. Information regarding the location of the residence and farms likely to be most impacted by Case J was obtained through telephone interviews with local planning offices and local agricultural extension agents. The local officials were asked to identify farms near the facility where subsistence activities would be likely. Farms identified by local officials were assessed to determine which would be most impacted by the facility emissions, and the maximally impacted farms were assumed to represent the location of the subsistence farmers.

Table A-10.3. Location of Receptors Identified for Case J

Receptor	Location (Distance (km)/Direction)	Source
Residence of home gardener	0.1 km north	City Clerk
Subsistence beef farm	5 km north	City Clerk
Subsistence dairy farm	10 km north-northwest	City Clerk
Subsistence poultry farm	5 km north[a]	City Clerk
Subsistence pork farm	5 km north[a]	City Clerk
Subsistence fisher location (inhalation and soil ingestion) Hudson River Mohawk River Tomhannock Reservoir Troy Reservoir	 1 km northwest 1 km northwest 16.5 km south-southeast 6 km east	Location of maximum air concentration of vapors within the watershed
Waterbody identified as surface drinking water source	Tomhannock Reservoir Hudson River Mohawk River	Water Department/ City Clerk

a Default assumption based upon location of subsistence beef farmer.

The waterbodies were selected from USGS topographical maps as those that would be large enough to support fish yet would reflect the highest impact from the facility. Phone calls to local officials verified that individuals might consume fish caught in the selected waterbodies. The topographic maps were also used in identifying the watersheds associated with each waterbody and in estimating waterbody and watershed surface areas. Table A-10.4 lists the surface areas and other surface water parameters for Case J. References for the surface water parameters are also listed in the table.

The fraction of food contaminated was varied depending on the scenario. In this analysis, the fraction contaminated is defined as the fraction of what is consumed that is contaminated by facility emissions. The fraction contaminated is independent of the level of contamination, which is dependent upon the production location. Contamination levels calculated for a subsistence farm located near the facility would be higher than those calculated for the typical farm (air concentrations and deposition rates averaged to 20 kilometers). The terms "subsistence level of contamination" and "typical level of contamination" are used to reflect the different levels.

Central tendency and high-end contaminated fractions were developed based on an economic analysis of regional production and recommendations of the fraction home-produced from the *Exposure Factors Handbook* (U.S. EPA, 1990). Fractions were developed using data from counties within 50 kilometers of Site H. The economic analysis is discussed in detail in Section II.E.2. The commodity with the highest fraction locally produced was assumed to be the commodity produced by the typical farmer. Local agricultural production indicated that the typical farmer for Case J was a dairy farmer. The fractions assumed to be locally produced and processed for Case J are as follows:

Beef	0.03	Pork	0.29
Dairy	1.0	Poultry	0.01
Produce	0.14	Eggs	0.01
Fish	0.01		

The subsistence farmers considered for Case J were beef, dairy, poultry, and pork farmers. The locations of the subsistence farmers, listed in Table A-10.3, were used for estimating exposures from direct inhalation and soil ingestion. The fraction contaminated is assumed to be 1 for the livestock the subsistence farmer is identified as producing. He was also assumed to grow all the fruits and vegetables he consumed. For example, the subsistence beef farmer was assumed to produce all the beef, vegetables, and fruits that he ingested and to purchase all other dietary items -- such as milk, pork, fish -- from local markets. The items raised on the subsistence farms had higher levels of contamination than the items available in the local market. The local items purchased in the market were contaminated at levels that reflected the average impact from the stack out to 20 kilometers from the facility. All subsistence farmers except those consuming fish from the Troy Reservoir were assumed to drink contaminated water. Tables A-10.5 through A-10.8 list the locations of contamination and the contaminated fraction by pathway for the subsistence farm scenarios.

Table A-10.4. Surface Water Parameters for Case J

Waterbody	Surface Area (m^2)	Watershed Area (m^2)	Impervious Watershed Area (m^2)	Average Volumetric Flow Rate (m^3/yr)	Current Velocity (m/s)	Depth of Water Column (m)	USLE Rainfall/ Erosivity Factor
Hudson River	1.5E+07	1.0E+09	1.0E+08	7.5E+09	0.96	1.0	125
Mohawk River	1.3E+07	1.9E+08	1.9E+07	5.2E+09	0.71	1.0	125
Tomhannock Reservoir	6.2E+06	7.5E+07	3.8E+05	1.9E+07	NA	4.5	125
Troy Reservoir	2.9E+05	3.5E+06	1.8E+04	9.0+05	NA	4.5	125

[a] Surface areas for the watersheds and waterbodies were determined from the USGS 1.25 000-scale topographic 7.5 min X 15 min quadrangles.

[b] Impervious watershed areas were estimated from USGS quadrangles, site-specific land use, and a study of percent imperviousness for different land uses conducted by Camp, Dresser, and McKee (1989).

[c] The volumetric flow rates for the Hudson and Mohawk Rivers were obtained from the REACH (U.S. EPA, 1995a) database. Flow rates for the other waterbodies were calculated from the watershed area and average annual surface runoff.

[d] Current velocities for the Hudson and Mohawk Rivers were obtained from the REACH (U.S. EPA, 1995a) database. Current velocities for lakes were not required and are listed as NA (Not Applicable).

[e] Depths for the waterbodies were assumed from a default of 4 to 6 meters for lakes and 1 meter for rivers.

[f] USLE Erosivity/Rainfall Factor was obtained from Edwards (1993) and was used in the universal soil loss equation (USLE).

Table A-10.5. Exposure Scenario for Subsistence Beef Farmer, Case J

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (5 km north)	1.0
Soil ingestion	Location of subsistence beef farm (5 km north)	1.0
Belowground vegetables	Location of subsistence beef farm (5 km north)	1.0
Aboveground produce	Location of subsistence beef farm (5 km north)	1.0
Beef ingestion	Location of subsistence beef farm (5 km north)	1.0
Milk ingestion	Average to 20 km	1.0
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.29
Fish ingestion	Each watershed	0.01

Table A-10.6. Exposure Scenario for Subsistence Dairy Farmer and Child, Case J

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence dairy farm (10 km north-northeast)	1.0
Soil ingestion	Location of subsistence dairy farm (10 km north-northeast)	1.0
Belowground vegetables	Location of subsistence dairy farm (10 km north-northeast)	1.0
Aboveground produce	Location of subsistence dairy farm (10 km north-northeast)	1.0
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Location of subsistence dairy farm (10 km north-northeast)	1.0
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.29
Fish ingestion	Each watershed	0.01

Table A-10.7. Exposure Scenario for Subsistence Pork Farmer, Case J

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence pork farm (5 km north)[a]	1.0
Soil ingestion	Location of subsistence pork farm (5 km north)[a]	1.0
Belowground vegetables	Location of subsistence pork farm (5 km north)[a]	1.0
Aboveground produce	Location of subsistence pork farm (5 km north)[a]	1.0
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Average to 20 km	1.0
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Location of subsistence pork farm (5 km north)[a]	1.0
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

Table A-10.8. Exposure Scenario for Subsistence Poultry Farmer, Case J

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence poultry farm (5 km north)[a]	1.0
Soil ingestion	Location of subsistence poultry farm (5 km north)[a]	1.0
Belowground vegetables	Location of subsistence poultry farm (5 km north)[a]	1.0
Aboveground produce	Location of subsistence poultry farm (5 km north)[a]	1.0
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Average to 20 km	1.0
Chicken meat ingestion	Location of subsistence poultry farm (5 km north)[a]	1.0
Egg ingestion	Location of subsistence poultry farm (5 km north)[a]	1.0
Pork ingestion	Average to 20 km	0.29
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

A subsistence fisher was modeled for each watershed. The fish consumption rate for the subsistence fisher was 60 g/d, rather than the 1.64-g/d rate of the general population. The locations of the residences of the subsistence fishers were assumed to be the sites of highest vapor air concentration within the affected watershed. The residence location was used for estimating exposures from direct inhalation and soil ingestion. All fish in the diet was assumed to be from the watershed in which the subsistence fisher resided. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. All subsistence fishers except those consuming fish from the Troy Reservoir were assumed to drink contaminated water. Table A-10.9 lists the locations of contamination and the contaminated fraction by pathway for the subsistence fisher scenario.

