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**HUMAN HEALTH  
RISK ASSESSMENT REPORT  
FOR  
EXPLOSIVE DESTRUCTION TECHNOLOGY (EDT) ALTERNATIVES  
AT  
BLUE GRASS CHEMICAL AGENT-DESTRUCTION PILOT PLANT**

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This document has been reviewed for ITAR/EAR and  
no ITAR/EAR sensitive information was found.

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## DEFINITIONS

AEGL-1 – Acute Exposure Guideline Level 1  
AERMAP – AERMOD’s terrain preprocessor  
AERMET – AERMOD’s meteorological data preprocessor  
AERMOD – American Meteorological Society/Environmental Protection Agency Regulatory Model  
AMS – American Meteorological Society  
BGAD – Blue Grass Army Depot  
BGCAPP – Blue Grass Chemical Agent Destruction Pilot Plant  
BPIP – Building Profile Input Program  
CBL – Convective Boundary Layer  
COPC – Constituent of Potential Concern  
CPF – Cumulative Probability Density Function  
CSF – Cancer Slope Factor  
CWC – Chemical Weapons Convention  
DAVINCH – Detonation of Ammunition in a Vacuum Integrated Chamber  
EA – Environmental Assessment  
EDS – Explosive Destruction System  
EDT – Explosive Destruction Technology  
EPA – Environmental Protection Agency  
Final HHRAP – 2005 Human Health Risk Assessment Protocol Guidance for Hazardous Waste Combustion Facilities  
GEP – Good Engineering Practice  
HEPA – High Efficiency Particulate Air Filter  
HI – Hazard Index  
HIA – Acute Hazard Index  
HQ – Hazard Quotient  
HQA – Acute Hazard Quotient  
IRIS – Integrated Risk Information System  
ISCST3 – Industrial Source Complex Short Term, Ver. 3 Air Model  
MPHHRA – Multi-Pathway Human Health Risk Assessment  
MRL – Toxicity Criteria Database ATSDR Minimal Risk Level  
NAD27 – North American Datum 1927  
NEPA – National Environmental Policy Act  
OEHHA – California EPA - Office of Environmental Health Hazard Assessment  
OGT – Off-Gas Treatment  
OSWER – Office of Solid Waste and Emergency Response  
PSD – Particle Size Distribution  
PRIME – Plume Rise Model Enhancements  
RfC – Reference Concentration  
RfD – Reference Dose toxicity value  
RSL – USEPA Risk Screening Level  
SBL – Stable Boundary Layer  
SCWO – Supercritical Water Oxidation  
SDC – Static Detonation Chamber

## **DEFINITIONS (Continued)**

SDC1 – SDC process stack source

SDC2 – SDC building vent source

SPB – Supercritical Water Oxidation Processing Building

TDC – Transportable Detonation Chamber

TEEL-1 – United States Department of Energy Temporary Emergency Exposure Limits.

TOCDF – Tooele Chemical Agent Disposal Facility

UTM – Universal Transverse Mercator

WTS – Waste Transfer Sub-system

## **1.0 INTRODUCTION AND EXECUTIVE SUMMARY**

The U.S. Army is destroying the nation's stockpile of lethal chemical agents and munitions under Congressional directive (Public Law 99-145) and an international treaty called the Chemical Weapons Convention (CWC). In response to the congressional directive and CWC, the U.S. Army has initiated the design, construction, and limited duration operation of a facility to destroy the types of chemical munitions stored at Blue Grass Army Depot (BGAD) Kentucky. The BGAD stockpile includes mustard agent (type H) contained in 155-mm projectiles. Four Explosive Destruction Technology (EDT) alternatives are being evaluated for destruction of this portion of the stockpile at the Blue Grass Chemical Agent Destruction Pilot Plant (BGCAPP). This evaluation includes an Environmental Assessment (EA) which is a requirement under the National Environmental Policy Act (NEPA) prior to initiating a significant federal government action. In support of the EA, a screening-level Multi-Pathway Human Health Risk Assessment (MPHHRA) was performed to estimate the potential impacts to human health.

Each of the four different EDT options was considered independently in this MPHHRA. The multi-pathway risk assessment results are provided to document the comparison of threshold toxicological factors to estimated emissions for the four treatment technologies being evaluated. The MPHHRA generally follows the U.S. EPA guidance document, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Final (September 2005) and EPA's Guideline on Air Quality Models (40 CFR, Part 51, Appendix W).

Estimated emissions of compounds were modeled in their movement through the environment to the local population and subsequently compared to acceptable exposure concentrations of those compounds. This report describes the risk assessment and air modeling methodologies used, including default parameters and exclusions, and inputs and outputs for the air modeling. The following paragraphs describe the methodology and the general steps used to complete this MPHHRA and summarize the results.

- Each of the four technologies was evaluated to develop a list of compounds anticipated to be emitted from the treatment process. The estimated emissions for each compound emitted from each of the four EDT options were then determined based on information provided by vendors of the specific technologies and engineering judgment. These emission rates were used in combination with the projected munitions feed plan to generate a maximum design emission rate for each Constituent of Potential Concern (COPC) emitted by each EDT alternative.

- The emission estimates, along with air dispersion modeling using site-specific conditions were used to determine concentrations of pollutants released to the environment through various exposure pathways. The air dispersion model selected for this purpose (AERMOD) is named for the American Meteorological Society/Environmental Protection Agency Regulatory Model. AERMOD quantifies atmospheric concentrations and deposition of the target COPCs within 10 km of the facility emission point. In general, only off-property locations were used to evaluate exposure to human receptors, except that receptors were placed on selected water bodies within the Blue Grass Army Depot's boundaries to ensure that all appropriate exposure scenarios were considered. Maximum total COPC-specific air concentrations and deposition were used to calculate risk and hazard.
- Based on site-specific conditions and guidance recommendations, exposure pathways were selected to allow quantification of chronic impacts to adult and child residents, farmers, and fishers. COPC concentrations for each of the corresponding exposure media for each of these pathways were calculated. Both direct impacts from inhalation of pollutants and indirect impacts through other contaminated media; such as surface water, home-grown produce and livestock, were included in the assessment. Chronic and acute health effects were also considered. Health effects from all pollutants are summed in the risk assessment to determine a cumulative risk and hazard estimate for each of the treatment technologies for each of the exposure scenarios. By comparing estimated concentrations of pollutants to accepted toxicological factors that indicate threshold levels for both cancer and non-cancer health effects in humans, conclusions may be made regarding the acceptability of the individual EDT alternatives at the designated facility.

The results of this MPHHA are summarized in Table 1-1 and demonstrate that emissions from each of the four EDT alternatives meet acceptable risk and hazard thresholds. A summary of the MPHHA results are as follows:

- A total of 77 COPCs were identified by the four EDT vendors, published literature, or engineering calculations. Of the 77 COPCs, 26 have carcinogenic toxicity factors, 66 have chronic non-carcinogenic toxicity factors, and 71 have acute toxicity factors.
- The maximum lifetime cancer risk to any human receptor presented by the worst-case EDT option is 4.0 E-08, which is less than 1 % of the acceptable risk level of 1 in 100,000 (i.e., 1.0 E-05). When added to the risk calculated in 2010 for BGCAPP operations, the maximum lifetime cancer risk is only 2 % of the acceptable risk level. Emissions from the TDC alternative result in this lifetime cancer risk for the adult farmer.

- For non-carcinogenic effects, the maximum combined Hazard Index (HI) to any human receptor presented by the worst-case EDT option is 0.0013, which is less than 1 % of the acceptable level of 0.25. When added to the HI calculated in 2010 for BGCAPP operations, the maximum lifetime HI is 0.0137, only 5 % of the acceptable risk level. This worst-case HI is based on the TDC alternative result for the farmer child exposure scenario.
- The total acute HI (i.e., the hazards associated with short-term emission release events for each COPC that has both a quantified short-term emission rate and an available acute toxicity value) presented by the worst-case EDT option is the TDC alternative, which is less than 1 % of the acceptable level of 0.25. When combined with the BGCAPP acute HI, the worst-case option is about 10 % of the acceptable level.

The results presented in this MPHRA report demonstrate that EDT emissions will produce exposures that are well below all specified risk and hazard threshold values, even when added to previously-acquired risk and hazard estimates for other BGCAPP operations. This evaluation includes consideration of quantifiable uncertainty parameters, employs very conservative assumptions, and represents a reasonable worst-case estimate of potential impacts.

Care was taken at each step in the risk assessment process to ensure that conservative (i.e., reasonable worst-case) estimates of the potential risk and hazard were derived. By selecting conservative estimates at each juncture of the risk assessment process, the final risk assessment results are indicative of an estimate of risk and hazard that exceeds the worst possible health effect that an individual would experience which assures that it is protective of human health. If the resulting risk and hazard estimates exceed the accepted thresholds for those parameters, more detailed site-specific values could be determined to refine the risk assessment model and more closely model actual conditions. However, the screening-level results are well within acceptable guidelines, so further refinement of the conservative screening assumptions is not necessary.

**Table 1-1  
Summary Results of Multi-Pathway Human Health Risk Assessment**

<b>Hazard and Risk Characterization from EDT Facility Only</b>									
<b>Exposure Scenario</b>	<b>Scenario Location</b>	<b>Total Cancer Risk (Benchmark = 1E-05)</b>				<b>Total Hazard Index (Benchmark = 0.25)</b>			
		Davinch	EDS	TDC	SDC	Davinch	EDS	TDC	SDC
Adult Resident	Rmax	2.01E-08	3.05E-10	2.42E-08	4.65E-10	0.000681	0.0000085	0.00120	0.000011
Child Resident	Rmax	4.16E-09	6.15E-11	4.89E-09	9.35E-11	0.000710	0.0000086	0.00121	0.000011
Fisher	Rmax	2.01E-08	3.05E-10	2.42E-08	4.65E-10	0.000681	0.0000085	0.00120	0.000011
Fisher Child	Rmax	4.16E-09	6.15E-11	4.89E-09	9.36E-11	0.000710	0.0000086	0.00121	0.000011
Farmer	Fmax	<b>3.26E-08</b>	<b>4.07E-10</b>	<b>4.03E-08</b>	<b>1.38E-09</b>	0.000868	0.0000085	0.00125	0.000016
Farmer Child	Fmax	5.43E-09	6.15E-11	6.60E-09	2.57E-10	<b>0.000985</b>	<b>0.0000086</b>	<b>0.00129</b>	<b>0.000018</b>
Acute Exposure	Amax	--	--	--	--	0.000246	0.0000104	<b>0.00083</b>	0.000395
<b>Worst-Case Hazard and Risk Characterization from EDT Facility and BGCAPP Facility</b>									
Farmer	Fmax	2.13E-07	1.80E-07	<b>2.20E-07</b>	1.81E-07				
Farmer Child	Fmax					0.013385	0.0124086	<b>0.01369</b>	0.012418
Acute Exposure	Amax	--	--	--	--	0.025846	0.0256104	<b>0.02643</b>	0.025995

Notes:

- <sup>a</sup> US EPA Region 6 recommends that a hazard index benchmark of 0.25 be utilized to account for COPCs (compounds of potential concern) in areas with industrial activity. Although significant industrial activities do not exist near BGCAPP, this very conservative benchmark was used for comparison to emissions to ensure risks were not underestimated.
- <sup>b</sup> The acute risk assessment scenario evaluates short-term 1-hour maximum air concentrations based on hourly emission rates. Inhalation is the route of exposure.

## **2.0 FACILITY DESCRIPTION**

The Blue Grass Army Depot (BGAD) encompasses nearly 15,000 acres in Madison County, southeast of Richmond, KY. The area surrounding the Depot is primarily agricultural and rural. Within this site, the Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) is under construction with the objective of safely and efficiently destroying the stockpile of chemical weapons currently in storage at the Depot. The plant is projected to destroy 523 tons of munitions containing blister and nerve agents.

The pilot plant is under construction on a variety of facilities to support chemical agent processing, energetic processing, control and storage, munitions storage, entry control, utility, laboratory analysis, personnel maintenance and other tasks. The primary method of destruction includes disassembly to allow the separation of chemical agent and energetic, which are chemically mixed to destroy the chemical agent using hydrolysis. Following neutralization, agent and energetic hydrolysates are to be fed to Supercritical Water Oxidation (SCWO) units to destroy the organic materials. Metal parts are cleaned by high-pressure washing, thermally decontaminated and subsequently recycled. Off-gases from treatment are treated in a thermal oxidizer, sent through a cyclone and scrubber, and filtered through a series of HEPA and carbon beds before being released to the atmosphere.

However, the Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) may also include the use of an Explosive Destruction Technology (EDT) to safely destroy problematic munitions currently in storage at the Blue Grass Army Depot. The Levinstein (H) mustard projectiles in the Blue Grass chemical weapons stockpile contain the oldest mustard remaining in the inventory. Similar projectiles that were manufactured in the same lots as those stored at Blue Grass were processed at Tooele Chemical Agent Disposal Facility (TOCDF), Utah, in 2008-2009. These projectiles showed large amounts of agent solidification, called "heels." Problems were also encountered with degraded bursters and burster wells.

The final results of an X-ray assessment conducted in 2011 indicate that destruction of this portion of the Blue Grass stockpile could be difficult using BGCAPP's current planned neutralization and SCWO technology. This risk assessment supports the NEPA environmental assessment of EDT alternatives that might more effectively process these problematic munitions.

### **2.1 EDT Alternatives**

Four EDTs are considered for this MPHRA:

1. Dynasafe's Static Detonation Chamber (SDC),
2. CH2M Hill's Transportable Detonation Chamber (TDC),
3. Kobe Steel's Detonation of Ammunition in a Vacuum Integrated Chamber (DAVINCH),  
and
4. US Army's Explosive Destruction System (EDS).

Each EDT includes one or more individual treatment units. Support facilities include, electrical equipment, generators, air compressors, and other utility supplies; buildings that will be used for storage and maintenance; buildings for access control; and buildings for other support functions. None of these support facilities will be significant emission sources of COPCs, and are not included in the MPPHRA.

### *2.1.1 SDC*

The SDC is a thermal destruction method for munitions. Chemical munitions are placed in a carrier, conveyed to the top of the SDC vessel, and fed into a detonation chamber, which is indirectly heated by electricity and operates at a temperature in excess of 1,000 °F. The destruction of the munitions is achieved by heating the item above the auto initiation temperature for the energetic materials, resulting in their detonation or deflagration. Agent released from the detonation or deflagration event is pyrolyzed by the detonation/deflagration and the temperatures existing within the detonation chamber. Gases generated as a result of the detonation are treated by an off-gas system that includes a thermal oxidizer to convert carbon monoxide and hydrogen into carbon dioxide and water. The SDC detonation chamber and off-gas treatment system (OTS) are enclosed in an environmental enclosure. Exhaust from the SDC process OTS is sent to a filter system for final clean-up. This filter system is located in a separate enclosure, and its stack has a chemical agent monitor. Air from the environmental enclosure is exhausted through a separate filter system and stack. This enclosure air filter system is located in another, separate enclosure and also has an agent monitor.

### *2.1.2 TDC*

The TDC consists of a detonation chamber, an expansion chamber, and an emission control system. The TDC is considered a "cold" detonation technology because the detonation chamber is not heated. Instead, munitions are wrapped in explosive and placed in the detonation chamber and detonated to destroy the chemical agent and energetics. The chamber's floor is covered in pea gravel, which absorbs some of the blast energy. Bags of water within the chamber also absorb blast energy and produce steam, which reacts with and destroys agent vapors.

Each TDC unit is enclosed in an environmental enclosure. Gases produced by the detonation are vented to the expansion chamber and then to the emissions control system. A catalytic oxidation unit oxidizes hydrogen, carbon monoxide, and organic vapors before the gas stream is vented through a carbon absorption bed and released within the environmental enclosure. All air within the environmental enclosure is then discharged through a pair of identical building air filtration systems and stacks, each equipped with a chemical agent monitor.

### *2.1.3 DAVINCH*

The DAVINCH is composed of a steel vacuum detonation chamber and an OTS. The DAVINCH system is also considered a "cold" detonation technology. Chemical munitions are placed in the DAVINCH detonation chamber where they are surrounded by donor explosives. The detonation of these donor explosives shatters the munitions, and the shock and heat of the explosion destroys the chemical agent and energetics. Off gases produced by the detonation are treated by a cold plasma oxidizer which converts carbon monoxide into carbon dioxide.

The DAVINCH process is enclosed in an environmental enclosure. Exhaust from the DAVINCH process OTS is combined with building ventilation air from the environmental enclosure, vented through an air filtration unit, and discharged through a single stack equipped with a chemical agent monitor.

### *2.1.4 EDS*

The EDS uses explosive charges to explosively access chemical munitions, eliminating their explosive capacity before the chemical agent is neutralized. The system's main component, a sealed, stainless steel vessel, contains all the blast, vapor, and fragments from the process. Agent treatment is confirmed by sampling residual liquid and air from the vessel prior to reopening the EDS.