Table A-10.9. Exposure Scenario for Subsistence Fisher, Case J

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of maximum vapor air concentration in each watershed	1.0
Soil ingestion	Location of maximum vapor air concentration in each watershed	1.0
Belowground vegetables	Average to 20 km	0.14
Aboveground produce	Average to 20 km	0.14
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Average to 20 km	1.0
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.29
Fish ingestion (60 g/d)	Each watershed	1.0

The location of the home gardener and child was derived from the locations of the closest actual residences to the facility. This residential location was used to estimate exposures from direct inhalation and soil ingestion. The fractions contaminated for the aboveground produce and belowground vegetables were determined by adding the fraction contaminated in the local market to the fraction that the gardener home-raised and consumed, as cited in the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.36 by adding the homegrown fraction of 0.25 to 14 percent of the remaining 0.75 purchased from local markets. All other dietary items were assumed to be purchased from local markets and to contain typical levels of contamination derived from average air dispersion and deposition estimates to 20 kilometers from the facility. All home gardeners except those consuming fish from the Troy Reservoir were assumed to drink contaminated water. Table A-10.10 lists the locations of contamination and the contaminated fraction by pathway for the home gardener scenarios.

Table A-10.10. Exposure Scenario for Home Gardener and Child, Case J

Exposure Pathway	**Location for Calculating Contamination**	**Fraction Contaminated**	
Direct inhalation	Location of closest residence (0.1 km north)	1.0	
Soil ingestion	Location of closest residence (0.1 km north)	1.0	
		Central tendency	**High end**
Belowground vegetables	Location of closest residence (0.1 km north)	0.25 Typical farmer + 0.75 x Local market =0.36	0.40 Typical farmer + 0.60 x Local market =0.48
Aboveground produce	Location of closest residence (0.1 km north)	0.25 Typical farmer + 0.75 x Local market =0.36	0.40 Typical farmer + 0.60 x Local market =0.48
Beef ingestion	Average to 20 km	0.03	0.03
Milk ingestion	Average to 20 km	1	1
Chicken meat ingestion	Average to 20 km	0.01	0.01
Egg ingestion	Average to 20 km	0.01	0.01
Pork ingestion	Average to 20 km	0.29	0.29
Fish ingestion	Each watershed	0.01	0.01

The typical adult resident and child exposures were based on averages of air concentrations and deposition rates out to 20 km. The averages were used for estimating exposures from direct inhalation and soil ingestion. All dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. All typical residents except those consuming fish from the Troy Reservoir were assumed to drink contaminated water. Table A-10.11 lists the locations of contamination and the contaminated fraction by pathway for the typical resident scenarios.

Table A-10.11. Exposure Scenario for Typical Adult Resident and Child, Case J

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average out to 20 km	1.0
Soil ingestion	Average out to 20 km	1.0
Belowground vegetables	Average out to 20 km	0.14
Aboveground produce	Average out to 20 km	0.14
Beef ingestion	Average out to 20 km	0.03
Milk ingestion	Average out to 20 km	1.0
Chicken meat ingestion	Average out to 20 km	0.01
Egg ingestion	Average out to 20 km	0.01
Pork ingestion	Average out to 20 km	0.29
Fish ingestion	Each watershed	0.01

The typical farmer for this site was assumed to be a dairy farmer because the fraction of dairy locally produced was higher than the fractions for the other commodities in the analysis. The typical dairy farmer was assumed to produce a fraction of the dairy, vegetables, and fruits he consumed and to purchase all other dietary items from the local market. The fractions contaminated for each pathway were determined by adding the fraction contaminated in the local market to the fraction that the farmer home-raised and consumed from the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.36 by adding the homegrown fraction of 0.25 to 14 percent of the remaining 0.75 purchased from local markets. Both the items raised on the typical farm and the items purchased from local markets had typical levels of contamination. The typical dairy farmer's exposures from direct inhalation and soil ingestion were estimated to be at levels derived from averages of air dispersion and deposition outputs to 20 kilometers. All typical farmers except those consuming fish from the Troy Reservoir were assumed to drink contaminated water. Table A-10.12 lists the locations of contamination and the contaminated fraction by pathway for the typical farmer scenario.

Table A-10.12. Exposure Scenario for Typical Farmer, Case J

Exposure Pathway	**Location for Calculating Contamination**	**Fraction Contaminated**	
Direct inhalation	Average to 20 km	1.0	
Soil ingestion	Average to 20 km	1.0	
		Central tendency	**High-end**
Belowground vegetables	Average to 20 km	0.25 Typical farmer + 0.75 x Local market =0.36	0.40 Typical farmer + 0.60 x Local market =0.48
Aboveground produce	Average to 20 km	0.25 Typical farmer + 0.75 x Local market =0.36	0.40 Typical farmer + 0.60 x Local market =0.48
Beef ingestion	Average to 20 km	0.03	0.03
Milk ingestion	Average to 20 km	0.40 Typical farmer + 0.60 x Local market =1.0	0.75 Typical farmer + 0.25 x Local market =1.0
Chicken meat ingestion	Average to 20 km	0.01	0.01
Egg ingestion	Average to 20 km	0.01	0.01
Pork ingestion	Average to 20 km	0.29	0.29
Fish ingestion	Each Watershed	0.01	0.01

Recreational fishers were modeled for each waterbody by combining the typical resident scenario with an increased consumption of contaminated fish recreationally caught (30 g/d). The recreational fisher's exposures from direct inhalation and soil ingestion were derived from averages of air dispersion and deposition output to 20 kilometers. All fish in the diet was assumed to be from a single waterbody. For instance, the recreational fisher identified for the Hudson River ate only fish caught in the Hudson River. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. All recreational fishers except those consuming fish from the Troy Reservoir were assumed to drink contaminated water. Table A-10.13 lists the location of contamination and the contaminated fraction by pathway for the recreational fisher scenario.

Table A-10.13. Exposure Scenario for Recreational Fisher, Case J

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average to 20 km	1.0
Soil ingestion	Average to 20 km	1.0
Below ground vegetables	Average to 20 km	0.14
Above ground produce	Average to 20 km	0.14
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Average to 20 km	0.71
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.29
Fish ingestion (30 g/d)	Each watershed	1.0

D. Air Modeling and Air Modeling Results

A test version of ISCSTDFT was the air dispersion and deposition model used to estimate air concentrations and deposition rates for Case J. Source inputs used in the modeling are listed in Table A-10.1. The meteorologic data required for the air modeling were created using PCRAMMET, DEPMET, and PMERGE preprocessors. Table A-10.14 lists site-specific data needed for the DEPMET preprocessor. An assumed anemometer height of 10 meters was used as a DEPMET input. For the other inputs, recommendations from the DEPMET User's Guide (U.S. EPA, 1994) based on the site-specific land use data were used. Land use information for Case J was obtained from telephone surveys and assessed through topographic maps.

The ISCSTDFT model was run using 5 years of meteorological data concatenated into a multiple-year meteorological file (U.S. EPA, 1995b). Therefore, results of the ISCSTDFT modeling conducted with this multiple-year meteorological file represent a 5-year average.

The ISCSTDFT model was run using the "default" model options. The terrain option was used because this site is located in an area of complex terrain, where the effects of terrain on air dispersion would be significant. Site-specific information on the building height, width, and location were not available, and an assessment of the good engineering practices stack height could not be conducted. Therefore, downwash was not used in the air dispersion modeling for Case J.

Specific receptor locations evenly spaced every 1,000 meters were identified for each watershed and waterbody using USGS topographic maps. The 5-year averages of air dispersions and deposition rates were then areally averaged over each specific watershed and waterbody.

The point of maximum combined deposition and the point of maximum vapor air concentration were used for "bounding" estimates. For a given scenario, the point of maximum concentration was used in calculating bounding risks for direct inhalation, while the maximum combined deposition or maximum concentration was used in estimating risks for other pathways. However, bounding exposure was considered only for the pathways involved in the subsistence activities for a given scenario. For example, bounding exposure for the subsistence poultry farmer was due to ingestion of soil, produce, poultry, and eggs (based on the point of maximum deposition) and to direct inhalation (based on the point of maximum concentration). The other exposure routes -- ingestion of beef, pork, milk, fish, and drinking water -- were not bounding but were, instead, based on the location of the subsistence poultry farmer. For the subsistence fisher scenario, a default watershed, which lies at the high end of the distribution of watersheds (Van der Leeden et al., 1990), was centered at the point of maximum combined deposition. Parameters for the bounding watershed are contained in the body of the document (Section II).

The ISCSTDFT air modeling results are presented in Figures A-10.1 through A-10.4. Figure A-10.1 shows the combined deposition of particles within 20 kilometers of Case J; Figure A-10.2 shows the air concentration of vapors within 20 kilometers of Case J; and Figures A-10.3 and A-10.4 show the wet and dry deposition of particles, respectively, within 3 kilometers of Facility J. The results are also presented in tabular form in Table A-10.15.

Table A-10.14. Air Modeling Inputs Used in ISCSTDFT Modeling

Meteorological location	
Surface / upper air	Albany, NY / Albany, NY
Anemometer height (m)	10.0
DEPMET Preprocessor Inputs	
Land use within 5 km	Suburban / rural
Min. M-O length (m)	2.0
Roughness height (m)	0.5[a]
Displacement height (m)	2.5
Noontime albedo (fraction)	0.28
Soil moisture available (fraction)	0.5
Net radiation absorbed in ground (fraction)	0.15
Anthropogenic heat flux (W/m^2)	0.0

[a] Based on a maximum roughness height of 1/20th of the anemometer height.

Table A-10.15. Results of ISCSTDFT Air Modeling for Case J[a]

Scenario	Location [Distance (m)/ Direction]	Particles				Vapors	
		Combined Deposition $(g/m^2\text{-yr})/(g/s)$	Wet Deposition $(g/m^2\text{-yr})/(g/s)$	Dry Deposition $(g/m^2\text{-yr})/(g/s)$	Air Concentration $(\mu g/m^3)/(g/s)$	Wet Deposition $(g/m^2\text{-yr})/(g/s)$	Air Concentration $(\mu g/m^3)/(g/s)$
Point of maximum combined deposition	700/NNW	0.53	0.026	0.51	1.1	0.038	1.2
Point of maximum vapor concentration	700/NNW	0.53	0.026	0.51	1.1	0.038	1.2
Home gardener (closest resident)	100/N	0.16	0.16	0	1.0E-05	0.21	1.0E-05
General population	--	0.0031	0.0005	0.0026	0.017	0.0008	0.020
Subsistence farmer - beef/ poultry/ pork	5000/N	0.018	0.0016	0.016	0.11	0.0027	0.12
Subsistence farmer - dairy	10,000/NNW	0.0082	0.00087	0.0073	0.053	0.0015	0.058
Subsistence fisher - Hudson River	1,000/NW	0.10	--	--	0.41	0.018	0.44
Subsistence fisher - Mohawk River	1,000/NW	0.10	--	--	0.41	0.018	0.44
Subsistence fisher - Tomhannock Reservoir	14,000/E	0.0014	--	--	0.0081	0.00019	0.0089
Subsistence fisher - Troy Reservoir	5,000/ENE	0.0084	--	--	0.040	0.0011	0.044
		Averages over Watershed			Averages over Waterbody		
		Combined Deposition of Particles $(g/m^2\text{-yr})/(g/s)$	Wet Deposition of Vapors $(g/m^2\text{-yr})/(g/s)$	Air Concentration of Vapors $(\mu g/m^3)/(g/s)$	Combined Deposition of Particles $(g/m^2\text{-yr})/(g/s)$	Wet Deposition of Vapors $(g/m^2\text{-yr})/(g/s)$	Air Concentration of Vapors $(\mu g/m^3)/(g/s)$
Hudson River		0.0040	0.001	0.024	0.0064	0.0035	0.025
Mohawk River		0.0054	0.0014	0.034	0.014	0.0022	0.074
Tomhannock Reservoir		4.3E-04	8.7E-05	0.0046	0.00036	7.3E-05	0.0043
Troy Reservoir		0.0040	5.8E-04	0.025	0.0084	0.0011	0.044

[a] The air modeling results in the table are based on an emission rate of 1 g/s for the stack.

Figure A.10.1 Combined deposition of particles within 3 kilometers of Facility J. Deposition in units of grams per mete r

Figure A.10.1 Combined deposition of particles within 3 kilometers of Facility J. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.

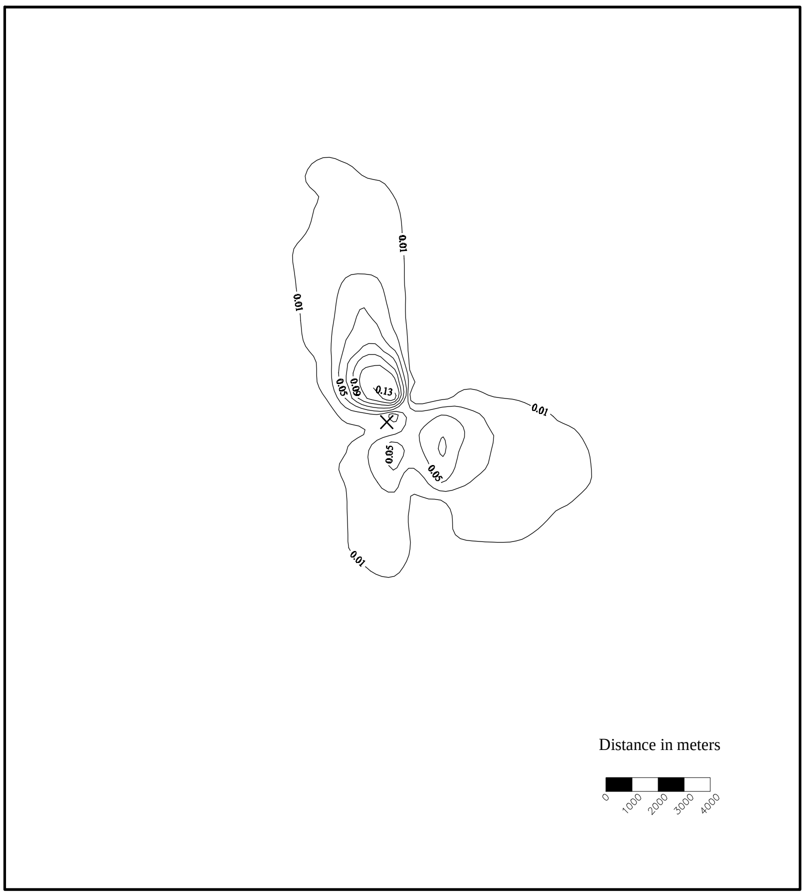


Figure A.10.2 Air concentration of vapors within 20 kilometers of Facility J. Air concentration in units of micrograms per cubic meter, resulting from a unit emission rate of 1 gram per second.