Each EDS has a Waste Transfer Sub-system (WTS) that receives liquid and gaseous wastes from the EDS vessel. The WTS has a canister filter that contains silica gel and activated carbon. The canister filter is changed after each batch of munitions treated in the EDS. Potential fugitive emissions associated with canister filter changeout are assumed to be negligible. Each EDS unit is enclosed in an environmental enclosure. Emissions from the WTS canister filter are combined with enclosure air prior to passing through an air filtration unit and exiting the stack, which is equipped with a chemical agent monitor.

## **2.2 EDT OPERATIONS**

### *2.2.1 Feed Material Assumptions*

Table 2-1 presents the quantity of feed materials and anticipated processing schedule by the EDT alternatives.

**Table 2-1  
BGCAPP EDT Processing Rates**

EDT Technology	Leakers				
	Demand Rate (munitions/hr)	Availability Factor	Effective Processing Rate		
			munitions/hr	munitions/day	munitions/week
SDC2000			0.29	7.0	49.1
TDC60			0.55	13.1	92.0
DV60			0.73	17.5	122.6
EDS			0.085	0.85	5.1

EDT Technology	Rejects				
	Demand Rate (munitions/hr)	Availability Factor	Effective Processing Rate		
			munitions/hr	munitions/day	munitions/week
SDC2000			3.80	91.1	637.7
TDC60			1.24	29.8	208.5
DV60			1.46	35.0	245.3
EDS			0.51	5.1	30.6

EDT Technology	Quantity of Leakers in the campaign	Quantity of Rejects in the campaign	Effective Weekly Processing Rate Per Unit		Weeks Required to Process with One Unit	Weeks Available	Number of Units Required	Weeks Required to Process with Multiple Units	Uncommitted Machine Weeks Available
			Leakers	Rejects					
SDC2000									
TDC60									
DV60									
EDS									

### 2.2.2 *Duration of EDT Operations*

The EDT specification for all four alternatives provides for operation 12 hours per day, 7 days per week during a [REDACTED] period of operation. Based on this schedule, the following number of each type of EDT is required: [REDACTED] SDC unit; [REDACTED] TDC units; [REDACTED] DAVINCH units; or [REDACTED] EDS units.

### 2.3 **EDT Location**

The selected EDT will be located [REDACTED] at the BGCAPP facility. The EDT site location within the BGAD facility is described more fully in Section 3.2 of this report.

### 2.4 **EDT Emission Sources**

The four EDT Alternatives each result in emissions of different Compounds of Potential Concern (COPCs) with different emission rates. For three of the technologies, a single stack will be used to model stack gas emissions. Although it is possible that the configuration or stack parameters for these technologies may change because complete vendor information regarding the technologies is not available at this time, the following stack characteristics are assumed for this MPHHA.

Emissions from each of the four treatment technologies will be modeled separately and evaluated separately for risk and hazard. All emissions of COPCs from both TCD units are air modeled as if the emissions are vented from one 50 foot stack. All emissions from the two DAVINCH units are air modeled as if the emissions are vented from one 50 foot stack. All emissions from the EDS units are air modeled as if the emissions are vented from one 50 foot stack. COPC emissions from the one SDC unit will be primarily vented from one 50 foot process stack, but emissions from the environmental enclosure building described in Section 2.1.1 will be vented from a 16 foot building vent. The characteristics of these emissions sources are summarized in Table 2-2.

#### 2.4.1 *Target Compounds*

A list of possible COPCs was developed by ERM Consulting & Engineering based on vendor information regarding potential EDT emissions and evaluation of munitions intended for destruction.

The COPCs were evaluated separately for each technology and are shown by technology in Table 2-3.

**Table 2-2  
Source Characteristics Required for Air Modeling**

Source Characteristics		SDC 1 Process Stack	SDC 2 Enclosure Stack	TDC Stack 2 Units	DAVINCH Stack 2 Units	EDS Stack 14 Units
Base Elevation	m	15.24	4.9	15.24	15.24	15.24
	ft	50	16	50	50	50
Height	m	15.24	4.9	15.24	15.24	15.24
	ft	50	16	50	50	50
Diameter	m	0.3	0.91	0.85	0.76	2.29
	ft	1.0	3.0	2.8	2.5	7.5
Temperature+	K	324	amb*	amb.+5.5*	amb*	300
	°F	124	amb*	amb.+10*	amb*	81
Velocity+	m/s	5.08	11.5	18.2	32.8	9.7
	ft/s	16.7	37.7	59.7	108	31.7
Emission Rate	g/s	1	1	1	1	1
	lb/hr	7.92	7.92	7.92	7.92	7.92
Mean Particle Size+	Microns	0.3	0.3	0.3	0.3	0.3
Mass Fraction#	(dimensionless)	1	1	1	1	1
Particle Density	g/cm <sup>3</sup>	1	1	1	1	1

+ Source characteristics provided by MPHRA Report from Pueblo Army Depot.

\* AERMOD feature that allows seasonal variation in temperature utilized for modeling.

# Mass Fraction of particles in the fine mode = 100%.

**Table 2-3  
Compounds of Potential Concern for EDT Facility**

	CAS	Chemical Grouping	COPC					
			SDC1	SDC2	TDC	DAVINCH	EDS	
1,1,1-trichloroethane	71-55-6	Organic	✓					
1,1-dichloroethane	75-34-3	Organic	✓					
1,1-dichloroethene	75-35-4	Organic	✓					
1,2-dichloroethane	107-06-2	Organic	✓					
1,2-dichloropropane	78-87-5	Organic	✓					
1,3-butadiene	106-99-0	Organic	✓					
1,4-dioxane	123-91-1	Organic			✓			
2-butanone	78-93-3	Organic	✓		✓			
acetone	67-64-1	Organic	✓		✓			✓
benzene	71-43-2	Organic	✓		✓			
benzoic acid	65-85-0	Organic	✓					
benzyl alcohol	100-51-6	Organic	✓					
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	✓		✓			✓
bromodichloromethane	75-27-4	Organic	✓					
bromomethane	74-83-9	Organic	✓					
carbon disulfide	75-15-0	Organic	✓					✓
carbon tetrachloride	56-23-5	Organic	✓					
chlorobenzene	108-90-7	Organic	✓					
chloroform	67-66-3	Organic	✓					
chloromethane	74-87-3	Organic	✓		✓			
cis-1,3-dichloropropene	542-75-6	Organic	✓					
dibromochloromethane	124-48-1	Organic	✓					
dichlorodifluoromethane	75-71-8	Organic	✓		✓			
di-n-butyl phthalate	84-74-2	Organic	✓		✓			
di-n-octyl phthalate	117-84-0	Organic			✓			
ethane	74-84-0	Organic			✓			
ethanol	64-17-5	Organic						✓
ethylbenzene	100-41-4	Organic	✓					
Freon 113	76-13-1	Organic	✓					
H	505-60-2	Organic	✓	✓	✓	✓		✓
hexane	110-54-3	Organic	✓					
methane	74-82-8	Organic			✓			✓
methylene chloride	75-09-2	Organic	✓					✓

**Table 2-3  
Compounds of Potential Concern for EDT Facility (continued)**

	CAS	Chemical Grouping	COPC				
			SDC1	SDC2	TDC	DAVINCH	EDS
naphthalene	91-20-3	Organic			✓		
styrene	100-42-5	Organic	✓				
tetrachloroethene	127-18-4	Organic	✓				
toluene	108-88-3	Organic	✓		✓		✓
trans-1,3-dichloropropene	10061-02-6	Organic	✓				
trichloroethene	79-01-6	Organic	✓				
trichlorofluoromethane	75-69-4	Organic	✓		✓		
vinyl chloride	75-01-4	Organic	✓			✓	✓
xylenes	1330-20-7	Organic	✓			✓	
1,2,3,4,6,7,8-HpCDD	35822-46-9	PCDDs, PCDFs, PCBs			✓		
1,2,3,4,6,7,8,9-OCDD	3268-87-9	PCDDs, PCDFs, PCBs			✓		
2,3,7,8-TCDF	51207-31-9	PCDDs, PCDFs, PCBs	✓				
1,2,3,4,6,7,8-HpCDF	67562-39-4	PCDDs, PCDFs, PCBs			✓		
1,2,3,4,6,7,8,9-OCDF	39001-02-0	PCDDs, PCDFs, PCBs			✓		
3,3',4,4'-TCB (PCB 77)	32598-13-3	PCDDs, PCDFs, PCBs				✓	
2,3',4,4',5-PeCB (PCB 118)	31508-00-6	PCDDs, PCDFs, PCBs				✓	
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4	PCDDs, PCDFs, PCBs				✓	
ammonia	7664-41-7	Inorganic			✓		
aluminum	91728-14-2	Inorganic					✓
antimony	7440-36-0	Inorganic	✓		✓		
arsenic	7440-38-2	Inorganic	✓		✓		✓
barium	7440-39-3	Inorganic	✓		✓		
beryllium	7440-41-7	Inorganic	✓		✓		
boron	7440-42-8	Inorganic	✓				
cadmium	7440-43-9	Inorganic	✓		✓		✓
chlorine	7782-50-5	Inorganic			✓		
chromium (3+)	16065-83-1	Inorganic	✓		✓		✓
chromium (6+)	18540-29-9	Inorganic	✓		✓		✓

**Table 2-3  
Compounds of Potential Concern for EDT Facility (continued)**

	CAS	Chemical Grouping	COPC				
			SDC1	SDC2	TDC	DAVINCH	EDS
cobalt	7440-48-4	Inorganic	✓		✓		
copper	7440-50-8	Inorganic	✓		✓	✓	✓
hydrogen chloride	7647-01-0	Inorganic			✓	✓	
iron	7439-89-6	Inorganic			✓		
lead	7439-92-1	Inorganic	✓		✓	✓	✓
manganese	7439-96-5	Inorganic	✓				
mercuric chloride	7487-94-7	Inorganic					
methyl mercury	22967-92-6	Inorganic					
elemental mercury	7439-97-6	Inorganic	✓		✓	✓	✓
nickel	7440-02-0	Inorganic	✓		✓		
phosphorus	7723-14-0	Inorganic	✓				
selenium	7782-49-2	Inorganic	✓		✓		
silver	7440-22-4	Inorganic	✓		✓		✓
tin	7440-31-5	Inorganic	✓				
vanadium	7440-62-2	Inorganic			✓		
zinc	7440-66-6	Inorganic	✓		✓		

The four EDT alternatives were modeled independently to assess the overall risks and hazards of emissions from each EDT unit.

### **2.3 Estimated Emission Rates**

Estimated emission rates were also developed by ERM Consulting & Engineering based on vendor information regarding potential EDT emissions and evaluation of munitions intended for destruction of HAPs. The estimated emission rate for each COPC from each process stack and the SDC building stack are provided in Table 2-4. The estimated COPC emission rates are not intended to be estimates of actual emissions rates for the COPCs, as a number of very conservative assumptions were used to ensure that the overall toxicity and magnitude of emissions were not underestimated.

**Table 2-4  
EDT Emissions by Technology Alternative**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS				
		Overpacks/ Rejects	Overpacks/ Rejects	Overpacks/ Rejects	Agent		Explosive		
		Emissions Rate (g COPC/s) <sup>(a, b)</sup>	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)		
<b>Volatile Organic Compounds</b>									
acetone	67-64-1	5.85E-06	3.30E-02		8.52E-05	4.14E-03			
acetaldehyde	75-07-0	U	U						
benzene	71-43-2	<5.52E-07	9.80E-04						
bromodichloromethane	75-27-4	<1.03E-06	U	--					
bromoform	75-25-2	<9.93E-07 ND	U	--					
2-butanone	78-93-3	<3.93E-06	2.30E-03	U					
carbon disulfide	75-15-0	<7.44E-07	U		4.10E-05	1.99E-03			
carbon tetrachloride	56-23-5	<2.06E-06	<1.9E-3						
chlorobenzene	108-90-7	<3.82E-07	<1.4E-3	U					
1-chlorobutane	109-69-3	U	U	U					
2-chlorobutane	78-86-4	U	U	U					
chloroethane	75-00-3	<1.99E-06 ND	<8.1E-4	U					
2-chloroethoxyethane	112-26-5	U	U	U					
chloroform	67-66-3	<6.00E-06	<1.5E-3						
chloromethane	74-87-3	<2.05E-06	2.50E-04						
chloromethoxyethane	3188-13-4	U	U	U					
dibromochloromethane	124-48-1	<7.53E-07	U	--					
1,2-dichlorobutane	616-21-7	U	U	U					
1,1-dichloroethane	75-34-3	<3.76E-07	<1.2E-3	U					
1,2-dichloroethane	107-06-2	<3.81E-07	<1.2E-3	U					

**Table 2-4  
EDT Emissions by Technology Alternative (Continued)**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS				
		Overpacks/Rejects	Overpacks/Rejects	Overpacks/Rejects	Agent		Explosive		
		Emissions Rate (g COPC/s) <sup>(a, b)</sup>	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)		
1,1-dichloroethene	75-35-4	<3.45E-07	<1.2E-3						
1,2-dichloropropane	78-87-5	<4.59E-07	<1.4E-3	U					
cis-1,3-dichloropropene	10061-01-5	<4.61E-07	<1E-3	U					
trans-1,3-dichloropropene	10061-02-6	<4.89E-07	U	U					
diethyl ether	60-29-7	U	U	U					
1,4-dioxane	123-91-1	U	1.20E-03	U					
1,4-dithiane	505-29-3	U	U	U					
ethane	74-84-0	U	<0.38						
ethene	74-85-1	U	<0.35						
ethylbenzene	100-41-4	<4.87E-07	<1.3E-3						
2-ethyl 1,3-butadiene	3404-63-5	U	U						
n-hexane	110-54-3	<8.53E-07	<0.31						
2-hexanone	591-78-6	<4.14E-06 ND	0.0012	U					
1-hexene	592-41-6	U	U						
methane	74-82-8	U	<0.16	--	2.74E-02	1.33E+00	4.04E-02	3.87E+01	
methylene chloride	75-09-2	4.84E-06	<2.9E-3						
4-methyl-2-pentanone	108-10-1	<4.14E-06 ND	<1.2E-3	U					
octane	111-65-9	U	U						
1,4-oxathiane	15980-15-1	U	U	U					
pentane	109-66-0	U	<0.26						
propene	115-07-1	U	U						
styrene	100-42-5	<3.47E-07	<1.3E-3						

**Table 2-4**  
**EDT Emissions by Technology Alternative (Continued)**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS			
		Overpacks/Rejects	Overpacks/Rejects	Overpacks/Rejects	Agent		Explosive	
		Emissions Rate (g COPC/s) <sup>(a, b)</sup>	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)	
styrene	100-42-5	<3.47E-07	<1.3E-3					
tert-butyl alcohol	75-65-0	U	U	U				
1,1,1,2-tetrachloroethane	630-20-6	<5.00E-07 ND	U	U				
1,1,2,2-tetrachloroethane	79-34-5	<9.93E-07 ND	<2.1E-3	U				
tetrachloroethene	127-18-4	<4.44E-07	<2.1E-3	U				
toluene	108-88-3	<2.90E-07	<5.5E-3		3.95E-05	1.92E-03		
1,2,3-trichlorobenzene	87-61-6	U	U	U				
1,1,1-trichloroethane	71-55-6	<7.93E-07	U	U				
trichloroethene	79-01-6	<4.41E-07	<1.6E-3	U				
1,2,4-trimethyl benzene	95-63-6	U	<1.5E-3	U				
vinyl chloride	75-01-4	<5.69E-07	<7.8E-3	U	7.87E-06	3.82E-04		
total xylene	108-38-3, 106-42-3, 95-47-6	<1.17E-06	<4.0E-3					
1,2-bis(ethylthio)-ethene	13105-10-7	U	U	U				
1,2-bis(vinylthio)-ethane	63938-34-1	U	U	U				
<b>Semi-volatile Organic Compounds</b>								
acrolein	107-02-8	U	U	U				
alpha-methylstyrene	98-83-9	U	U	U				
benzoic acid	65-85-0	<1.94E-05	< 2.2E-3	U				
benzyl alcohol	100-51-6	<1.82E-06	< 8.8E-4	U				
di-n-butyl phthalate	84-74-2	<2.05E-06	3.20E-05	U				

**Table 2-4**  
**EDT Emissions by Technology Alternative (Continued)**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS			
		Overpacks/Rejects	Overpacks/Rejects	Overpacks/Rejects	Agent		Explosive	
		Emissions Rate (g COPC/s) <sup>(a, b)</sup>	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)	
diethyl phthalate	84-66-2	<2.42E-06 ND	< 4.4E-4	U				
dimethyl phthalate	131-11-3	<2.42E-06 ND	< 4.4E-4	U				
2,3-dimethyl-thiopene	632-16-6	U	U	U				
2,2-dimethyl-trans-thiirane	3772-13-2	U	U	U				
di-n-octyl phthalate	117-84-0	<2.42E-06 ND	<4.4E-4	U				
bis(2-ethylhexyl)-phthalate	117-81-7	<2.94E-06	<4.4E-4	U				
hexachloro-1,3-butadiene	87-68-3	<2.42E-06 ND	<4.4E-4	U				
hexachloroethane	67-72-1	<2.42E-06 ND	<4.4E-4	U				
2-methyl-1,3-dithiacyclopentane	5616-51-3	U	U	U				
2-methyl-1,3-dithiane	6007-26-7	U	U	U				
2-methyl-1,3-oxathiolane	17642-74-9	U	U	U				
2-methylphenol (o-cresol)	95-48-7	<2.42E-06 ND	<4.4E-4					
3-methylphenol (m-cresol)	108-39-4	<1.21E-05 ND	<4.4E-4					
4-methylphenol (p-cresol)	106-44-5	<2.42E-06 ND	<4.4E-4					
methyl-tert-butyl ether	1634-04-4	U	U	U				
naphthalene	91-20-3	<2.42E-06 ND	<4.4E-4					
thiodiglycol	111-48-8	U	U	U				
thiirane	420-12-2	U	U	U				
1,2,4-trichlorobenzene	120-82-1	<2.42E-06 ND	<4.4E-4	U				
<b>Miscellaneous Analytes</b>								
ammonia	7664-41-7	U	1.00E-04					
chlorine		<1.94E-05 ND	1.20E-03	U				

**Table 2-4  
EDT Emissions by Technology Alternative (Continued)**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS			
		Overpacks/ Rejects	Overpacks/ Rejects	Overpacks/ Rejects	Agent		Explosive	
		Emissions Rate (g COPC/s) <sup>(a, b)</sup>	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)	
HD/H	505-60-2	<8.95E-15 ND (see Note 1)	<GPL	--				
HF	7664-39-3	<8.22E-05 ND	U	--				
HCl	7647-01-0	<8.11E-05 ND	0.004	8.8E-3 lb/shot				
particulate		1.07E-04	0.05	1.1E-5 lb/shot				
<b>Dioxins and Furans (include isomers and congener groups or the 2, 3, 7, 8 tetra-equivalents)</b>		0.040 ng/dscm@7%O2	8.2E-13 based on TEQ	1.3E-12 lb/shot				
2,3,7,8-TCDD	1746-01-6			A				
1,2,3,7,8-PeCDD	40321-76-4			A				
1,2,3,4,7,8-HxCDD	39227-28-6			A				
1,2,3,6,7,8-HxCDD	57653-85-7			A				
1,2,3,7,8,9-HxCDD	19408-74-3			A				
1,2,3,4,6,7,8-HpCDD	35822-46-9			A				
1,2,3,4,6,7,8,9-OCDD	3268-87-9			A				
2,3,7,8-TCDF	51207-31-9			A				
1,2,3,7,8-PeCDF	57117-41-6			A				
2,3,4,7,8-PeCDF	57117-31-4			A				
1,2,3,4,7,8-HxCDF	70648-26-9			A				
1,2,3,6,7,8-HxCDF	57117-44-9			A				
1,2,3,7,8,9-HxCDF	72918-21-9			A				
2,3,4,6,7,8-HxCDF	60851-34-5			A				
1,2,3,4,6,7,8-HpCDF	67562-39-4			A				

**Table 2-4  
EDT Emissions by Technology Alternative (Continued)**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS			
		Overpacks/ Rejects	Overpacks/ Rejects	Overpacks/ Rejects	Agent		Explosive	
		Emissions Rate (g COPC/s) (a, b)	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)	
1,2,3,4,7,8,9-HpCDF	55673-89-7			A				
1,2,3,4,6,7,8,9-OCDF	39001-02-0			A				
3,4,4',5'-TCB (PCB 81)	70362-50-4			A				
3,3',4,4'-TCB (PCB 77)	32598-13-3			5.29E-13				
3,3',4,4',5'-PeCB (PCB 126)	57465-28-8			A				
3,3',4,4',5,5'-HxCB (PCB 169)	32774-16-6			A				
2',3,4,4',5'-PeCB (PCB 123)	65510-44-3			A				
2,3',4,4',5'-PeCB (PCB 118)	31508-00-6			1.32E-12				
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4			5.29E-13				
2,3,4,4',5'-PeCB (PCB 114)	74472-37-0			A				
2,3',4,4',5,5'-HxCB (PCB 167)	52663-72-6			A				
2,3,3',4,4',5'-HxCB (PCB 156)	38380-08-4			A				
2,3,3',4,4',5'-HxCB (PCB 157)	69782-90-7			A				
2,3,3',4,4',5,5'-HpCB (PCB 189)	39635-31-9			A				
<b>Metals</b>								
antimony	7440-36-0	6.49E-09	<3.4E-5	--				
arsenic	7440-38-2	<6.47E-08	8.80E-04	--	4.77E-06	2.32E-04	1.70E-05	1.63E-02
barium	7440-39-3	2.59E-07	<6.8E-6	--				
beryllium	7440-41-7	<6.62E-09	<3.2E-6	--				
boron	7440-42-8	4.77E-06	U	--				
cadmium	7440-43-9	8.97E-09	2.90E-05	--	4.21E-06	2.04E-04		
chromium	7440-47-3	1.87E-07	<7.6E-5	--				

**Table 2-4  
EDT Emissions by Technology Alternative (Continued)**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS			
		Overpacks/ Rejects	Overpacks/ Rejects	Overpacks/ Rejects	Agent		Explosive	
		Emissions Rate (g COPC/s) <sup>(a, b)</sup>	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)	
cobalt	7440-48-4	1.14E-08	<1.2E-5	--				
copper	744-50-8	1.32E-07	<2.4E-5	2.2E-8 lb/shot	1.90E-05	9.23E-04	8.11E-05	7.76E-02
lead	7439-92-1	5.45E-08	<1.3E-5	3.1E-10 lb/shot	3.86E-05	1.83E-03	2.76E-05	2.64E-02
manganese	7439-96-5	5.41E-05	U	--				
mercury	7439-97-6	<2.22E-07 (see Note 2)	<1.3E-5	6.6E-9 lb/shot				
nickel	7440-02-0	2.13E-07	<1.5E-5	--				
phosphorus	7723-14-0	<2.27E-06	U	--				
selenium	7782-49-2	<9.07E-08	<9.4E-5	--				
silver	7440-22-4	7.03E-08	<8.3E-6	--	2.24E-07	1.09E-05		
thallium	7440-28-0	<2.51E-08 ND	<4.6E-5	--				
tin	7440-31-5	<3.98E-07	U	--				
vanadium	7440-62-2	<1.26E-07 ND	<6.4E-5	--				
zinc	7440-66-6	2.22E-06	<5.6E-4	--				
<b>Other Emissions Not Listed Above (Populated by vendors)</b>								
Total Volatile TOCs (C1 through C7, includes above)		7.29E-04						
Semivolatile Total Chromatographable Organics (C8 through C17, includes above)		4.44E-05						
Semivolatile Total Gravimetric Organics (includes above)		2.14E-04						
Total Organics (includes above)		<5.48E-03						
2,4-dinitrotoluene	121-14-2	<1.76E-07 ND						
2,6-dinitrotoluene	606-20-2	<1.76E-07 ND						
HMX (cyclotetramethylenetetranitramine)	2691-41-0	<1.76E-07 ND						

**Table 2-4  
EDT Emissions by Technology Alternative (continued)**

Chemical of Potential Concern (COPC)	CAS Number	SDC	TDC	DAVINCH	EDS			
		Overpacks/Rejects	Overpacks/Rejects	Overpacks/Rejects	Agent		Explosive	
		Emissions Rate (g COPC/s) <sup>(a, b)</sup>	Emissions Rate (lb COPC/hr) <sup>(c)</sup>	Emissions Rate (lb COPC/hr) <sup>(d)</sup>	Emission Factor (after controls) (g COPC/lb H)		Emission Factor (after controls) (g COPC/lb NEW)	
nitroglycerin	55-63-0	<7.08E-07 ND						
RDX (cyclonite)	121-82-4	<1.76E-07 ND						
2,4,6-trinitrotoluene	118-96-7	<1.76E-07 ND						
iron	7439-89-6		0.05					
calcium	7789-78-8		0.02					
propane	74-98-6		0.05					
butane	106-97-8		0.21					
dichlorodifluoromethane	75-71-8	<9.76E-07	2.90E-04					
trichlorofluoromethane	75-69-4	<5.09E-07	1.30E-04					
1,3-butadiene	106-99-0	<3.30E-07						
bromomethane	74-83-9	<1.92E-06						
Freon 113	76-13-1	<1.01E-06						
aluminum	91728-14-2				1.32E-04	6.41E-03		
1,4-dichlorobenzene	106-46-7							
acetylene	74-86-2							
bromomethane	74-83-9							
monoethanolamine	141-43-5							
nitrobenzene	98-95-3							
hydrogen cyanide	74-90-8							
ethanol	64-17-5				1.71E-04	8.31E-03		

See notes on following page:

\*P=Present, A=Absent, and U=Unknown  
Note: Pollutant order is as presented in the PCAPP RFP.

Note 1 - Results given for HD are for testing performed in Germany in 2007 using US protocols on a similar system. No H or HD was detected. DE for HD was greater than 99.99999986%.

Note 2 - Hg is high due to no Sulfur Impregnated activated Carbon (SIC) filter followed by activated carbon (AC) being present in the final filter to remove it.

a. The emissions rates were obtained during testing at ANCDF in July 2011 using mustard munitions and with the Pollution Abatement System (PAS) in full operation. The PAS in operation consisted of a thermal oxidizer, quench system, baghouse filter, acid and neutral scrubbers, and a chemical agent demilitarization filter bank consisting of a HEPA filter followed by a SIC filter and AC filter and a final HEPA filter before going to the stack.

b. A value with the "<" qualifier listed but without the "ND" qualifier means that the chemical species so denoted was detected, but the amount detected was below the quantitation limit for that particular chemical. In this case the quantitation limit for the chemical is reported, along with the "<" qualifier to denote that the actual value is less than the quantitation limit but is more than the detection limit. If both the "<" and the "ND" qualifiers are present this means that the chemical species denoted was not detected (i.e., was Absent). The value reported is the detection limit, and the "<" qualifier means the actual value (if any) is less than the detection limit.

c. The vendor obtained emission rates during testing at Porton Down, UK in 2006 using UK 25-pdr mustard-filled munitions. The vendor then scaled up the emission rates by a factor of 3.5 to account for the difference in mustard contained in the 25-pdr munitions compared to the 155-mm projectiles at the Pueblo Chemical Depot. Emission rates are after controls, including a candle filter with upstream lime addition for particulate and acid gas removal, a catalytic oxidizer for removal of carbon monoxide, and carbon adsorption vessels for semi-volatile compound removal. In addition, the system enclosure has a HEPA/carbon filtration unit.

d. Emission rates are after controls, including an oxidizer (cold plasma), scrubber, HEPA filter, and sulfur-impregnated charcoal filter. Emissions are in units of pounds per hour unless otherwise noted.

### **3.0 AIR DISPERSION AND DEPOSITION MODELING**

Methodologies and models utilized for this project are as described in the following sections and are in accordance with common practice and regulatory guidance. Any deviations from common practice or regulatory guidance are described in the following sections.

#### **3.1 Model Description**

The AMS/EPA Regulatory Model, AERMOD (version 12060), is used for this analysis since it is the preferred model listed in EPA's "Guideline on Air Quality Models". This air model replaced the previous US EPA preferred model, ISCST3.

Using a relatively simple approach, AERMOD incorporates current concepts about flow and dispersion in complex terrain. Where appropriate the plume is modeled as either impacting and/or following the terrain. This approach has been designed to be physically realistic and simple to implement while avoiding the need to distinguish among simple, intermediate and complex terrain, as required by other regulatory models.

AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. In the stable boundary layer (SBL) AERMOD assumes the concentration distribution to be Gaussian in both the vertical and horizontal planes. In the convective boundary layer (CBL), the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function (pdf).

AERMOD approximates the physical processes occurring in the atmosphere that influence the dispersion and deposition of gaseous and particulate emissions from the BGCAPP treatment process stacks. The AERMOD air pollution dispersion model is an integrated system for modeling the dispersion of air pollutants using three program modules, which include:

1. a steady-state dispersion model designed for short-range (up to 50 kilometers) dispersion of air pollutant emissions from stationary industrial sources;
2. a meteorological data preprocessor (AERMET) that accepts surface meteorological data, upper air soundings, or data from on-site instrument towers, then calculates atmospheric parameters needed by the dispersion model; and
3. a terrain preprocessor (AERMAP) that provides a physical relationship between terrain features and the behavior of air pollution plumes.

AERMOD also includes PRIME (Plume Rise Model Enhancements) which is an algorithm for modeling the effects of downwash created by the pollution plume flowing over nearby buildings. Meteorological data from on-site towers for the years 2004 through 2008 were used for the air modeling. Separate vapor phase and particle phase air modeling runs were used for each of the five years of meteorological data. This section presents the data sources for the AERMOD inputs and the required air modeling parameters.

The model options for concentration, total deposition, dry deposition and wet deposition were selected based on the HHRAP recommendations. All other model options were set to the default.

### **3.2 Emission Source Characterization**

The construction site for the proposed Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) is located within the Blue Grass Army Depot in Richmond, Kentucky and is shown on Figure 3-1. Figure 3-2 presents the general arrangement of the BGCAPP building and equipment in the vicinity of the proposed EDT site.

#### *3.2.1 Stack Coordinates and Base Elevation*

Reference points for emission sources from the facility plot plan were determined using USGS 7.5 minute quadrant maps. The Kentucky State Plane – South Zone grid utilized for facility mapping was converted to Universal Transverse Mercator (UTM), North American Datum 1927 (NAD27) using the program Google Earth – Earth Point Program. Using two reference points, the stack coordinates and locations of applicable buildings (i.e., for the calculation of downwash) were determined in UTM NAD27. Table 2-2 in the previous section presents the coordinates for all evaluated emission sources and other emissions source characteristics used as inputs to AERMOD.

#### *3.2.2 Stack Height and Building Wake Effects*

The emitting sources modeled at the BGAD facility include two SDC sources: the process stack as SDC1 and the vent as SDC2. Each of the other technologies evaluated are modeled as a single source. All sources are modeled at the same location for this screening analysis.

All four process stacks were given an assumed stack height of 50 ft, per Bechtel Parsons specifications. The building vent for the SDC alternative was modeled at 16 feet, as specified by the 2012 PCAPP MPHRA report. Due to the proximity of buildings in the vicinity of the process





stacks, it was anticipated that building wake effects might influence the dispersion of stack gas from the evaluated stacks. As stated in Section 3.4.3 of the Final HHRAP, “significant decreases in concentrations and deposition rates will begin at stack heights at least 1.2 times the building height, and further decreases occur at 1.5 times building height, with continual decreases of up to 2.5 times building height (GEP stack height) where the building no longer influences stack gas.”

Several of the plant buildings are “nearby”, meaning these buildings may have meaningful wake effects. As described in Section 3.4.3 of the Final HHRAP, a building is “nearby” if the distance from the building to the stack is within five times the lesser of building height or crosswind width. Nearby buildings are shown in Figure 3-2.

The Building Profile Input Program (BPIP) was used to generate the AERMOD input data required to model building wake effects.

### *3.2.3 Stack Gas Temperature, Flowrate and Velocity*

The stack gas temperature and velocities are design parameters obtained from the 2012 PCAPP MPHRA Report. The individual stack velocities for each of the four process stacks were based on the vendor supplied velocities. Stack diameter for each unit was calculated using the assumed stack height and vendor supplied stack velocity.

### *3.2.4 Modeled Emission Rate and Particle-Size Distribution*

AERMOD air modeling was performed based on a unit emission rate of 1.0 g/s, instead of compound-specific emission rates. The unitized air modeling outputs based on a unit emission rate were multiplied by a compound-specific emission rate prior to use in the risk assessment.

The AERMOD model requires input of particle size distribution (PSD) and density data for completion of the particle phase and particle-bound phase modeling. Site-specific data for these parameters are not available. The EDT vendors indicated that stack gases will exhaust through a ventilation system including high efficiency particulate air (HEPA) filters that remove 99.7% of particles greater than 0.3 microns in size. Thus, a single particle category with a mean size of 0.3 microns is used. With a single particle size category, the mass fraction is set to 1 (100%), and only one model run is needed to represent both particle and particle-bound phases of the risk assessment. A particle density of 1 g/cm<sup>3</sup> is assumed for the sources as recommended in HHRAP.