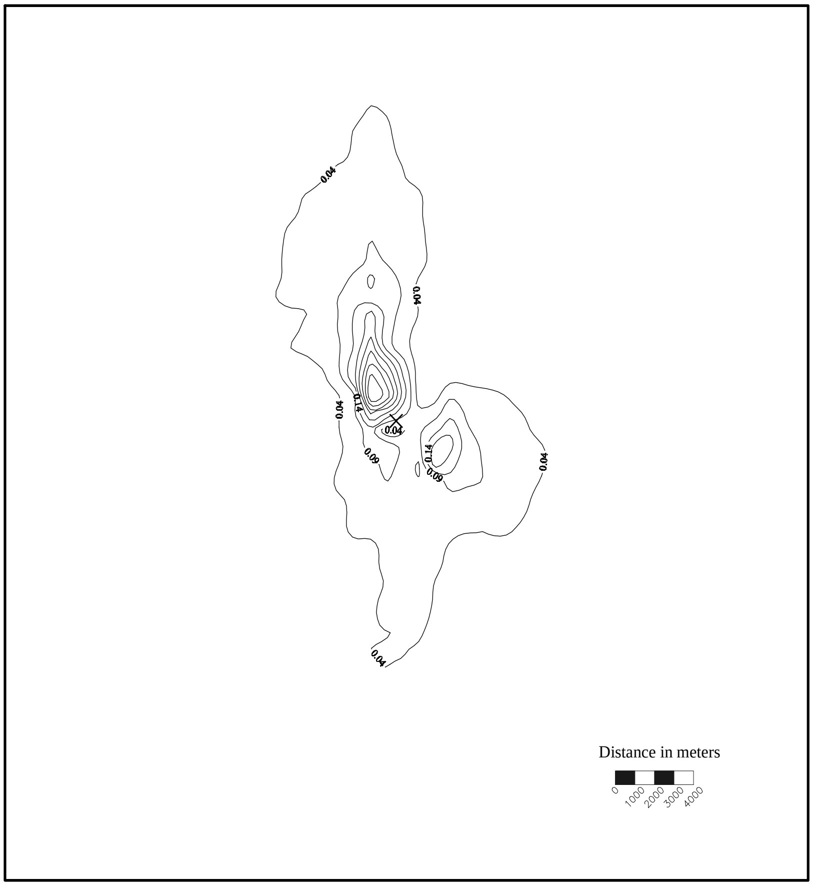


Figure A.10.3 Wet deposition of particles within 3 kilometers of Facility J. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.

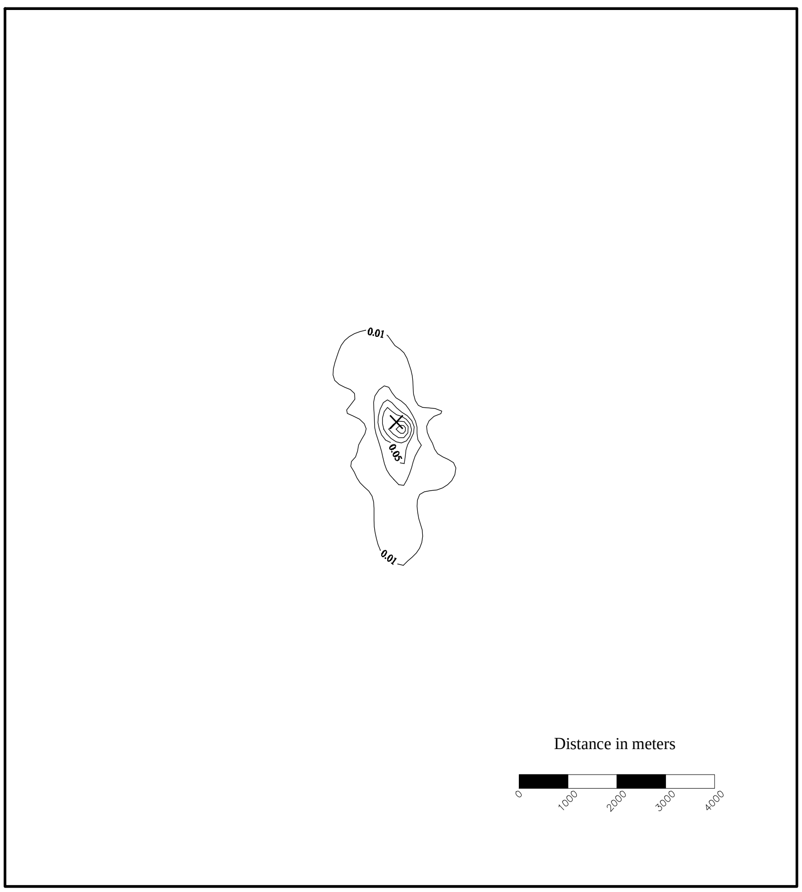
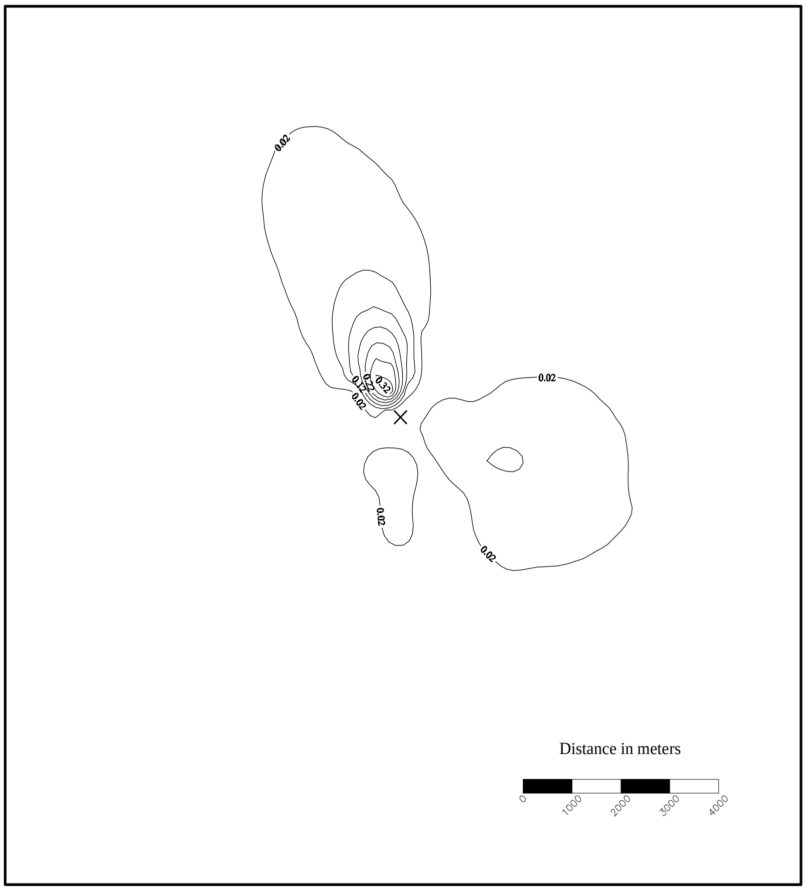


Figure A.10.4 Dry deposition of particles within 3 kilometers of Facility J. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second.



11. Case K

A. Source Characterization

Case K is one of two lightweight aggregate kilns selected for this analysis. Facility and source parameters used in the air dispersion modeling and risk assessment of this site are presented in Table A-11.1. Values listed in the table were obtained from facility-specific information provided by the EPA.