### 3.3 Urban/Rural

The 3-kilometer area around BGAD was reviewed on the 7.5 minute topographic map and Google satellite maps to determine the correct land use type for the dispersion coefficients. Although there is some industrial/commercial land use around the facility, the predominant land uses in the 3-kilometer area are forest and agricultural land. Based on the Auer method as described in EPA's "Guideline on Air Quality Models", these land use type are considered rural. Thus, there is more than 50% rural, and the dispersion coefficients are set to rural.

### 3.4 Deposition Parameters

The new deposition algorithms in AERMOD require land use characteristics and some gas deposition resistance terms based on five seasonal categories, defined as:

Season Category 1: Midsummer with lush vegetation

Season Category 2: Autumn with non-harvested cropland

Season Category 3: Late autumn after frost and harvest, or winter with no snow

Season Category 4: Winter with continuous snow on ground

Season Category 5: Transitional spring with partial green coverage or short annuals

The seasonal categories used for modeling in this region are summarized in Table 3-1.

The nine land use categories required for deposition are entered for each of the 36 wind direction sectors (every 10 degrees). The EPA program AERSURFACE (08009) is used to calculate site-specific values used in the meteorological data processing. However, the output includes land use for the 12 sectors surrounding the facility. The 36 land use categories were estimated from the AERSURFACE land use percentages, and are shown in Table 3-2.

Figure 3-3 presents a best-fit curve developed by M. Jindal and D. Heinold<sup>1</sup> for the wet (liquid) scavenging rate coefficient versus particle size. From this curve, the liquid scavenging rate coefficient of  $4.0E-5$  ( $s^{-1}/mm-h^{-1}$ ) was obtained for a one micron particle size. The scavenging rate coefficient for frozen precipitation (ice) was determined as one-third ( $1/3$ ) of the liquid scavenging coefficient. This gives an ice scavenging coefficient of  $1.3E-5$  ( $s^{-1}/mm-h^{-1}$ ) for a one micron particle size.

The liquid scavenging coefficient for vapor phase compounds was determined based on a particle size of  $0.1 \mu m$ , following the recommendations of the HHRAP Guidance. This gives the

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<sup>1</sup> Jindal, M. and D. Heinold, 1991: Development of particulate scavenging coefficients to model wet deposition from industrial combustion sources. Paper 91-59.7, 84th Annual Meeting - Exhibition of AWMA, Vancouver, BC, June 16-21, 1991.

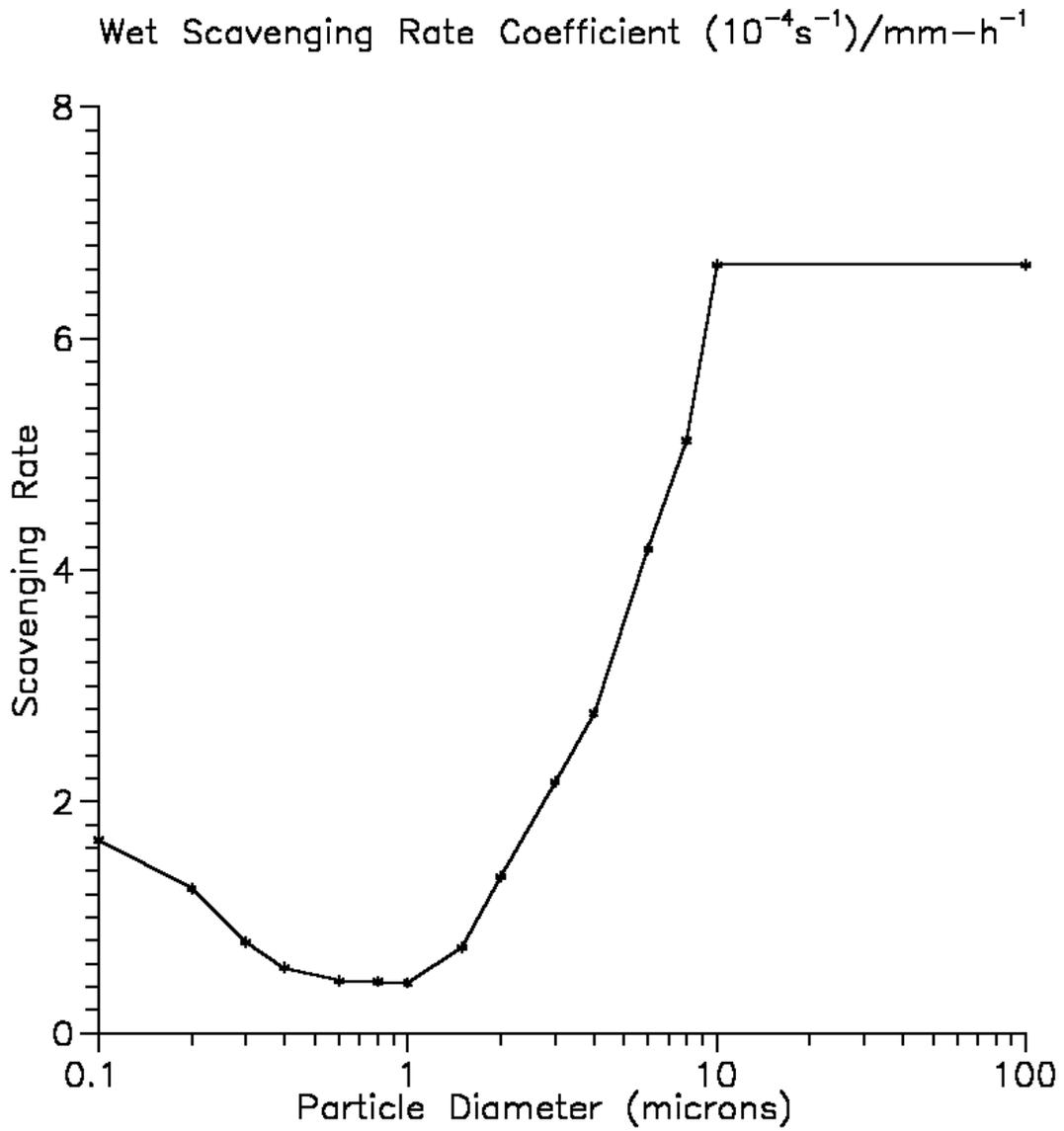
**Table 3-1**  
**Seasonal Categories**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Season	3	3	5	5	1	1	1	1	1	2	2	3

**Table 3-2  
Land Use Categories**

<b>Sector:</b>		1	2	3	4	5	6	7	8	9	10	11	12
<b>Range:</b>		0-30°	30-60°	60-90°	90-120°	120-150°	150-180°	180-210°	210-240°	240-270°	270-300°	300-330°	330-360°
AERSURFACE Land Use	AERMOD Category	%	%	%	%	%	%	%	%	%	%	%	%
21 Low Intensity Residential	6 - suburban areas, forested	0%	0%	0%	0%	0%	13%	11%	11%	1%	0%	0%	2%
22 High Intensity Residential	1 - Urban land/ no vegetation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
23 Commercial/Industrial/Transp	1 - Urban land/ no vegetation	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	1%
Total: 1 – Urban land/ no vegetation		0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	1%
41 Deciduous Forest	4 – forest	17%	26%	32%	44%	34%	39%	55%	50%	40%	13%	2%	12%
42 Evergreen Forest	4 – forest	1%	2%	3%	0%	0%	0%	0%	0%	0%	1%	1%	1%
43 Mixed Forest	4 – forest	14%	13%	20%	14%	17%	7%	4%	9%	10%	9%	2%	13%
Total: 4 – forest		32%	41%	<b>55%</b>	<b>58%</b>	<b>51%</b>	<b>46%</b>	<b>59%</b>	<b>59%</b>	<b>50%</b>	23%	5%	26%
81 Pasture/Hay	2 - Agricultural land	56%	49%	39%	36%	36%	8%	0%	0%	2%	62%	92%	56%
82 Row Crops	2 - Agricultural land	11%	10%	5%	5%	6%	4%	1%	0%	0%	4%	1%	6%
Total: 2 - Agricultural land		<b>67%</b>	<b>59%</b>	44%	41%	42%	12%	1%	0%	2%	<b>66%</b>	<b>93%</b>	<b>62%</b>
85 Urban/Recreational Grasses	5 - suburban areas, grassy	0%	0%	0%	0%	7%	30%	28%	29%	47%	10%	1%	9%
<b>AERMOD Land Use:</b>		2	2	4	4	4	4	4	4	4	2	2	2

**Figure 3-3**  
**Wet Scavenging Rate Coefficient as a Function of Particle Size**  
**From Jindal and Heinold, 1991**



gas scavenging coefficients of  $1.68\text{E-}04$  ( $\text{s}^{-1}/\text{mm-h}^{-1}$ ) and  $0.56\text{E-}04$  ( $\text{s}^{-1}/\text{mm-h}^{-1}$ ) for liquid and ice, respectively.

### **3.5 Meteorological Data**

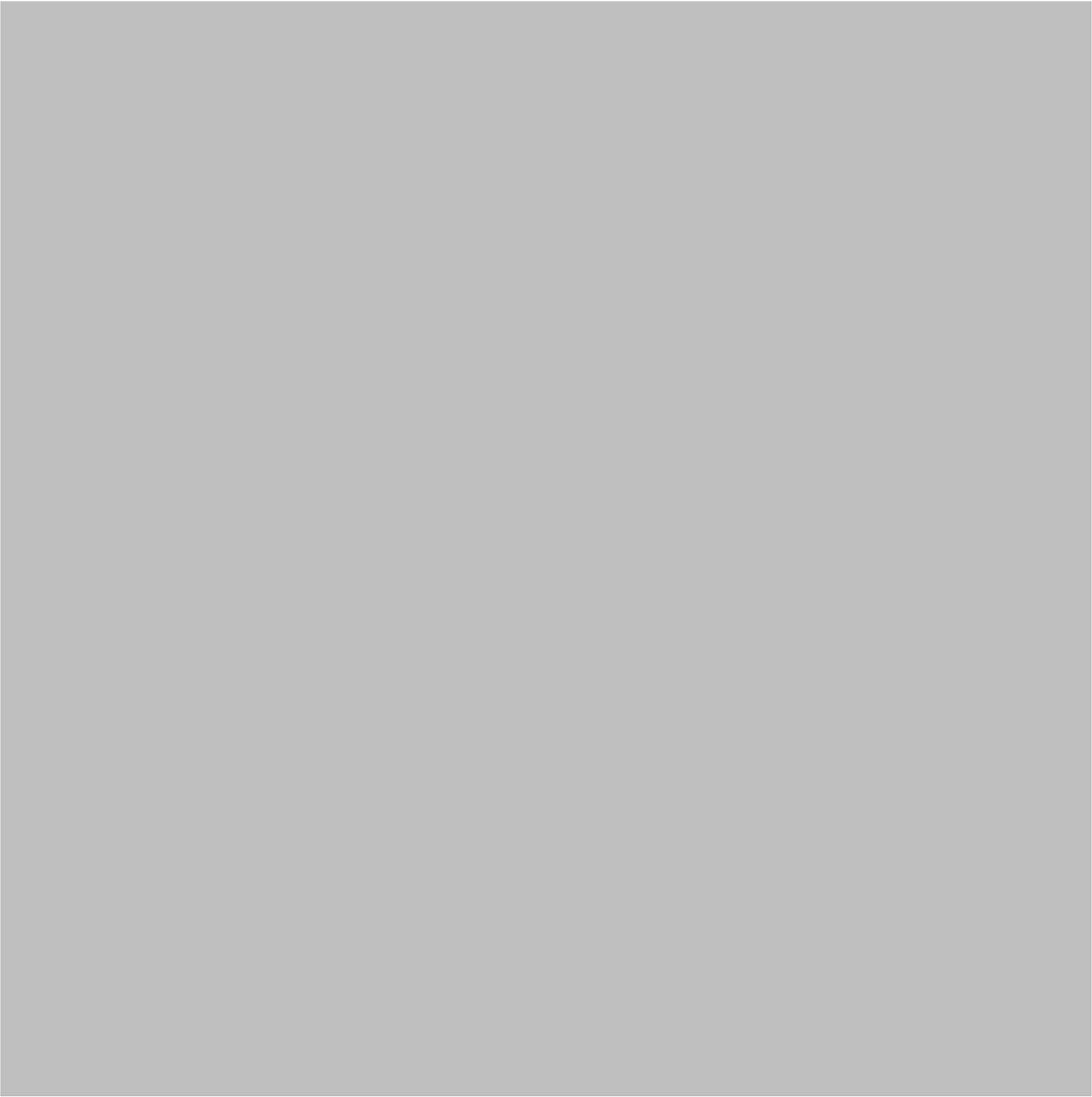
AERMOD requires hourly meteorological data. Since the meteorological preprocessor, AERMET (version 06341), requires additional parameters such as pressure, relative humidity and precipitation, a complete on-site met data set is important for this analysis. Meteorological data is collected on-site at several towers and includes all the necessary measurements of required parameters. This analysis utilized data from the closest location, Tower 1, from which the data is provided in 15-minute records. This on-site meteorological station, designated as Tower 1, is just south of the EDT site. The current version of AERMET is unable to process the 15-minute data and correctly average it into hourly records. Thus, the data were averaged into hourly records following EPA guidance before processing.

The 5-year period of on-site surface data for 2004 through 2008 is combined with the twice daily upper air soundings in FSL format from Wilmington, OH (13841). Site-specific surface roughness, albedo and Bowen ratio parameters were calculated using the AERSURFACE program and used in AERMET to generate hourly data for the analysis. Since the AERMET program did not correctly include the onsite precipitation and relative humidity in the processed surface file, these parameters were added back into each year's file using MS Excel. The five years of processed data are combined into single, 5-year surface and profile meteorological files for input into AERMOD. The AERMET processing files are included on the attached CD-ROM.

### **3.6 Receptor Grid and Terrain**

The receptor grid for this project was designed according to HHRAP guidance. The grid includes 100-meter spacing out to three kilometers from the facility centroid and 500-meter spacing out to 10 kilometers. Figure 3-4 indicates the entire grid developed, including the 100-meter dense receptor spacing and the 500-meter receptor spacing that extends to 10 kilometers from the centroid of the designated sources, excluding most on-site receptors. On-site receptors are shown at 100-meter spaces over the surface of Lake Vega, which was modeled for water-based exposure scenarios.

Terrain elevations were included in the modeling analysis for completeness. AERMAP (version 11103) is used to calculate the receptor elevations from 7.5-minute DEM data files. AERMAP also calculates the critical hill height for each receptor location.



### **3.7 Chemical-Specific Parameters**

For vapor phase runs, AERMOD requires the user to enter chemical-specific gas deposition parameters. These parameters include diffusivity in air ( $D_a$ ), diffusivity in water ( $D_w$ ), cuticular resistance to uptake by lipids for individual leaves (rcl) and Henry's Law constant (H). Thus, separate vapor model runs were required for each pollutant. Parameters for all Chemicals of Potential Concern (COPCs) were first derived from the appendices to the ANL report, as recommended in the AERMOD User's Guide. If parameters were not found in the ANL appendices, then the HHRAP chemical database is used as a secondary source of information. This database does not contain rcl values. Thus, a median value of all other found rcl values is used for the COPCs found in this database. If chemical-specific values were not found for a particular COPC in these two data sources, then values were either found via other chemical information sources or assumed based on the chemical's properties. A summary of the modeled chemical-specific parameters is provided in Table 3-3.

### **3.8 Modeling Results**

The unitized modeling results presented in this section include concentration, dry deposition, wet deposition and total deposition for short-term (1-hour) and long-term (annual) exposures. There are a total of 87 model runs. Most modeled maximums occurred north of the facility, except for the SDC2 stack, which had most modeled maximums occurring at the Lake Vega water receptors on-site. The modeling run types and counts are summarized in Table 3-4.

Results of dispersion modeling runs for particle and particle bound phase modeling are summarized in Table 3-5. Tables 3-6 through 3-9 provide summary results for modeling runs for vapor phase modeling. Results provided include concentration maxima, as well as total, dry and wet deposition maxima.