Table A-11.1. Facility and Source Parameters for Case K

Parameter	Case K		
Facility type	Lightweight aggregate kiln		
Land use w/in 5 km	Suburban / rural		
Terrain use	No		
Operating hours (8,760/year possible)	7,884		
Stack parameters	Stack 1	Stack 2	Stack 3
Stack height (m)	21.9	21.9	21.9
Diameter (m)	1.29	1.32	1.32
Total flow rate (dscfm) / (dscms)	20,377 / 9.6	32,400 / 15.3	28,100 / 13.3
Exit velocity (m/s)	10.9	17.8	16.4
Exit temperature (K)	431.3	446.5	446.5

B. Setting Characterization

Case K is located in the southeastern United States in an area of flat terrain. Land use immediately surrounding the site is forested and rural.

The National Weather Service Station at Greensboro, North Carolina, provided the most appropriate meteorologic data for Case K. Upper air data, also from Greensboro, were paired with the surface data for air dispersion modeling. Five years of meteorologic data, for the years 1985 and 1987-1990, were used to determine long-term average air dispersion and deposition estimates. Table A-11.2 lists the annual average meteorologic parameters, which were obtained from the International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992). Also listed in Table A-11.2 are the average evapotranspiration rate and annual runoff. These values were used with the precipitation rate to calculate a water balance for Case K. One-half of the average annual runoff value cited in the *Water Atlas* (Geraghty et. al, 1973) was used in the analysis. The adjustment was made to account for surface runoff only and not the subsurface inflows to surface waters. The evapotranspiration rate was calculated by assuming 70 percent of the precipitation evaporates.

Table A-11.2. Annual Average Meteorologic Parameters for Case K

Ave. annual evapotranspiration (cm/yr)	Ave. annual runoff [a] (cm/yr)	Ave. annual precipitation[b] (cm/yr)	Ambient air temperature[b] (K)	Mean annual windspeed[b] (m/s)
75.6	21.6	108	287	3.6

[a] *Water Atlas* (Geraghty et al., 1973).
[b] International Station Meteorological Climate Summary CD-ROM (U. S. Department of Commerce, 1992).

C. *Characterization of Exposed Populations*

Table A-11.3 presents the locations of exposed populations identified for Case K. Information regarding the location of the residence and farms likely to be most impacted by Case K was obtained through telephone interviews with local planning offices and local agricultural extension agents. The local officials were asked to identify farms near the facility where subsistence activities would be likely. Farms identified by local officials were assessed to determine which would be most impacted by the facility emissions, and the maximally impacted farms were assumed to represent the location of the subsistence farmers.

Table A-11.3. Location of Receptors Identified for Case K

Receptor	Location (Distance (km)/Direction)	Source
Residence of home gardener	0.4 km northeast	Residents Office
Subsistence beef farm	3 km east-northeast	Agricultural Extension Agency
Subsistence dairy farm	3 km east-northeast[a]	Agricultural Extension Agency
Subsistence poultry farm	3 km east-northeast[a]	Agricultural Extension Agency
Subsistence pork farm	3 km east-northeast[a]	Agricultural Extension Agency
Subsistence fisher location (inhalation and soil ingestion) Cascade Creek Dan River Smith River	 1 km northeast 1 km northeast 4 km west	Location of maximum air concentration of vapors within the watershed
Waterbody identified as surface drinking water source	None	City Office

[a] Default assumption based on location of subsistence beef farmer.

The waterbodies were selected from USGS topographical maps as those that would be large enough to support fish yet would reflect the highest impact from the facility. Phone calls to local officials verified that individuals might consume fish caught in the selected waterbodies. The topographic maps were also used in identifying the watersheds associated with each waterbody and in estimating waterbody and watershed surface areas. Table A-11.4 lists the surface areas and other surface water parameters for Case K. References for the surface water parameters are also listed in the table.

The fraction of food contaminated was varied depending on the scenario. In this analysis, the fraction contaminated is defined as the fraction of what is consumed that is contaminated by facility emissions. The fraction contaminated is independent of the level of contamination, which is dependent upon the production location. Contamination levels calculated for a subsistence farm located near the facility would be higher than those calculated for the typical farm (air concentrations and deposition rates averaged to 20 kilometers). The terms "subsistence level of contamination" and "typical level of contamination" are used to reflect the different levels.

Central tendency and high-end contaminated fractions were developed based on an economic analysis of regional production and the fraction home-produced recommendations from the *Exposure Factors Handbook* (U.S. EPA, 1990). Fractions were developed using data from counties within 50 kilometers of Site B. The economic analysis is discussed in detail in Section II.E.2. The commodity with the highest fraction locally produced was assumed to be the commodity produced by the typical farmer. Local agricultural production indicated that the typical farmer for Case K was a dairy farmer. The fractions assumed to be locally produced and processed for Case K are as follows:

Beef	0.03	Pork	0.05
Dairy	0.01	Poultry	0.01
Produce	0.26	Eggs	0.01
Fish	0.01		

The subsistence farmers considered for Case K were beef, dairy, poultry, and pork farmers. The locations of the subsistence farmers, listed in Table A-11.3, were used for estimating exposures from direct inhalation and soil ingestion. The fraction contaminated is assumed to be 1 for the livestock the subsistence farmer is identified as producing. He was also assumed to grow all the fruits and vegetables he consumed. For example, the subsistence beef farmer was assumed to produce all the beef, vegetables, and fruits that he ingested and to purchase all other dietary items -- such as milk, pork, fish -- from local markets. The items raised on the subsistence farms had higher levels of contamination than items available in the local market. The local items purchased in the market were contaminated at levels that reflected the average impact from the unit out to 20 kilometers from the facility. Since the water supplied to the area surrounding Case K came from sources other than surface waterbodies, the subsistence farmers did not drink contaminated water. Tables A-11.5 through A-11.8 list the locations of contamination and the contaminated fraction by pathway for the subsistence farm scenarios.

Table A-11.4. Surface Water Parameters for Case K

Waterbody	Surface Area (m^2)[a]	Watershed Area (m^2)[a]	Impervious Watershed Area (m^2)[b]	Average Volumetric Flow Rate (m^3/yr)[c]	Current Velocity (m/s)[d]	Depth of Water Column (m)[e]	USLE Rainfall/ Erosivity Factor[f]
Cascade River	1.4E+05	1.2E+08	6.0E+05	2.6E+07	0.08	0.5	200
Dan River	7.9E+07	1.2E+09	6.1E+06	1.8E+09	0.50	1.0	200
Smith River	1.5E+06	3.0E+08	1.5E+06	5.7E+08	0.41	1.0	200

[a] Surface areas for the watersheds and waterbodies were determined from the USGS 1.25 000-scale topographic 7.5 min X 15 min quadrangles.

[b] Impervious watershed areas were estimated from USGS quadrangles, site-specific land use, and a study of percent imperviousness for different land uses conducted by Camp, Dresser, and McKee (1989).

[c] The volumetric flow rates for the Dan and Smith Rivers were obtained from the REACH (U.S. EPA, 1995a) database. Flow rates for Cascade Creek was calculated from the watershed area and average annual surface runoff.

[d] Current velocities for the Dan and Smith Rivers were obtained from the REACH (U.S. EPA, 1995a) database. Current velocity for Smith River calculated from volumetric flow rates and cross-sectional area.

[e] Depths for the waterbodies were assumed from a default 1 meter for rivers and 0.5 meters for small creeks.

[f] USLE Erosivity/Rainfall Factor was obtained from Edwards (1993) and was used in the universal soil loss equation (USLE).