**Table 3-3  
Chemical-Specific Values**

COPC	CAS No.	SDC1	SDC2	TDC	DAV	EDS	Modeling ID	D <sub>a</sub> (cm <sup>2</sup> /s)	D <sub>w</sub> (cm <sup>2</sup> /s)	rcl (s/m)	H (Pa-m <sup>3</sup> /mol)
1,1,1-trichloroethane	71-55-6	✓					TRICL111	7.80E-02	8.80E-06	6.64E+04	1.72E+03
1,1-dichloroethane	75-34-3	✓					DCHLOR11	7.40E-02	1.00E-05	1.37E+05	5.67E+02
1,1-dichloroethene	75-35-4	✓					DCHLRE11	9.28E-02	1.11E-05	5.78E+04	2.33E+03
1,2-dichloroethane	107-06-2	✓					DCHLOR12	1.00E-01	9.90E-06	1.66E+05	9.93E+01
1,2-dichloropropane	78-87-5	✓					DCHLPN12	7.82E-02	8.73E-06	1.79E+04	2.84E+02
1,3-butadiene	106-99-0	✓					BUTADIEN	1.01E-01	1.15E+00	1.14E+04	7.45E+03
1,4-dioxane	123-91-1			✓			14DIOXAN	9.50E-02	1.06E+00	6.52E+07	4.86E-01
2-butanone	78-93-3	✓		✓			MEK	9.18E-02	1.04E+00	3.88E+07	3.63E+00
acetone	67-64-1	✓		✓			ACETONE	1.20E-01	1.10E-05	7.60E+08	3.95E+00
benzene	71-43-2	✓		✓			BENZENE	8.96E-02	1.04E-05	2.51E+04	5.57E+02
benzoic acid	65-85-0	✓					BNZCACID	1.00E-03	7.97E-06	1.79E+04	2.91E-01
benzyl alcohol	100-51-6	✓					BNZLALCO	1.00E-03	1.00E-05	1.79E+04	3.41E-02
bis(2-ethylhexyl)-phthalate	117-81-7	✓		✓		✓	BIS2EPHTH	3.72E-02	1.00E-01	2.79E+02	2.70E-02
bromodichloromethane	75-27-4	✓					BRDCLMTH	1.00E-03	1.00E-05	1.79E+04	1.62E+02
bromomethane	74-83-9	✓					BROMMETH	1.15E-01	1.44E+00	2.49E+05	6.33E+02
carbon disulfide	75-15-0	✓				✓	CRBDSULF	1.05E-01	1.29E+00	7.45E+02	1.75E+03
carbon tetrachloride	56-23-5	✓					CRBTCHLD	8.02E-02	9.37E-01	2.88E+04	2.94E+03
chlorobenzene	108-90-7	✓					CHLOBENZ	7.93E-02	9.17E-01	6.02E+03	3.67E+02
chloroform	67-66-3	✓					CHLOFORM	8.94E-02	1.07E-05	1.62E+05	3.81E+02
chloromethane	74-87-3	✓		✓			CHLOMETH	1.28E-01	1.47E+00	1.89E+06	9.74E+02
cis-1,3-dichloropropene	542-75-6	✓					DCHLPR13	6.26E-02	1.00E-05	1.79E+04	1.82E+03
dibromochloromethane	124-48-1	✓					DBCHLMTH	1.00E-03	1.00E-05	1.79E+04	7.93E+01
dichlorodifluoromethane	75-71-8	✓		✓			DCLFLMTH	1.00E-03	1.00E-05	1.79E+04	3.48E+04
di-n-butyl phthalate	84-74-2	✓		✓			DINBPHTH	4.64E-02	3.03E-01	6.46E+01	5.00E-02
di-n-octyl phthalate	117-84-0			✓			DINOPHTH	1.00E-03	1.00E-05	1.79E+04	6.79E+00
ethane	74-84-0			✓			ETHANE	1.96E-01	2.28E-05	1.79E+04	4.88E+04
ethanol	64-17-5					✓	ETHANOL	1.32E-01	8.30E+04	1.79E+04	5.07E-01

**Table 3-3  
Chemical-Specific Values (Continued)**

COPC	CAS No.	SDC1	SDC2	TDC	DAV	EDS	Modeling ID	D <sub>a</sub> (cm <sup>2</sup> /s)	D <sub>w</sub> (cm <sup>2</sup> /s)	rcl (s/m)	H (Pa-m <sup>3</sup> /mol)
ethylbenzene	100-41-4	✓					ETHLBENZ	7.37E-02	8.05E-01	1.65E+04	8.88E+02
Freon 113	76-13-1	✓					FREON113	5.80E-02	6.70E-06	1.79E+04	2.73E+03
H	505-60-2	✓	✓	✓	✓	✓	H	6.50E-02	7.50E-06	1.79E+04	3.04E+00
hexane	110-54-3	✓					HEXANE	7.66E-02	8.04E-01	2.73E+04	1.84E+05
methane	74-82-8			✓		✓	METHANE	2.99E-01	3.46E-05	1.79E+04	6.45E+04
methylene chloride	75-09-2	✓				✓	METHCHLO	1.03E-01	1.23E+00	9.07E+04	1.69E+02
naphthalene	91-20-3			✓			NAPHTHAL	7.03E-02	7.75E-01	3.65E+02	4.30E+01
styrene	100-42-5	✓					STYRENE	7.50E-02	8.38E-01	1.13E+04	3.06E+02
tetrachloroethene	127-18-4	✓					TRCHLETH	7.49E-02	8.61E-01	6.04E+03	2.69E+03
toluene	108-88-3	✓		✓		✓	TOLUENE	8.05E-02	9.10E-06	1.74E+04	6.80E+02
trans-1,3-dichloropropene	10061-02-6	✓					T13DCHLP	8.30E-02	9.63E-01	1.79E+04	8.82E+01
trichloroethene	79-01-6	✓					TRICLETH	8.23E-02	9.71E-01	1.88E+04	1.18E+03
trichlorofluoromethane	75-69-4	✓		✓			TCLFLMTH	8.70E-02	9.70E-06	1.79E+04	9.83E+03
vinyl chloride	75-01-4	✓				✓	VINLCHLR	1.10E-01	1.29E+00	7.35E+03	2.29E+03
xylene	1330-20-7	✓			✓		XYLENES	7.37E-02	8.05E-01	1.83E+04	6.24E+02
1,2,3,4,6,7,8-HpCDD	35822-46-9			✓			HPCDD	4.66E-02	3.29E-01	5.97E-01	1.33E-01
1,2,3,4,6,7,8,9-OCDD	3268-87-9			✓			OCDD	4.52E-02	2.97E-06	4.94E+00	6.84E-01
2,3,7,8-TCDF	51207-31-9	✓					2378TCBF	5.27E-02	4.54E-06	9.67E+00	1.46E+00
1,2,3,4,6,7,8-HpCDF	67562-39-4			✓			123HPCBF	4.72E-02	3.41E-06	1.27E+01	1.43E+00
1,2,3,4,6,7,8,9-OCDF	39001-02-0			✓			OCDF	4.57E-02	3.08E-06	1.42E+00	1.91E-01
3,3',4,4'-TCB (PCB 77)	32598-13-3				✓		3344TCB	5.11E-02	4.38E-01	9.23E+01	1.04E+01
2,3',4,4',5-PeCB (PCB 118)	31508-00-6				✓		23445PCB	4.92E-02	3.99E-01	1.52E+02	1.27E+01
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4				✓		23344PCB	4.92E-02	3.99E-01	1.38E+02	1.01E+01
ammonia	7664-41-7			✓			AMMONIA	1.98E-01	1.24E-05	1.79E+04	5.61E+05
aluminum	91728-14-2					✓	(no vapor phase)				
antimony	7440-36-0	✓		✓			(no vapor phase)				

**Table 3-3  
Chemical-Specific Values (Continued)**

COPC	CAS No.	SDC1	SDC2	TDC	DAV	EDS	Modeling ID	D <sub>a</sub> (cm <sup>2</sup> /s)	D <sub>w</sub> (cm <sup>2</sup> /s)	rcl (s/m)	H (Pa- m <sup>3</sup> /mol)
arsenic	7440-38-2	✓		✓		✓		(no vapor phase)			
barium	7440-39-3	✓		✓				(no vapor phase)			
beryllium	7440-41-7	✓		✓				(no vapor phase)			
boron	7440-42-8	✓						(no vapor phase)			
cadmium	7440-43-9	✓		✓		✓		(no vapor phase)			
chlorine	7782-50-5			✓			CL2	1.00E-03	1.00E-05	4.25E+25	1.20E-02
chromium (3+)	16065-83-1	✓		✓		✓		(no vapor phase)			
chromium (6+)	18540-29-9	✓		✓		✓		(no vapor phase)			
cobalt	7440-48-4	✓		✓				(no vapor phase)			
copper	7440-50-8	✓		✓	✓	✓		(no vapor phase)			
hydrogen chloride	7647-01-0			✓	✓		HCL	3.00E-01	1.00E-05	1.00E+05	1.00E-12
iron	7439-89-6			✓				(no vapor phase)			
lead	7439-92-1	✓		✓	✓	✓		(no vapor phase)			
manganese	7439-96-5	✓						(no vapor phase)			
mercuric chloride	7487-94-7	✓		✓	✓	✓	MERCCHLR	4.53E-02	5.25E-06	1.79E+04	7.19E-05
methyl mercury	22967-92-6	✓		✓	✓	✓		(no vapor phase)			
elemental mercury	7439-97-6	✓		✓	✓	✓	MERCURY	1.09E-02	3.01E-05	1.00E+05	1.50E+02
nickel	7440-02-0	✓		✓				(no vapor phase)			
phosphorus	7723-14-0	✓						(no vapor phase)			
selenium	7782-49-2	✓		✓				(no vapor phase)			
silver	7440-22-4	✓		✓		✓		(no vapor phase)			
tin	7440-31-5	✓						(no vapor phase)			
vanadium	7440-62-2			✓				(no vapor phase)			
zinc	7440-66-6	✓		✓				(no vapor phase)			

**Table 3-4  
Modeling Run Types and Counts**

<b>Source</b>	<b>Phase Type</b>	<b>Model Run Count</b>
SDC1	Vapor	39
	Particle/Particle-Bound	1
SDC2	Vapor	1
	Particle/Particle-Bound	1
TDC	Vapor	24
	Particle/Particle-Bound	1
DAVINCH	Vapor	8
	Particle/Particle-Bound	1
EDS	Vapor	10
	Particle/Particle-Bound	1

**Table 3-5  
Particle/Particle-Bound Phase Modeling Maxima Summary**

	<b>Units</b>	<b>SDC1</b>	<b>SDC2</b>	<b>TDC</b>	<b>DAVINCH</b>	<b>EDS</b>
<b>Particle Phase Annual Concentration (Cyp)</b>	$\mu\text{g-s/g-m}^3$	9.18E-01	2.94E+00	2.49E-01	1.24E+00	1.08E-01
<b>Particle Phase Annual Total Deposition (Dytp)</b>	$\text{s/m}^2\text{-yr}$	3.80E-03	1.12E-02	1.19E-03	4.71E-03	7.90E-04
<b>Particle Phase Annual Dry Deposition (Dydp)</b>	$\text{s/m}^2\text{-yr}$	3.80E-03	1.12E-02	1.18E-03	4.70E-03	7.90E-04
<b>Particle Phase Annual Wet Deposition (Dywp)</b>	$\text{s/m}^2\text{-yr}$	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
<b>Particle Phase Hourly Concentration (Chp)</b>	$\mu\text{g-s/g-m}^3$	2.28E+02	7.47E+02	9.54E+01	2.20E+02	1.30E+02

**Table 3-6  
Vapor Phase Modeling Maxima Summary – Concentration**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Concentration ( $\mu\text{g}/\text{m}^3/\text{g}/\text{s}$ )											
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS			
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual		
1,1,1-trichloroethane	71-55-6	Organic	TRICL111	228.35	0.93										
1,1-dichloroethane	75-34-3	Organic	DCHLOR11	228.36	0.93										
1,1-dichloroethene	75-35-4	Organic	DCHLRE11	228.35	0.93										
1,2-dichloroethane	107-06-2	Organic	DCHLOR12	228.35	0.93										
1,2-dichloropropane	78-87-5	Organic	DCHLPN12	228.33	0.93										
1,3-butadiene	106-99-0	Organic	BUTADIEN	228.32	0.93										
1,4-dioxane	123-91-1	Organic	14DIOXAN					95.42	0.25						
2-butanone	78-93-3	Organic	MEK	228.27	0.93			95.49	0.25						
acetone	67-64-1	Organic	ACETONE	228.28	0.93			95.49	0.25				132.91	0.11	
benzene	71-43-2	Organic	BENZENE	228.34	0.93			95.50	0.25						
benzoic acid	65-85-0	Organic	BNZCACID	228.12	0.92										
benzyl alcohol	100-51-6	Organic	BNZLALCO	228.05	0.92										
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPH	226.90	0.89			95.29	0.24				127.19	0.11	
bromodichloromethane	75-27-4	Organic	BRDCLMTH	228.34	0.93										
bromomethane	74-83-9	Organic	BROMMETH	228.36	0.93										
carbon disulfide	75-15-0	Organic	CRBDSULF	227.84	0.92								131.30	0.11	
carbon tetrachloride	56-23-5	Organic	CRBTCHLD	228.34	0.93										
chlorobenzene	108-90-7	Organic	CHLOBENZ	228.28	0.93										

**Table 3-6  
Vapor Phase Modeling Maxima Summary – Concentration (Continued)**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Concentration ( $\mu\text{g}/\text{m}^3/\text{g}/\text{s}$ )									
				SDC1		SDC2		TDC		DAVINCH		EDS	
			MODEL ID	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual
cis-1,3-dichloropropene	542-75-6	Organic	DCHLPR13	228.33	0.93								
dibromochloromethane	124-48-1	Organic	DBCHLMTH	228.34	0.93								
dichlorodifluoromethane	75-71-8	Organic	DCLFLMTH	228.34	0.93			95.50	0.25				
di-n-butyl phthalate	84-74-2	Organic	DINBPPTH	226.75	0.88			95.27	0.24				
di-n-octyl phthalate	117-84-0	Organic	DINOPPTH					95.49	0.25				
ethane	74-84-0	Organic	ETHANE					95.50	0.25				
ethanol	64-17-5	Organic	ETHANOL									131.41	0.11
ethylbenzene	100-41-4	Organic	ETHLBENZ	228.33	0.93								
Freon 113	76-13-1	Organic	FREON113	228.33	0.93								
H	505-60-2	Organic	H	228.23	0.93	766.1 5	3.02	95.48	0.25	226.5 0	1.26	132.76	0.11
hexane	110-54-3	Organic	HEXANE	228.35	0.93								
methane	74-82-8	Organic	METHANE					95.50	0.25			133.11	0.11
methylene chloride	75-09-2	Organic	METHCHLO	228.35	0.93							133.18	0.11
naphthalene	91-20-3	Organic	NAPHTHAL					95.36	0.25				
styrene	100-42-5	Organic	STYRENE	228.32	0.93								
tetrachloroethene	127-18-4	Organic	TRCHLETH	228.28	0.93								
toluene	108-88-3	Organic	TOLUENE	228.33	0.93			95.50	0.25			133.10	0.11
trans-1,3-dichloropropene	10061-02-6	Organic	T13DCHLP	228.33	0.93								

**Table 3-6  
Vapor Phase Modeling Maxima Summary – Concentration (Continued)**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Concentration (µg/m <sup>3</sup> /g/s)											
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS			
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual		
vinyl chloride	75-01-4	Organic	VINLCHLR	228.29	0.93							226.45	1.26	132.97	0.11
xylenes	1330-20-7	Organic	XYLENES	228.33	0.93							226.60	1.26		
1,2,3,4,6,7,8-HpCDD	35822-46-9	PCDDs, PCDFs, PCBs	HPCDD							95.24	0.24				
1,2,3,4,6,7,8,9-OCDD	3268-87-9	PCDDs, PCDFs, PCBs	OCDD							95.25	0.24				
2,3,7,8-TCDF	51207-31-9	PCDDs, PCDFs, PCBs	2378TCBF	226.51	0.86										
1,2,3,4,6,7,8-HpCDF	67562-39-4	PCDDs, PCDFs, PCBs	123HPCBF							95.25	0.24				
1,2,3,4,6,7,8,9-OCDF	39001-02-0	PCDDs, PCDFs, PCBs	OCDF							95.25	0.24				
3,3',4,4'-TCB (PCB 77)	32598-13-3	PCDDs, PCDFs, PCBs	3344TCB									215.64	1.21		
2,3',4,4',5-PeCB (PCB 118)	31508-00-6	PCDDs, PCDFs, PCBs	23445PCB									218.68	1.22		
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4	PCDDs, PCDFs, PCBs	23344PCB									218.13	1.22		
ammonia	7664-41-7	Inorganic	AMMONIA							95.50	0.25				
chlorine	7782-50-5	Inorganic	CL2							95.46	0.25				
hydrogen chloride	7647-01-0	Inorganic	HCL							95.15	0.22	201.31	1.07		
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	226.52	0.85					95.24	0.24	206.06	1.14	125.41	0.10
elemental mercury	7439-97-6	Inorganic	MERCURY	228.36	0.93					95.50	0.25	226.67	1.26	133.20	0.11

**Table 3-7  
Vapor Phase Modeling Maxima Summary - Total Deposition**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Total Deposition (s/m <sup>2</sup> -yr)										
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS		
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	
1,1,1-trichloroethane	71-55-6	Organic	TRICL111	0	4.00E-05									
1,1-dichloroethane	75-34-3	Organic	DCHLOR11	0	4.00E-05									
1,1-dichloroethene	75-35-4	Organic	DCHLRE11	0	5.00E-05									
1,2-dichloroethane	107-06-2	Organic	DCHLOR12	1.00E-05	5.00E-05									
1,2-dichloropropane	78-87-5	Organic	DCHLPN12	0	1.10E-04									
1,3-butadiene	106-99-0	Organic	BUTADIEN	0	1.50E-04									
1,4-dioxane	123-91-1	Organic	14DIOXAN					6.00E-05	5.40E-04					
2-butanone	78-93-3	Organic	MEK	1.00E-05	3.10E-04			1.00E-05	1.00E-04					
acetone	67-64-1	Organic	ACETONE	1.00E-05	3.00E-04			1.00E-05	9.00E-05				1.00E-05	6.00E-05
benzene	71-43-2	Organic	BENZENE	0	9.00E-05			0	3.00E-05					
benzoic acid	65-85-0	Organic	BNZCACID	4.00E-05	1.63E-03									
benzyl alcohol	100-51-6	Organic	BNZLALCO	6.00E-05	3.39E-03									
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPTH	2.70E-04	1.12E-02			1.40E-04	3.71E-03				1.10E-04	2.43E-03
bromodichloromethane	75-27-4	Organic	BRDCLMTH	0	9.00E-05									
bromomethane	74-83-9	Organic	BROMMETH	0	4.00E-05									
carbon disulfide	75-15-0	Organic	CRBDSULF	5.00E-05	1.85E-03								3.00E-05	2.30E-04
carbon tetrachloride	56-23-5	Organic	CRBTCHLD	0	7.00E-05									
chlorobenzene	108-90-7	Organic	CHLOBENZ	1.00E-05	2.80E-04									
chloroform	67-66-3	Organic	CHLOFORM	0	4.00E-05									

**Table 3-7  
Vapor Phase Modeling Maxima Summary - Total Deposition (Continued)**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Total Deposition (s/m <sup>2</sup> -yr)									
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS	
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual
chloromethane	74-87-3	Organic	CHLOMETH	0	3.00E-05			0	2.00E-05				
cis-1,3-dichloropropene	542-75-6	Organic	DCHLPR13	0	1.00E-04								
dibromochloromethane	124-48-1	Organic	DBCHLMTH	0	1.00E-04								
dichlorodifluoromethane	75-71-8	Organic	DCLFLMTH	0	9.00E-05			0	2.00E-05				
di-n-butyl phthalate	84-74-2	Organic	DINBPHTH	3.10E-04	1.30E-02			1.70E-04	4.98E-03				
di-n-octyl phthalate	117-84-0	Organic	DINOPHTH					0	6.00E-05				
ethane	74-84-0	Organic	ETHANE					0	3.00E-05				
ethanol	64-17-5	Organic	ETHANOL									4.00E-05	2.90E-04
ethylbenzene	100-41-4	Organic	ETHLBENZ	0	1.10E-04								
Freon 113	76-13-1	Organic	FREON113	0	1.00E-04								
H	505-60-2	Organic	H	1.00E-05	4.40E-04	4.00E-05	1.17E-03	1.00E-05	1.30E-04	1.00E-05	5.30E-04	1.00E-05	7.00E-05
hexane	110-54-3	Organic	HEXANE	0	6.00E-05								
methane	74-82-8	Organic	METHANE					0	3.00E-05			0	1.00E-05
methylene chloride	75-09-2	Organic	METHCHLO	1.00E-05	5.00E-05							0	2.00E-05
naphthalene	91-20-3	Organic	NAPHTHAL					4.00E-05	9.50E-04				
styrene	100-42-5	Organic	STYRENE	0	1.60E-04								
tetrachloroethene	127-18-4	Organic	TRCHLETH	1.00E-05	2.70E-04								

**Table 3-7  
Vapor Phase Modeling Maxima Summary - Total Deposition (Continued)**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Total Deposition (s/m <sup>2</sup> -yr)									
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS	
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual
toluene	108-88-3	Organic	TOLUENE	0	1.10E-04			0	3.00E-05			0	2.00E-05
trans-1,3-dichloropropene	10061-02-6	Organic	T13DCHLP	0	1.20E-04								
trichloroethene	79-01-6	Organic	TRICLETH	0	1.00E-04								
trichlorofluoromethane	75-69-4	Organic	TCLFLMTH	0	1.00E-04			0	3.00E-05				
vinyl chloride	75-01-4	Organic	VINLCHLR	1.00E-05	2.30E-04					1.00E-05	2.80E-04	0	3.00E-05
xylenes	1330-20-7	Organic	XYLENES	0	1.10E-04					0	1.30E-04		
1,2,3,4,6,7,8-HpCDD	35822-46-9	PCDDs, PCDFs, PCBs	HPCDD					2.60E-04	1.85E-02				
1,2,3,4,6,7,8,9-OCDD	3268-87-9	PCDDs, PCDFs, PCBs	OCDD					2.50E-04	1.69E-02				
2,3,7,8-TCDF	51207-31-9	PCDDs, PCDFs, PCBs	2378TCBF	3.80E-04	2.05E-02								
1,2,3,4,6,7,8-HpCDF	67562-39-4	PCDDs, PCDFs, PCBs	123HPCBF					2.10E-04	1.06E-02				
1,2,3,4,6,7,8,9-OCDF	39001-02-0	PCDDs, PCDFs, PCBs	OCDF					2.60E-04	1.82E-02				
3,3',4,4'-TCB (PCB 77)	32598-13-3	PCDDs, PCDFs, PCBs	3344TCB							2.30E-04	1.04E-02		
2,3',4,4',5-PeCB (PCB 118)	31508-00-6	PCDDs, PCDFs, PCBs	23445PCB							1.80E-04	7.66E-03		
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4	PCDDs, PCDFs, PCBs	23344PCB							1.80E-04	8.15E-03		
ammonia	7664-41-7	Inorganic	AMMONIA					0	2.00E-05				
chlorine	7782-50-5	Inorganic	CL2					4.00E-05	1.90E-03				
hydrogen chloride	7647-01-0	Inorganic	HCL					9.20E-04	8.17E-02	1.45E-03	9.23E-02		
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	5.70E-04	3.45E-02			2.80E-04	2.85E-02	5.50E-04	3.85E-02	3.70E-04	2.18E-02
elemental mercury	7439-97-6	Inorganic	MERCURY	0	3.00E-05			0	1.00E-05	0	3.00E-05	0	1.00E-05

**Table 3-8  
Vapor Phase Modeling Maxima Summary - Dry Deposition**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Dry Deposition (s/m <sup>2</sup> -yr)											
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS			
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual		
1,1,1-trichloroethane	71-55-6	Organic	TRICL111	0	4.00E-05										
1,1-dichloroethane	75-34-3	Organic	DCHLOR11	0	3.00E-05										
1,1-dichloroethene	75-35-4	Organic	DCHLRE11	0	5.00E-05										
1,2-dichloroethane	107-06-2	Organic	DCHLOR12	1.00E-05	5.00E-05										
1,2-dichloropropane	78-87-5	Organic	DCHLPN12	0	1.10E-04										
1,3-butadiene	106-99-0	Organic	BUTADIEN	0	1.50E-04										
1,4-dioxane	123-91-1	Organic	14DIOXAN					2.00E-05	4.60E-04						
2-butanone	78-93-3	Organic	MEK	1.00E-05	3.00E-04			1.00E-05	8.00E-05						
acetone	67-64-1	Organic	ACETONE	1.00E-05	2.90E-04			1.00E-05	8.00E-05				1.00E-05	5.00E-05	
benzene	71-43-2	Organic	BENZENE	0	9.00E-05			0	3.00E-05						
benzoic acid	65-85-0	Organic	BNZCACID	4.00E-05	1.61E-03										
benzyl alcohol	100-51-6	Organic	BNZLALCO	6.00E-05	3.37E-03										
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPH	2.30E-04	1.06E-02			1.00E-04	3.24E-03				1.00E-04	1.59E-03	
bromodichloromethane	75-27-4	Organic	BRDCLMTH	0	9.00E-05										
bromomethane	74-83-9	Organic	BROMMETH	0	4.00E-05										
carbon disulfide	75-15-0	Organic	CRBDSULF	5.00E-05	1.85E-03								3.00E-05	2.30E-04	
carbon tetrachloride	56-23-5	Organic	CRBTCHLD	0	7.00E-05										
chlorobenzene	108-90-7	Organic	CHLOBENZ	1.00E-05	2.80E-04										
chloroform	67-66-3	Organic	CHLOFORM	0	4.00E-05										

**Table 3-8  
Vapor Phase Modeling Maxima Summary - Dry Deposition (Continued)**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Dry Deposition (s/m <sup>2</sup> -yr)									
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS	
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual
chloromethane	74-87-3	Organic	CHLOMETH	0	3.00E-05			0	2.00E-05				
cis-1,3-dichloropropene	542-75-6	Organic	DCHLPR13	0	1.00E-04								
dibromochloromethane	124-48-1	Organic	DBCHLMTH	0	1.00E-04								
dichlorodifluoromethane	75-71-8	Organic	DCLFLMTH	0	9.00E-05			0	2.00E-05				
di-n-butyl phthalate	84-74-2	Organic	DINBPPTH	2.60E-04	1.23E-02			1.10E-04	4.03E-03				
di-n-octyl phthalate	117-84-0	Organic	DINOPPTH					0	6.00E-05				
ethane	74-84-0	Organic	ETHANE					0	3.00E-05				
ethanol	64-17-5	Organic	ETHANOL									3.00E-05	1.50E-04
ethylbenzene	100-41-4	Organic	ETHLBENZ	0	1.10E-04								
Freon 113	76-13-1	Organic	FREON113	0	1.00E-04								
H	505-60-2	Organic	H	1.00E-05	4.20E-04	4.00E-05	1.13E-03	1.00E-05	1.10E-04	1.00E-05	5.10E-04	1.00E-05	4.00E-05
hexane	110-54-3	Organic	HEXANE	0	6.00E-05								
methane	74-82-8	Organic	METHANE					0	3.00E-05			0	1.00E-05
methylene chloride	75-09-2	Organic	METHCHLO	1.00E-05	5.00E-05							0	2.00E-05
naphthalene	91-20-3	Organic	NAPHTHAL					4.00E-05	9.50E-04				
styrene	100-42-5	Organic	STYRENE	0	1.60E-04								
tetrachloroethene	127-18-4	Organic	TRCHLETH	1.00E-05	2.70E-04								
toluene	108-88-3	Organic	TOLUENE	0	1.10E-04			0	3.00E-05			0	2.00E-05

**Table 3-8  
Vapor Phase Modeling Maxima Summary - Dry Deposition (Continued)**

COPC	CAS	Chemical Grouping	AERMOD MODEL ID	Unitized Modeled Maximum Dry Deposition (s/m <sup>2</sup> -yr)										
				SDC1		SDC2		TDC		DAVINCH		EDS		
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	
trans-1,3-dichloropropene	10061-02-6	Organic	T13DCHLP	0	1.20E-04									
trichloroethene	79-01-6	Organic	TRICLETH	0	1.00E-04									
trichlorofluoromethane	75-69-4	Organic	TCLFLMTH	0	1.00E-04			0	3.00E-05					
vinyl chloride	75-01-4	Organic	VINLCHLR	1.00E-05	2.30E-04					1.00E-05	2.80E-04	0	3.00E-05	
xylene	1330-20-7	Organic	XYLENES	0	1.10E-04					0	1.30E-04			
1,2,3,4,6,7,8-HpCDD	35822-46-9	PCDDs, PCDFs, PCBs	HPCDD					2.60E-04	1.79E-02					
1,2,3,4,6,7,8,9-OCDD	3268-87-9	PCDDs, PCDFs, PCBs	OCDD					2.50E-04	1.67E-02					
2,3,7,8-TCDF	51207-31-9	PCDDs, PCDFs, PCBs	2378TCBF	3.80E-04	2.05E-02									
1,2,3,4,6,7,8-HpCDF	67562-39-4	PCDDs, PCDFs, PCBs	123HPCBF					2.10E-04	1.06E-02					
1,2,3,4,6,7,8,9-OCDF	39001-02-0	PCDDs, PCDFs, PCBs	OCDF					2.60E-04	1.78E-02					
3,3',4,4'-TCB (PCB 77)	32598-13-3	PCDDs, PCDFs, PCBs	3344TCB							2.30E-04	1.04E-02			
2,3',4,4',5-PeCB (PCB 118)	31508-00-6	PCDDs, PCDFs, PCBs	23445PCB							1.80E-04	7.65E-03			
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4	PCDDs, PCDFs, PCBs	23344PCB							1.80E-04	8.14E-03			
ammonia	7664-41-7	Inorganic	AMMONIA					0	2.00E-05					
chlorine	7782-50-5	Inorganic	CL2					4.00E-05	1.86E-03					
hydrogen chloride	7647-01-0	Inorganic	HCL					9.20E-04	7.68E-02	1.45E-03	8.76E-02			
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	5.10E-04	3.34E-02			2.80E-04	2.74E-02	5.00E-04	3.74E-02	3.70E-04	2.07E-02	
elemental mercury	7439-97-6	Inorganic	MERCURY	0	3.00E-05			0	1.00E-05	0	3.00E-05	0	1.00E-05	

**Table 3-9  
Vapor Phase Modeling Maxima Summary - Wet Deposition**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Wet Deposition (s/m <sup>2</sup> -yr)											
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS			
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual		
1,1,1-trichloroethane	71-55-6	Organic	TRICL111	0	0										
1,1-dichloroethane	75-34-3	Organic	DCHLOR11	0	0										
1,1-dichloroethene	75-35-4	Organic	DCHLRE11	0	0										
1,2-dichloroethane	107-06-2	Organic	DCHLOR12	0	0										
1,2-dichloropropane	78-87-5	Organic	DCHLPN12	0	0										
1,3-butadiene	106-99-0	Organic	BUTADIEN	0	0										
1,4-dioxane	123-91-1	Organic	14DIOXAN					6.00E-05	1.70E-04						
2-butanone	78-93-3	Organic	MEK	1.00E-05	3.00E-05			1.00E-05	2.00E-05						
acetone	67-64-1	Organic	ACETONE	1.00E-05	2.00E-05			1.00E-05	2.00E-05				1.00E-05	2.00E-05	
benzene	71-43-2	Organic	BENZENE	0	0			0	0						
benzoic acid	65-85-0	Organic	BNZCACID	1.00E-05	3.00E-05										
benzyl alcohol	100-51-6	Organic	BNZLALCO	1.00E-05	3.00E-05										
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPH	1.90E-04	1.03E-03			1.40E-04	9.40E-04				1.10E-04	8.60E-04	
bromodichloromethane	75-27-4	Organic	BRDCLMTH	0	0										
bromomethane	74-83-9	Organic	BROMMETH	0	0										
carbon disulfide	75-15-0	Organic	CRBDSULF	0	0								0	0	
carbon tetrachloride	56-23-5	Organic	CRBTCHLD	0	0										
chlorobenzene	108-90-7	Organic	CHLOBENZ	0	0										
chloroform	67-66-3	Organic	CHLOFORM	0	0										

**Table 3-9  
Vapor Phase Modeling Maxima Summary - Wet Deposition (Continued)**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Wet Deposition (s/m <sup>2</sup> -yr)									
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS	
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual
chloromethane	74-87-3	Organic	CHLOMETH	0	0			0	0				
cis-1,3-dichloropropene	542-75-6	Organic	DCHLPR13	0	0								
dibromochloromethane	124-48-1	Organic	DBCHLMTH	0	0								
dichlorodifluoromethane	75-71-8	Organic	DCLFLMTH	0	0			0	0				
di-n-butyl phthalate	84-74-2	Organic	DINBPHTH	2.30E-04	1.04E-03			1.70E-04	9.50E-04				
di-n-octyl phthalate	117-84-0	Organic	DINOPHTH					0	1.00E-05				
ethane	74-84-0	Organic	ETHANE					0	0				
ethanol	64-17-5	Organic	ETHANOL									4.00E-05	1.50E-04
ethylbenzene	100-41-4	Organic	ETHLBENZ	0	0								
Freon 113	76-13-1	Organic	FREON113	0	0								
H	505-60-2	Organic	H	1.00E-05	3.00E-05	1.00E-05	4.00E-05	1.00E-05	3.00E-05	1.00E-05	3.00E-05	1.00E-05	3.00E-05
hexane	110-54-3	Organic	HEXANE	0	0								
methane	74-82-8	Organic	METHANE					0	0			0	0
methylene chloride	75-09-2	Organic	METHCHLO	0	0							0	0
naphthalene	91-20-3	Organic	NAPHTHAL					0	0				
styrene	100-42-5	Organic	STYRENE	0	0								
tetrachloroethene	127-18-4	Organic	TRCHLETH	0	0								
toluene	108-88-3	Organic	TOLUENE	0	0			0	0			0	0
trans-1,3-dichloropropene	10061-02-6	Organic	T13DCHLP	0	0								