Table A-11.5. Exposure Scenario for Subsistence Beef Farmer, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence beef farm (3 km east-northeast)	1.0
Soil ingestion	Location of subsistence beef farm (3 km east-northeast)	1.0
Belowground vegetables	Location of subsistence beef farm (3 km east-northeast)	1.0
Aboveground produce	Location of subsistence beef farm (3 km east-northeast)	1.0
Beef ingestion	Location of subsistence beef farm (3 km east-northeast)	1.0
Milk ingestion	Average to 20 km	0.01
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.05
Fish ingestion	Each watershed	0.01

Table A-11.6. Exposure Scenario for Subsistence Dairy Farmer and Child, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence dairy farm (3 km east-northeast)[a]	1.0
Soil ingestion	Location of subsistence dairy farm (3 km east-northeast)[a]	1.0
Belowground vegetables	Location of subsistence dairy farm (3 km east-northeast)[a]	1.0
Aboveground produce	Location of subsistence dairy farm (3 km east-northeast)[a]	1.0
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Location of subsistence dairy farm (3 km east-northeast)[a]	1.0
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.05
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

Table A-11.7. Exposure Scenario for Subsistence Pork Farmer, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence pork farm (3 km east-northeast)[a]	1.0
Soil ingestion	Location of subsistence pork farm (3 km east-northeast)[a]	1.0
Belowground vegetables	Location of subsistence pork farm (3 km east-northeast)[a]	1.0
Aboveground produce	Location of subsistence pork farm (3 km east-northeast)[a]	1.0
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Average to 20 km	0.01
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Location of subsistence pork farm (3 km east-northeast)[a]	1.0
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

Table A-11.8. Exposure Scenario for Subsistence Poultry Farmer, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of subsistence poultry farm (3 km east-northeast)[a]	1.0
Soil ingestion	Location of subsistence poultry farm (3 km east-northeast)[a]	1.0
Belowground vegetables	Location of subsistence poultry farm (3 km east-northeast)[a]	1.0
Aboveground produce	Location of subsistence poultry farm (3 km east-northeast)[a]	1.0
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Average to 20 km	0.01
Chicken meat ingestion	Location of subsistence poultry farm (3 km east-northeast)[a]	1.0
Egg ingestion	Location of subsistence poultry farm (3 km east-northeast)[a]	1.0
Pork ingestion	Average to 20 km	0.05
Fish ingestion	Each watershed	0.01

[a] Default assumption based on location of subsistence beef farmer.

A subsistence fisher was modeled for each watershed. The fish consumption rate for the subsistence fisher was 60 g/d, rather than the 1.64-g/d rate of the general population. The locations of the residences of the subsistence fishers were assumed to be the site of highest vapor air concentration within the affected watershed. The residence location was used for estimating exposures from direct inhalation and soil ingestion. All fish in the diet was assumed to be from the watershed in which the subsistence fisher resided. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. Since the water supplied to the area surrounding Case K came from sources other than surface waterbodies, the subsistence fishers did not drink contaminated water. Table A-11.9 lists the locations of contamination and the contaminated fraction by pathway for the subsistence fisher scenario.

Table A-11.9. Exposure Scenario for Subsistence Fisher, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Location of maximum vapor air concentration in each watershed	1.0
Soil ingestion	Location of maximum vapor air concentration in each watershed	1.0
Belowground vegetables	Average to 20 km	0.01
Aboveground produce	Average to 20 km	0.01
Beef ingestion	Average to 20 km	0.03
Milk ingestion	Average to 20 km	0.01
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.05
Fish ingestion (60 g/d)	Each watershed	1.0

The location of the home gardener and child was derived from the locations of the closest actual residences to the facility. This residential location was used to estimate exposures from direct inhalation and soil ingestion. The fractions contaminated for the aboveground produce and belowground vegetables were determined by adding the fraction contaminated in the local market to the fraction that the gardener home-raised and consumed, as cited in the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.26 by adding the homegrown fraction of 0.25 to 21 percent of the remaining 0.75 purchased from local markets. All other dietary items were assumed to be purchased from local markets and to contain typical levels of contamination derived from average air dispersion and deposition estimates to 20 kilometers from the facility. Because the water supplied to the area surrounding Case K came from sources other than surface waterbodies, the home gardeners did not drink contaminated water. Table A-11.10 lists the locations of contamination and the contaminated fraction by pathway for the home gardener scenarios.

Table A-11.10. Exposure Scenario for Home Gardener and Child, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated	
Direct inhalation	Location of closest residence (0.4 km northeast)	1.0	
Soil ingestion	Location of closest residence (0.4 km northeast)	1.0	
		Central tendency	**High end**
Belowground vegetables	Location of closest residence (0.4 km northeast)	0.25 Typical farmer + 0.75 x Local market = 0.26	0.40 Typical farmer + 0.60 x Local market = 0.41
Aboveground produce	Location of closest residence (0.4 km northeast)	0.25 Typical farmer + 0.75 x Local market = 0.26	0.40 Typical farmer + 0.60 x Local market = 0.41
Beef ingestion	Average to 20 km	0.03	0.03
Milk ingestion	Average to 20 km	0.01	0.01
Chicken meat ingestion	Average to 20 km	0.01	0.01
Egg ingestion	Average to 20 km	0.01	0.01
Pork ingestion	Average to 20 km	0.05	0.05
Fish ingestion	Each watershed	0.01	0.01

The typical adult resident and child exposures were based on averages of air concentrations and deposition rates out to 20 km. The averages were used for estimating exposures from direct inhalation and soil ingestion. All dietary items were assumed purchased from the local market and to contain typical levels of contamination. Because the water supplied to the area surrounding Case K came from sources other than surface waterbodies, the typical residents did not drink contaminated water. Table A-11.11 lists the locations of contamination and the contaminated fraction by pathway for the typical resident scenarios.

Table A-11.11. Exposure Scenario for Typical Adult Resident and Child, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average out to 20 km	1.0
Soil ingestion	Average out to 20 km	1.0
Belowground vegetables	Average out to 20 km	0.01
Aboveground produce	Average out to 20 km	0.01
Beef ingestion	Average out to 20 km	0.03
Milk ingestion	Average out to 20 km	0.01
Chicken meat ingestion	Average out to 20 km	0.01
Egg ingestion	Average out to 20 km	0.01
Pork ingestion	Average out to 20 km	0.05
Fish ingestion	Each watershed	0.01

The typical farmer for this site was assumed to be a dairy farmer because the fraction of dairy locally produced was higher than the fractions for the other commodities in the analysis. The typical dairy farmer was assumed to produce a fraction of the pork, vegetables, and fruits he consumed and to purchase all other dietary items from the local market. The fractions contaminated for each pathway were determined by adding the fraction contaminated in the local market to the fraction that the farmer home-raised and consumed from the *Exposure Factors Handbook* (U.S. EPA, 1990). For example, the central tendency contaminated fraction for belowground vegetables was calculated as 0.26 by adding the homegrown fraction of 0.25 to 21 percent of the remaining 0.75 purchased from local markets. Both the items raised on the typical farm and the items purchased from local markets had typical levels of contamination. The typical dairy farmer's exposures from direct inhalation and soil ingestion were estimated to be at levels derived from averages of air dispersion and deposition outputs to 20 kilometers. Because the water supplied to the area surrounding Case K came from sources other than surface waterbodies, the typical residents did not drink contaminated water. Table A-11.12 lists the locations of contamination and the contaminated fraction by pathway for the typical farmer scenario.