**Table 3-9  
Vapor Phase Modeling Maxima Summary - Wet Deposition (Continued)**

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Wet Deposition (s/m <sup>2</sup> -yr)									
			MODEL ID	SDC1		SDC2		TDC		DAVINCH		EDS	
				1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour	Annual
trichloroethene	79-01-6	Organic	TRICLETH	0	0								
trichlorofluoromethane	75-69-4	Organic	TCLFLMTH	0	0			0	0				
vinyl chloride	75-01-4	Organic	VINLCHLR	0	0					0	0	0	0
xylene	1330-20-7	Organic	XYLENES	0	0					0	0		
1,2,3,4,6,7,8-HpCDD	35822-46-9	PCDDs, PCDFs, PCBs	HPCDD					1.70E-04	5.80E-04				
1,2,3,4,6,7,8,9-OCDD	3268-87-9	PCDDs, PCDFs, PCBs	OCDD					4.00E-05	1.20E-04				
2,3,7,8-TCDF	51207-31-9	PCDDs, PCDFs, PCBs	2378TCBF	3.00E-05	6.00E-05								
1,2,3,4,6,7,8-HpCDF	67562-39-4	PCDDs, PCDFs, PCBs	123HPCBF					2.00E-05	6.00E-05				
1,2,3,4,6,7,8,9-OCDF	39001-02-0	PCDDs, PCDFs, PCBs	OCDF					1.50E-04	4.20E-04				
3,3',4,4'-TCB (PCB 77)	32598-13-3	PCDDs, PCDFs, PCBs	3344TCB							0	1.00E-05		
2,3',4,4',5-PeCB (PCB 118)	31508-00-6	PCDDs, PCDFs, PCBs	23445PCB							0	1.00E-05		
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4	PCDDs, PCDFs, PCBs	23344PCB							0	1.00E-05		
ammonia	7664-41-7	Inorganic	AMMONIA					0	0				
chlorine	7782-50-5	Inorganic	CL2					0	3.00E-05				
hydrogen chloride	7647-01-0	Inorganic	HCL					7.00E-04	5.85E-03	1.10E-03	6.78E-03		
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	2.30E-04	1.38E-03			1.70E-04	1.27E-03	2.50E-04	1.44E-03	1.30E-04	1.20E-03
elemental mercury	7439-97-6	Inorganic	MERCURY	0	0			0	0	0	0	0	0

#### **4.0 EXPOSURE SCENARIO IDENTIFICATION**

Individual human receptors evaluated in the risk assessment have different potential direct and indirect exposure to COPCs emitted from the EDT facility, depending on age, activities, and location. This section identifies these receptors and defines the pathways by which the receptors are exposed to the COPCs. The selected pathways and exposure scenarios described are the same as previously used for the BGCAPP risk assessment. Likewise, location was eliminated as a parameter used to define exposure scenarios by utilizing the maximum off-site impact (based on air dispersion modeling) of all receptors in the evaluated off-property assessment area. This technique effectively maximizes the estimated exposure to every individual regardless of the actual location of the resident/farmer/fisher. The use of this very conservative assumption is expected to significantly overestimate potential risk assessment impacts, but was considered appropriate for this screening level assessment. The only exception to the application of this assumption was at Lake Vega where the estimated deposition of COPCs was averaged over the entire area of the water body.

Each exposure scenario defines a particular combination of exposure pathways and the parameter values used to characterize risk and hazards. The differences between age and activity were accounted for when defining the applicable exposure scenarios. Table 4-1 presents the chronic and acute exposure pathways and exposure scenarios considered in this risk assessment. Acute exposure was evaluated for residents only. The drinking water and fish consumption pathways require site-specific data regarding water bodies and their watersheds. For this risk assessment, the source of drinking water is the Upper Kentucky River and the source for fish is Lake Vega. Default values and methodologies are identical to the previous BGCAPP risk assessment to allow comparisons between the EDT risk assessment and the BGCAPP risk assessment.

#### **4.1 Use of HHRAP Recommended Default Model Parameters**

Although the model does use some site specific data, HHRAP defaults are selected for physical constants, most agricultural parameters, soil loss parameters and many water body parameters, as listed below. Site specific data was obtained for evapotranspiration, irrigation, runoff, watershed area, impervious watershed area, depth of water bodies, rainfall factor, river velocity, volumetric flow of water bodies, and average wind speed.

Physical constants and parameters for which default values were used:

- Soil bulk density
- Drag coefficient

**Table 4-1  
Selected Exposure Scenarios and Associated Exposure Pathways**

Exposure Pathways	Exposure Scenarios						
	Farmer	Farmer Child	Adult Resident	Child Resident	Fisher	Fisher Child	Acute Risk <sup>a</sup>
Inhalation of Vapors and Particulates	X	X	X	X	X	X	X
Incidental Ingestion of Soil	X	X	X	X	X	X	
Ingestion of Homegrown Produce	X	X	X	X	X	X	
Ingestion of Homegrown Beef	X	X					
Ingestion of Milk from Homegrown Cows	X	X					
Ingestion of Homegrown Chicken	X	X					
Ingestion of Eggs from Homegrown Chickens	X	X					
Ingestion of Homegrown Pork	X	X					
Ingestion of Fish					X	X	
Ingestion of Breast Milk <sup>b</sup>	X		X		X		

Notes:

<sup>a</sup> The acute risk scenario evaluates short-term 1-hour maximum pollutant air concentrations based on hourly emission rates.

<sup>b</sup> PCDD/PCDF estimated concentrations in the three exposure scenarios indicated are utilized to model exposure to infants. Infant exposure to PCDD/PCDF via the ingestion of their mother's breast milk is evaluated as an additional exposure pathway, separately from the recommended exposure scenario.

- Von Karman constant
- Plant surface loss coefficient
- Viscosity of air and water
- Density of air, water and soil
- Universal gas constant
- Model start time (zero)
- Ambient temperature
- Duration of deposition period
- Soil water content
- Soil mixing zone depth interception fraction, growth period for edible plant fraction, and yield, each for aboveground plants, silage and forage
- Empirical correction factor for forage and silage
- Metabolism factor for BEHP
- Daily consumption each of forage, silage, grain and soil by beef cows, dairy cows, pigs, chickens for meat and chickens for eggs
- Universal soil loss equation parameters: empirical slope coefficient, cover management factor, erodibility factor, length slope factor and practice factor
- Bed sediment concentration
- Depth of upper benthic sediment layer
- Fish lipid content
- Viscous sub layer thickness
- Fraction of organic carbon in bottom sediment
- Temperature correction factor
- Bed sediment porosity
- Total suspended solids
- Water temperature
- Half life of dioxin in adults
- Fraction of ingested dioxin and dioxin-like PCBs that is stored in fat
- Fraction of mother's weight that is fat
- Fraction of mother's breast milk that is fat
- Fraction of ingested COPC that is absorbed
- Infant body weight
- Consumption rate of breast milk
- For each exposure scenario (adult and child, resident, farmer and fisher):
  - Body weight
  - Consumption rate of soil, above ground produce, protected produce, below ground produce, beef, milk, pork, egg, and chicken

- Fraction of each food raised in contaminated area
- Exposure duration, exposure frequency, exposure time
- Averaging time for cancer effects

#### **4.2 Special On-site and Off-site Water Body Considerations**

Water bodies identified as relevant include Lake Vega Reservoir which is a dammed section of Muddy Creek about 2 km southwest of the EDT facility, and the lower Kentucky River which most closely approaches the source near [REDACTED]. The modeled pollutant concentration at the receptor grid point on the lower Kentucky River that was nearest to the source was utilized as the concentration for the entire water body. Receptors were placed at 100 meter increments on the surface of Lake Vega and the results from air dispersion modeling for all receptors were averaged to yield the concentration utilized in the risk model for Lake Vega impacts.

#### **4.3 Exposure Period Considerations**

Based on guidance recommendations, the assumed duration of exposure to the modeled concentrations of COPCs vary based on age and the exposure pathway. Additionally, the operating life of the facility being evaluated must be considered in risk calculations. The adult chronic exposure scenarios were based on the assumption that an adult is located at the location of maximum impact continuously for the entire exposure duration. For adult farmers, the direct exposure to emissions by inhalation occurs for the anticipated operating life of the facility, but indirect exposure from ingestion of home-grown produce and livestock continues for 40 years. Direct exposure periods are the same for each exposure scenario, although the operating life of each of the EDT technology alternatives is slightly different (from 28 to 39 weeks as shown previously in Table 2.1). Indirect exposure for adult residents continues for 30 years, and this value is assumed to be 25 years for adult fishers. Each exposure scenario receives indirect exposure through ingestion of contaminated homegrown food and direct contact with soil and water.

Chronic exposure scenarios for all children in the assessment area are based on the assumption that a child resides at the location of maximum impact from the second through the sixth year of life. As with the adult exposure scenarios, direct exposure through inhalation of EDT emissions occurs for the operating life of the specific EDT technology alternative. During this time, the child also receives indirect exposure to the same pathways as described for adults and contaminated homegrown food. The same considerations for exposure apply to infants for the first year of life. Infants in the assessment area are assumed to be exposed to COPCs through breast milk, inhalation pathway and consumption of home-grown food.

## 5.0 TOXICITY DATA

Chemical toxicity data utilized for this MPHRA was largely based on information in the Battelle Memorial Institute's March 2012 MPHRA Report for Explosive Destruction Technology Alternatives at the Pueblo Chemical Depot. Additional toxicity data not included in the PCAPP MPHRA database were compiled based on EPA's preferred hierarchy for these types of applications.

Reference Dose values (RfDs) and Cancer Slope Factors (CSFs) were obtained from information sources based on the hierarchy of human health toxicity values described in the Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-53 (USEPA, 2003).

The recommended toxicity value hierarchy for chronic toxicity factors begins with USEPA's Integrated Risk Information System (IRIS), followed by USEPA's provisional peer reviewed toxicity values. Also recommended if data are not available from those sources, are the California EPA - Office of Environmental Health Hazard Assessment (OEHHA), Toxicity Criteria Database ATSDR Minimal Risk Levels (MRLs), and USEPA RSLs. EPA recommends OEHHA as the preferred source for Acute Inhalation Exposure Criteria.

Table 5-1 presents the toxicity database, and associated references, compiled for this MPHRA obtained from the various sources based on the hierarchy presented above.

**Table 5-1  
MPHHRA Toxicity Factors**

COPC	CAS	Chemical Grouping	AIEC	TEF	URFi	CSFo	RfC	RfDo	AIEC	TEF	URFi	CSFo	RfC	RfDo
			mg/m <sup>3</sup>	--	1/(μg/m <sup>3</sup> )	1/(mg/kg/day)	mg/m <sup>3</sup>	mg/kg/day	Data source					
1,1,1-trichloroethane	71-55-6	Organic	68				5.0E+00	2.00E+00	Cal/EPA				IRIS	IRIS
1,1-dichloroethane	75-34-3	Organic	3,000		1.63E-06	5.70E-03	4.9E-01	1.00E-01	TEEL-1		Cal/EPA	Cal/EPA	Reg 9 PRG	Reg 9 PRG
1,1-dichloroethene	75-35-4	Organic	250				2.0E-01	5.00E-02	TEEL-1				IRIS	IRIS
1,2-dichloroethane	107-06-2	Organic	202		2.60E-05	9.10E-02	4.9E-03	2.00E-02	AIHA		IRIS	IRIS	Reg 9 PRG	Reg 9 PRG
1,2-dichloropropane	78-87-5	Organic	1,000		1.94E-05	6.80E-02	4.0E-03	9.00E-02	TEEL-1		Reg 9 PRG	Reg 9 PRG	IRIS	ATSDR
1,3-butadiene	106-99-0	Organic	1,482		3.00E-05	3.40E+00	2.0E-03		AEGL-1		IRIS	RSL	IRIS	
1,4-dioxane	123-91-1	Organic	3		7.71E-06	1.10E-02	3.0E+00	1.00E-01	Cal/EPA		RSL	IRIS	Cal/EPA	ATSDR
2-butanone	78-93-3	Organic	13				5.0E+00	6.00E-01	Cal/EPA				IRIS	IRIS
acetone	67-64-1	Organic	475				3.2E+00	9.00E-01	AEGL-1				Reg 9 PRG	IRIS
benzene	71-43-2	Organic	1.3		7.71E-06	5.50E-02	3.0E-02	4.00E-03	Cal/EPA		IRIS	IRIS	IRIS	IRIS
benzoic acid	65-85-0	Organic	12.5					4.00E+00	TEEL-1					IRIS
benzyl alcohol	100-51-6	Organic	600					1.00E-01	TEEL-1					RSL
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	10		2.40E-06	1.40E-02		2.00E-02	TEEL-1		RSL	IRIS		IRIS
bromodichloromethane	75-27-4	Organic	4		3.71E-05	6.20E-02		2.00E-02	TEEL-1		RSL	IRIS		IRIS
bromomethane	74-83-9	Organic	100				5.0E-03	1.40E-03	TEEL-1				IRIS	IRIS
carbon disulfide	75-15-0	Organic	6.2				7.0E-01	1.00E-01	Cal/EPA				IRIS	IRIS
carbon tetrachloride	56-23-5	Organic	1.9		6.00E-06	7.00E-02	1.0E-01	4.00E-03	Cal/EPA		IRIS	IRIS	IRIS	IRIS
chlorobenzene	108-90-7	Organic	46				5.0E-02	2.00E-02	AEGL-1				RSL	IRIS

**Table 5-1  
MPHHRA Toxicity Factors (Continued)**

COPC	CAS	Chemical Grouping	AIEC	TEF	URFi	CSFo	RfC	RfDo	AIEC	TEF	URFi	CSFo	RfC	RfDo
			mg/m <sup>3</sup>	--	1/(μg/m <sup>3</sup> )	1/ (mg/kg/ day)	mg/m <sup>3</sup>	mg/kg/day	Data source					
chloroform	67-66-3	Organic	0.15		2.30E-05	3.1E-02	4.90E-02	1.00E-02	Cal/EPA		IRIS	Cal/EPA	Reg 9 PRG	IRIS
chloromethane	74-87-3	Organic	200				9.00E-02	2.60E-02	TEEL-1				IRIS	Reg 9 PRG
cis-1,3-dichloropropene	542-75-6	Organic	0.6		4.00E-06	1.0E-01	2.00E-02	3.00E-02	TEEL-1		IRIS	IRIS	IRIS	IRIS
dibromochloromethane	124-48-1	Organic	125		2.69E-05	8.4E-02		2.00E-02	TEEL-1		Cal/EPA	IRIS		IRIS
dichlorodifluoromethane	75-71-8	Organic	15,000				1.00E-01	2.00E-01	TEEL-1				RSL	IRIS
di-n-butyl phthalate	84-74-2	Organic	10					1.00E-01	TEEL-1					IRIS
di-n-octyl phthalate	117-84-0	Organic												
ethane	74-84-0	Organic												
ethanol	64-17-5	Organic												
ethylbenzene	100-41-4	Organic	143		2.53E-05	1.1E-02	1.00E+00	1.00E-01	AEGL-1		Cal/EPA	Cal/EPA	IRIS	IRIS
Freon 113	76-13-1	Organic	10,000				3.00E+01	3.00E+01	TEEL-1				RSL	IRIS
H	505-60-2	Organic	0.065		4.00E-03	7.7E+00	2.10E-05	7.00E-06	AEGL-1		CHPPM	CHPPM	CHPPM	CHPPM
hexane	110-54-3	Organic	1500				7.00E-01	1.10E+01	TEEL-1				IRIS	Reg 9 PRG
methane	74-82-8	Organic												
methylene chloride	75-09-2	Organic	14		1.00E-08	7.5E-03	6.00E-01	6.00E-02	Cal/EPA		IRIS	IRIS	IRIS	IRIS
naphthalene	91-20-3	Organic			3.43E-05		3.01E-03	2.00E-02					IRIS	IRIS
styrene	100-42-5	Organic	21				1.00E+00	2.00E-01	Cal/EPA				IRIS	IRIS