Table A-11.12. Exposure Scenario for Typical Farmer, Case K

Exposure Pathway	**Location for Calculating Contamination**	**Fraction Contaminated**	
Direct inhalation	Average to 20 km	1.0	
Soil ingestion	Average to 20 km	1.0	
Belowground vegetables	Average to 20 km	Central tendency	High-end
		0.25 Typical farmer + 0.75 x Local market = 0.26	0.40 Typical farmer + 0.60 x Local market = 0.41
Aboveground produce	Average to 20 km	0.25 Typical farmer + 0.75 x Local market = 0.26	0.40 Typical farmer + 0.60 x Local market = 0.41
Beef ingestion	Average to 20 km	0.03	0.03
Milk ingestion	Average to 20 km	0.01	0.01
Chicken meat ingestion	Average to 20 km	0.01	0.01
Egg ingestion	Average to 20 km	0.01	0.01
Pork ingestion	Average to 20 km	0.44 x Typical Farmer + 0.56 x Local market = 0.47	0.75 x Typical farmer + 0.25 x Local market = 0.76
Fish ingestion	Each watershed	0.01	0.01

Recreational fishers were modeled for each waterbody by combining the typical resident scenario with an increased consumption of contaminated fish recreationally caught (30 g/d). The recreational fisher's exposures from direct inhalation and soil ingestion were derived from averages of air dispersion and deposition output to 20 kilometers. All fish in the diet was assumed to be from a single waterbody. For instance, the recreational fisher identified for the Smith River ate only fish caught in the Smith River. All other dietary items were assumed to be purchased from the local market and to contain typical levels of contamination. Because the water supplied to the area surrounding Case K came from sources other than surface waterbodies, the recreational fishers did not drink contaminated water. Table A-11.13 lists the location of contamination and the contaminated fraction by pathway for the recreational fisher scenario.

Table A-11.13 Exposure Scenario for Recreational Fisher, Case K

Exposure Pathway	Location for Calculating Contamination	Fraction Contaminated
Direct inhalation	Average to 20 km	1.0
Soil ingestion	Average to 20 km	1.0
Belowground vegetables	Average to 20 km	0.24
Aboveground produce	Average to 20 km	0.24
Beef ingestion	Average to 20 km	0.01
Milk ingestion	Average to 20 km	0.20
Chicken meat ingestion	Average to 20 km	0.01
Egg ingestion	Average to 20 km	0.01
Pork ingestion	Average to 20 km	0.06
Fish ingestion (30 g/d)	Each watershed	1.0

D. Air Modeling and Air Modeling Results

A test version of ISCSTDFT was the air dispersion and deposition model used to estimate air concentrations and deposition rates for Case K. Source inputs used in the modeling are listed in Table A-11.1. The meteorologic data required for the air modeling were created using PCRAMMET, DEPMET, and PMERGE preprocessors. Table A-11.14 lists site-specific data needed for the DEPMET preprocessor. An assumed anemometer height of 10 meters was used as a DEPMET input. For the other inputs, recommendations from the DEPMET User's Guide (U.S. EPA, 1994) based on the site-specific land use data were used. Land use information for Case K was obtained from telephone surveys and assessed through topographic maps.

The ISCSTDFT model was run using 5 years of meteorological data concatenated into a multiple-year meteorological file (U.S. EPA, 1995b). Therefore, results of the ISCSTDFT modeling conducted with this multiple-year meteorological file represent a 5-year average.

The ISCSTDFT model was run using the "default" model options. The terrain option was not used because this site is an area of flat terrain, and the effects of terrain on air dispersion would not be significant for this site. Site-specific information on the building height, width, and location were not available, and an assessment of the good engineering practices stack height could not be conducted. Therefore, downwash was not used in the air dispersion modeling for Case K.

Specific receptor locations evenly spaced every 1,000 meters were identified for each watershed and waterbody using USGS topographic maps. The 5-year averages of air dispersions and deposition rates were areally averaged over each specific watershed and waterbody.

The point of maximum combined deposition and the point of maximum vapor air concentration were used for "bounding" estimates. For a given scenario, the point of maximum concentration was used in calculating bounding risks for direct inhalation, while the maximum combined deposition or maximum concentration was used in estimating risks for other pathways. However, bounding exposure was considered for only the pathways involved in the subsistence activities for a given scenario. For example, bounding exposure for the subsistence poultry farmer was due to ingestion of soil, produce, poultry, and eggs (based on the point of maximum deposition) and to direct inhalation (based on the point of maximum concentration). The other exposure routes -- ingestion of beef, pork, milk, fish, and drinking water -- were not bounding but were, instead, based on the location of the subsistence poultry farmer. For the subsistence fisher scenario, a default watershed, which lies at the high end of the distribution of watersheds (Van der Leeden et al., 1990), was centered at the point of maximum combined deposition. Parameters for the bounding watershed are contained in the body of the document (Section II).

The ISCSTDFT air modeling results are presented in Figures A-11.1 through A-11.4. Figure A-11.1 shows the combined deposition of particles within 20 kilometers of Case K; Figure A-11.2 shows the air concentration of vapors within 20 kilometers of Case K; and Figures A-11.3 and A-11.4 show the wet and dry deposition of particles, respectively, within 3 kilometers of Facility K. The results are also presented in tabular form in Table A-11.15.

Table A-11.14. Air Modeling Inputs Used in ISCSTDFT Modeling

Meteorological location	
Surface / upper air	Greensboro, NC / Greensboro, NC
Anemometer height (m)	10.0
DEPMET Preprocessor Inputs	
Land use within 5 km	Forest / rural
Min. M-O length (m)	2.0
Roughness height (m)	0.5[a]
Displacement height (m)	2.5
Noontime albedo (fraction)	0.28
Soil moisture available (fraction)	0.5
Net radiation absorbed in ground (fraction)	0.15
Anthropogenic heat flux (W/m^2)	0.0

[a] Based on a maximum roughness height of 1/20th of the anemometer height.

Table A-11.15. Results of ISCSTDFT Air Modeling for Case K[a]

Scenario	Location [Distance (m)/ Direction]	Particles				Vapors	
		Combined Deposition (g/m²-yr)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Dry Deposition (g/m²-yr)/(g/s)	Air Concentration (µg/m³)/(g/s)	Wet Deposition (g/m²-yr)/(g/s)	Air Concentration (µg/m³)/(g/s)
Point of maximum combined deposition	100/SW	1.49	1.49	2.0E-05	6.0E-05	1.98	7.0E-05
Point of maximum vapor concentration	1000/NE	0.22	0.028	0.19	0.59	0.043	0.64
Home gardener (closest resident)	400/NE	0.21	0.086	0.12	0.31	0.13	0.33
General population	--	0.0099	0.0055	0.0044	0.045	0.0075	0.047
Subsistence farmer beef/ dairy/ pork/ poultry	3000/ENE	0.050	0.0085	0.041	0.27	0.010	0.29
Subsistence fisher - Cascade River	1,000/NE	0.17	--	--	0.54	0.028	0.58
Subsistence fisher - Dan River	1,000/NE	0.17	--	--	0.54	0.028	0.58
Subsistence fisher - Smith River	11,000 BW	0.007	--	--	0.055	0.0038	0.057
		Averages over Watershed			**Averages over Waterbody**		
		Combined Deposition of Particles (g/m²-yr)/(g/s)	**Wet Deposition of Vapors (g/m²-yr)/(g/s)**	**Air Concentration of Vapors (µg/m³)/(g/s)**	**Combined Deposition of Particles (g/m²-yr)/(g/s)**	**Wet Deposition of Vapors (g/m²-yr)/(g/s)**	**Air Concentration of Vapors (µg/m³)/(g/s)**
Cascade River	--	0.023	0.0069	0.14	0.047	0.019	0.19
Dan River	--	0.013	0.010	0.054	0.0083	0.0026	0.061
Smith River	--	0.0012	0.00051	0.014	0.0038	0.0014	0.037

[a] The air modeling results in the table are based on an emission rate of 1 g/s for each of the three stacks for Case K, for a total emission rate of 3 g/s.

Figure A.11.1 Combined deposition of particles within 20 kilometers of Facility K. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second from each stack.

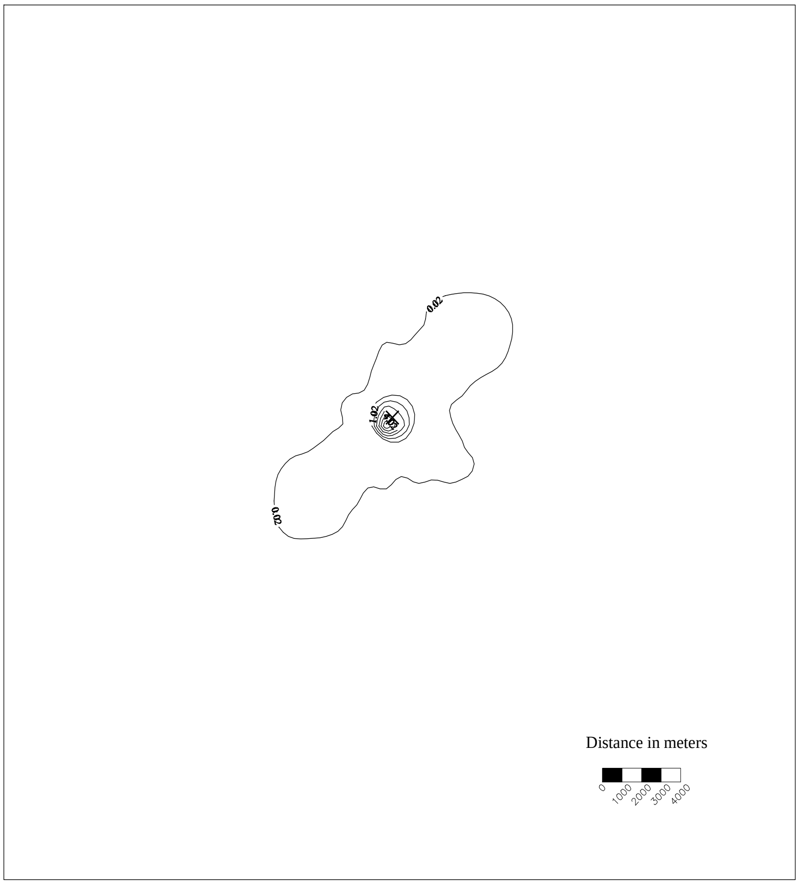


Figure A.11.2 Air concentration of vapors within 20 kilometers of Facility K. Air concentration in units of micrograms per cubic meter, resulting from a unit emission rate of 1 gram per second from each stack.

Figure A.11.3 Wet deposition of particles within 3 kilometers of Facility K. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second from each stack.

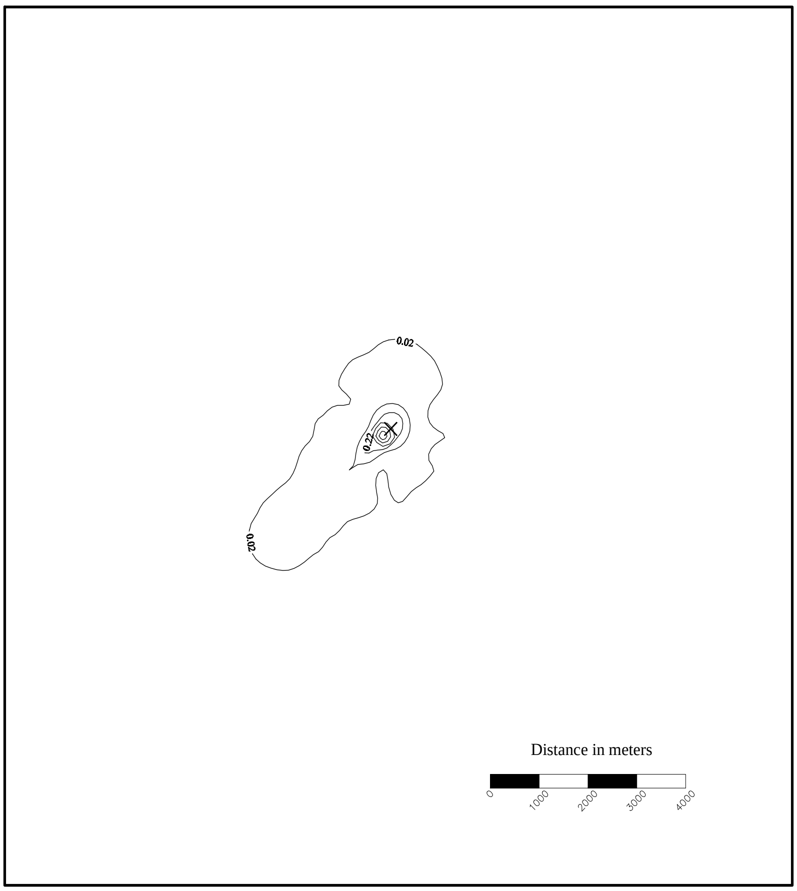
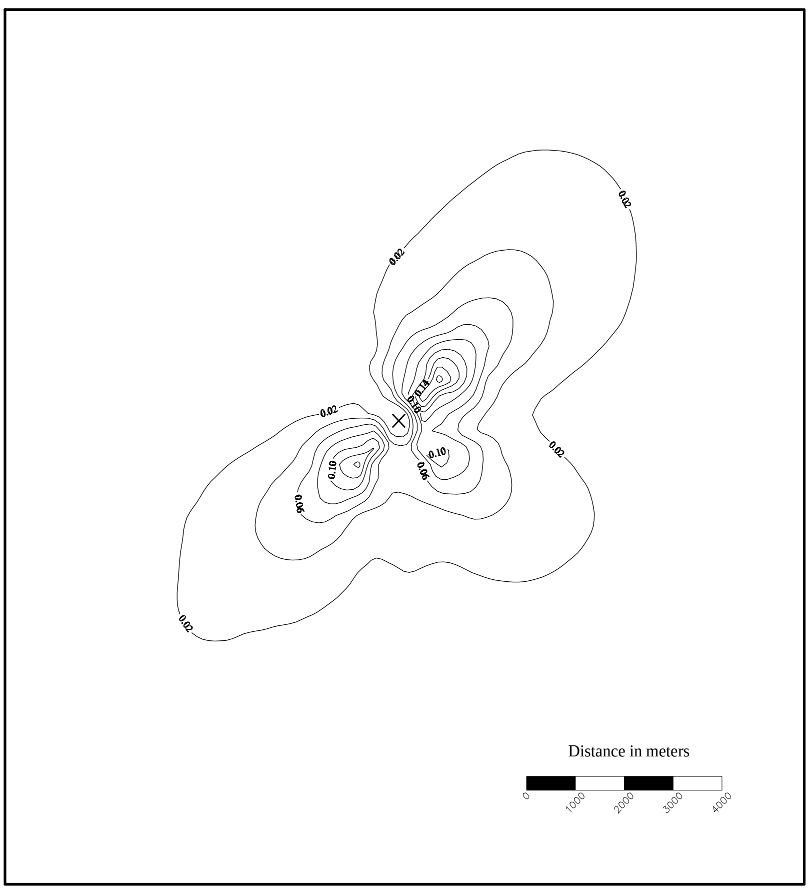


Figure A.11.4 Dry deposition of particles within 3 kilometers of Facility K. Deposition in units of grams per meter squared per year, resulting from a unit emission rate of 1 gram per second from each stack.



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