**Table 5-1  
MPHRA Toxicity Factors (Continued)**

COPC	CAS	Chemical Grouping	AIEC	TEF	URFi	CSFo	RfC	RfDo	AIEC	TEF	URFi	CSFo	RfC	RfDo
			mg/m <sup>3</sup>	--	1/(µg/m <sup>3</sup> )	1/(mg/kg/day)	mg/m <sup>3</sup>	mg/kg/day	Data source					
tetrachloroethene	127-18-4	Organic	20		2.60E-07	5.40E-01	4.0E-02	1.00E-02	Cal/EPA		IRIS	Reg 9 PRG	IRIS	IRIS
toluene	108-88-3	Organic	37				5.0E+00	8.00E-02	Cal/EPA				IRIS	IRIS
trans-1,3-dichloropropene	10061-02-6	Organic	75		4.00E-06	1.00E-01	1.1E-01	3.00E-02	TEEL-1		IRIS	IRIS	ATSDR	IRIS
trichloroethene	79-01-6	Organic	698		1.14E-04	4.00E-01	2.0E-03	3.00E-04	AEGL-1		IRIS	Reg 9 PRG	IRIS	Reg 9 PRG
trichlorofluoromethane	75-69-4	Organic	5000				7.0E-01	3.00E-01	TEEL-1				RSL	IRIS
vinyl chloride	75-01-4	Organic	180		4.29E-06	7.20E-01	1.0E-01	3.00E-03	Cal/EPA		IRIS	IRIS	IRIS	IRIS
xylene	1330-20-7	Organic	22				1.0E-01	2.00E-01	Cal/EPA				IRIS	IRIS
1,2,3,4,6,7,8-HpCDD	35822-46-9	PCDDs, PCDFs, PCBs	0.5	0.01					TEEL-1					
1,2,3,4,6,7,8,9-OCDD	3268-87-9	PCDDs, PCDFs, PCBs	0.01	0.0003					TEEL-1					
2,3,7,8-TCDF	51207-31-9	PCDDs, PCDFs, PCBs	0.0006	0.1					TEEL-1					
1,2,3,4,6,7,8-HpCDF	67562-39-4	PCDDs, PCDFs, PCBs	0.15	0.01					TEEL-1					
1,2,3,4,6,7,8,9-OCDF	39001-02-0	PCDDs, PCDFs, PCBs	0.0075	0.0003					TEEL-1					
3,3',4,4'-TCB (PCB 77)	32598-13-3	PCDDs, PCDFs, PCBs	0.125	0.0001			4.0E-04	1.00E-05	TEEL-1	TEQ Basis			RSL	RSL
2,3',4,4',5-PeCB (PCB 118)	31508-00-6	PCDDs, PCDFs, PCBs	0.125	0.0003			1.3E-03	3.30E-05	TEEL-1	TEQ Basis			RSL	RSL

**Table 5-1  
MPHHRA Toxicity Factors (Continued)**

COPC	CAS	Chemical Grouping	AIEC	TEF	URFi	CSFo	RfC	RfDo	AIEC	TEF	URFi	CSFo	RfC	RfDo
			mg/m <sup>3</sup>	--	1/(µg/m <sup>3</sup> )	1/(mg/kg/day)	mg/m <sup>3</sup>	mg/kg/day	Data source					
2,3,3',4,4'-PeCB (PCB 105)	32598-14-4	PCDDs, PCDFs, PCBs	0.125	3.0E-05			1.3E-03	3.30E-05	TEEL-1	TEQ Basis			RSL	RSL
ammonia	7664-41-7	Inorganic	3.2				1.0E-01		Cal/EPA				IRIS	
aluminum	91728-14-2	Inorganic	3				5.0E-03	1.00E+00	TEEL-1				RSL	ATSDR
antimony	7440-36-0	Inorganic	1.5					4.00E-04	TEEL-1					IRIS
arsenic	7440-38-2	Inorganic	0.0002		4.30E-03	1.50E+00		3.00E-04	Cal/EPA		IRIS	IRIS		IRIS
barium	7440-39-3	Inorganic	1.5				5.0E-04	2.00E-01	TEEL-1				RSL	IRIS
beryllium	7440-41-7	Inorganic	0.0035		2.40E-03		2.0E-05	2.00E-03	TEEL-1		IRIS		IRIS	IRIS
boron	7440-42-8	Inorganic	7.5				2.1E-02	2.00E-01	TEEL-1				Reg 9 PRG	IRIS
cadmium	7440-43-9	Inorganic	0.1		1.80E-03		1.0E-05	5.00E-04	AEGL-1		IRIS		ATSDR	IRIS
chlorine	7782-50-5	Inorganic	0.21				1.5E-04	1.00E-01	Cal/EPA				ATSDR	IRIS
chromium (3+)	16065-83-1	Inorganic	1					1.50E+00	TEEL-1					IRIS
chromium (6+)	18540-29-9	Inorganic			1.20E-02	5.00E-01	1.0E-04	3.00E-03			IRIS	RSL	IRIS	IRIS
cobalt	7440-48-4	Inorganic	0.3				2.4E-04	3.00E-03	TEEL-1				ATSDR	RSL
copper	7440-50-8	Inorganic	0.1					4.00E-02	Cal/EPA					RSL
hydrogen chloride	7647-01-0	Inorganic	2.1				2.0E-02		Cal/EPA				IRIS	
iron	7439-89-6	Inorganic	6					7.00E-01	TEEL-1					RSL

**Table 5-1  
MPHHRA Toxicity Factors (Continued)**

COPC	CAS	Chemical Grouping	AIEC	TEF	URFi	CSFo	RfC	RfDo	AIEC	TEF	URFi	CSFo	RfC	RfDo
			mg/m <sup>3</sup>	--	1/ (µg/m <sup>3</sup> )	1/ (mg/kg/day)	mg/m <sup>3</sup>	mg/kg/day	Data source					
lead	7439-92-1	Inorganic	0.15		1.20E-05	8.50E-03			TEEL-1		Cal/EPA	Cal/EPA		
manganese	7439-96-5	Inorganic	3				5.00E-05	1.40E-01	TEEL-1				IRIS	IRIS
mercuric chloride	7487-94-7	Inorganic	4				3.00E-05	3.00E-04	TEEL-1				RSL	IRIS
methyl mercury	22967-92-6	Inorganic	0.0322					1.00E-04	TEEL-1					IRIS
elemental mercury	7439-97-6	Inorganic	0.0006				3.00E-04		Cal/EPA				IRIS	
nickel	7440-02-0	Inorganic	0.006		2.40E-04		9.00E-05	2.00E-02	Cal/EPA		IRIS		ATSDR	IRIS
phosphorus	7723-14-0	Inorganic	3.7						AEGL-1					
selenium	7782-49-2	Inorganic	0.6				2.00E-02	5.00E-03	TEEL-1				RSL	IRIS
silver	7440-22-4	Inorganic	0.3					5.00E-03	TEEL-1					IRIS
tin	7440-31-5	Inorganic	6						TEEL-1					
vanadium	7440-62-2	Inorganic	1.5				1.04E-04	5.00E-03	TEEL-1				ATSDR	RSL
zinc	7440-66-6	Inorganic	3					3.00E-01	TEEL-1					IRIS

**Source notes:** IRIS - USEPA's Integrated Risk Information System

AEGL - 1 - Acute Exposure Guideline Level 1

Cal/EPA - California EPA, OEHHA Toxicity Criteria Database

Reg 9 PRG - USEPA Region IX PRGs 2004 Table

RSL - USEPA Risk Screening Level Tables

TEQ Basis - Cancer Risk from PCDD, PCDF's and coplanar PCB's evaluated on the basis of toxic equivalence to 2,3,7,8-TCDD, per "Recommended Toxicity Equivalence Factors for HHRA of 2,3,7,8-TCDD like Compounds".

CHPPM - "Derivation of Health-Based Environmental Screening Levels for Chemical Warfare Agents -A Technical Evaluation." March 1999, US Army Center for Health Promotion and Preventative Medicine.

TEEL -1 - United States Department of Energy (DOE) Temporary Emergency Exposure Limits.

ATSDR - The ATSDR MRLs

## 6.0 RISK RESULTS

The risk characterization for the EDT was performed in accordance with USEPA risk assessment guidelines. Air dispersion modeling results are combined with toxicity information, emissions estimates, and other site-specific information to generate risk and hazard values for individuals exposed to EDT emissions. The risk and hazard values for individuals can then be compared to acceptable benchmarks for human health. The magnitude and types of risks depend on the nature, duration, and frequency of exposure to the selected chemicals emitted from the process and the characteristics of the exposed human receptors.

This section presents the results of the EDT MPHHA. Summary results of the EDT MPHHA are presented in Section 6.4 below in a series of tables organized by EDT. Detailed MPHHA model output also is provided in Appendices 1 – 4 for EDS, TDC, DAVINCH, and SDC, respectively. Health effects results are presented in the following order: carcinogenic risk, non-carcinogenic hazard, and acute hazard. A summary of the top five COPCs contributing the majority of the EDT risk and hazard follows these health effects results.

Quantitative estimates of carcinogenic risks and non-carcinogenic hazards were calculated for direct inhalation exposures and indirect exposures to EDT emissions. Estimated total carcinogenic risk was compared to an acceptable level of 1 case in one hundred thousand ( $1 \times 10^{-5}$ ).

The typical benchmark for evaluation of the estimated long-term, non-carcinogenic hazard from airborne unit emissions is 1.0. US EPA Region 6 recommended that a hazard index benchmark of 0.25 be utilized to take background concentrations of COPCs into consideration in areas where significant industrial activity takes place. Although the BGAD location does not represent an area of significant industrial activity, hazard indices based on emissions from the EDT facility were compared against this very conservative benchmark [i.e., total non-carcinogenic hazard was compared to an acceptable hazard index (HI) of 0.25 (or total cumulative dose is less than 25 percent of the RfD)]. In addition, an acute hazard analysis was performed and the results were compared to an acceptable HI of 1.0.

Cumulative BGCAPP impacts (i.e., risks of EDT and BGCAPP main plant operating simultaneously) were also addressed by adding the results of the EDT MPHHA to the results of the previous SLHHA results and compared to the stated acceptable levels. These cumulative results are tabulated and presented below in Section 6.6.

Additionally, utilizing the HHRAP Guidance for evaluation of dioxin/furan compounds, a nursing infant's estimated daily intake of 2, 3, 7, 8-TCDD TEQ was also calculated based on its mother's exposure, for each adult chronic exposure scenario for each EDT alternative for which there were estimated dioxin/furan emissions. A summary of these exposure estimates is provided in Table 6-1. Based on the HHRAP Guidance, an average daily intake of 1 pg TEQ/kg-day or less for adults, and 60 pg TEQ/kg-day or less for nursing infants do not pose a significant concern for adverse health-effects. Since the highest average daily intake of 2, 3, 7, 8-TCDD estimated in this screening assessment was 0.0002 pg TEQ/kg-day versus an allowable intake of 1 pg TEQ/kg-day, COPC emissions of dioxin-like PCBs, PCDDs, and PCDFs from any of the EDT alternatives are unlikely to cause adverse non-carcinogenic health-effects.

### **6.1 Characterization of Carcinogenic Health Effects**

Carcinogenic risk is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to specified emissions. For this risk assessment, carcinogenic risk is estimated as an incremental probability of fatal cancer from exposure to emissions from each EDT alternative for specific potential carcinogens (i.e., excess individual lifetime cancer risk). Carcinogenic risk is estimated from both direct and indirect exposures as described in Section 4.0 of this report. The toxicity factors related to carcinogens presented in Table 5-1 were used to develop this estimate.

### **6.2 Characterization of Non-Carcinogenic Health Effects**

For COPCs with non-carcinogenic effects, the potential for non-carcinogenic toxic effects in an individual is evaluated by comparing the estimated exposure level over a specified time period with the appropriate non-cancer reference dose, also presented in Table 5-1 as RfD. The non-carcinogenic hazard quotient (HQ) is a unitless value that considers a threshold exposure limit that below which health effects are not expected to occur. Sensitive populations are considered in this benchmark. HQs represent a non-carcinogenic hazard associated with an individual COPC and a specific exposure pathway.

Both direct and indirect exposures are considered in the estimation of non-cancer health effects. HQs for direct exposures to COPCs are calculated by dividing the inhalation intake of a COPC by the inhalation reference dose (RfD) for that COPC. HQs for indirect exposures to COPCs are calculated similarly, and incorporate the averaging time for non-carcinogenic health effects.

A Hazard Index (HI) is generated by summing HQ's for all selected COPCs for a given receptor.

**Table 6-1  
Impacts from Dioxin-Like PCBs, PCDDs, and PCDFs**

<b>Exposure Scenario</b>	<b>Location</b>	<b>Benchmark pg TEQ/kg/day</b>	<b>I_teq pg TEQ/kg/day</b>	<b>I_bmilk pg TEQ/kg/day</b>
<b>TDC Alternative</b>				
Adult Resident	Rmax	1	4.84E-08	1.4114E-06
Child Resident	Rmax	60	1.34E-07	
Fisher	Rmax	1	4.88E-08	1.4216E-06
Fisher Child	Rmax	60	1.35E-07	
Farmer	Fmax	1	9.83E-08	2.8662E-06
Farmer Child	Fmax	60	2.07E-07	
<b>DAVINCH Alternative</b>				
Adult Resident	Rmax	1	9.33E-12	2.72E-10
Child Resident	Rmax	60	2.60E-11	
Fisher	Rmax	1	1.26E-11	3.67E-10
Fisher Child	Rmax	60	2.83E-11	
Farmer	Fmax	1	3.88E-09	1.13E-07
Farmer Child	Fmax	60	5.56E-09	
<b>SDC Alternative</b>				
Adult Resident	Rmax	1	3.11E-08	9.07E-07
Child Resident	Rmax	60	8.67E-08	
Fisher	Rmax	1	4.31E-08	1.25E-06
Fisher Child	Rmax	60	9.51E-08	
Farmer	Fmax	1	6.61E-06	<b>1.93E-04</b>
Farmer Child	Fmax	60	9.48E-06	

### **6.3 Characterization of Acute Health Effects**

Potential acute hazards associated with short-term emission release events were evaluated for each COPC. The acute HQ (HQA) represents the hazard associated with short-term direct exposure to each COPC in air during a short-term emission release event. HQAs for each COPC were summed to calculate the overall acute HI (HIA).

### **6.4 Results for Each EDT Technology**

Overall risk and hazard results are provided with all pertinent assumptions, input constants, and conditions in Appendices 1-4. The tables included in the following sections provide summary information and clarification of results

#### *6.4.1 EDS Results*

Table 6-2 presents the total carcinogenic and non-carcinogenic risks estimated for each human receptor by pathway, including acute exposure. Table 6-3 identifies the COPC responsible for the maximum impact for each pathway for each exposure scenario.

#### *6.4.2 TDC Results*

Table 6-4 presents the total carcinogenic and non-carcinogenic risks estimated for each human receptor by pathway, including acute exposure. Table 6-5 identifies the COPC responsible for the maximum impact for each pathway for each exposure scenario.

#### *6.4.3 DAVINCH Results*

Table 6-6 presents the total carcinogenic and non-carcinogenic risks estimated for each human receptor by pathway, including acute exposure. Table 6-7 identifies the COPC responsible for the maximum impact for each pathway for each exposure scenario.

#### *6.4.4 SDC Results*

Table 6-8 presents the total carcinogenic and non-carcinogenic risks estimated for each human receptor by pathway, including acute exposure. Table 6-9 identifies the COPC responsible for the maximum impact for each pathway for each exposure scenario.

### **6.5 Summary and Cumulative EDT and BGCAPP Risk and Hazard Results**

Table 6-10 provides a summary of the carcinogenic risks, non-carcinogenic hazards, and acute hazards, for all of the EDTs. This table includes the baseline results previously obtained when conducting the BGCAPP SLHHRA and compares the total impacts to acceptable levels. None of the EDT technologies is expected to result in impacts, individually or in addition to 2010

estimated BGCAPP impacts that exceed acceptable limits. In fact, the results of cumulative risk from both sources are well below threshold values.

The results for both cumulative non-carcinogenic and cumulative carcinogenic risk calculations are approximately one-tenth or less of the established, generally accepted and recommended (i.e., for areas of industrial activity) bench marks. The air modeling and risk calculations clearly indicate that unacceptable non-carcinogenic or carcinogenic health effects are not expected. This conclusion (i.e., adverse health effects are not expected due to BGCAPP and EDT emissions) is further strengthened by the use of very conservative assumptions which over-estimated the chronic and acute health hazards while also overestimating the cancer risks posed by BGCAPP and EDT air emissions. The results of this MPHRA are summarized in the Table 6-11.

**Table 6-2  
Total Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology**

Exposure Scenario	Scenario Location	Cancer Risk (Benchmark = 1E-05)			Total Hazard Index (Benchmark = 0.25)		
		Oral	Inhalation	Total	Oral	Inhalation	Total
Adult Resident	Rmax	1.94E-12	3.03E-10	3.05E-10	0.00000008	0.00000839	0.00000848
Child Resident	Rmax	8.65E-13	6.06E-11	6.15E-11	0.00000019	0.00000839	0.00000858
Fisher	Rmax	2.08E-12	3.03E-10	3.05E-10	0.00000009	0.00000839	0.00000848
Fisher Child	Rmax	8.86E-13	6.06E-11	6.15E-11	0.00000019	0.00000839	0.00000858
Farmer	Fmax	2.70E-12	4.04E-10	4.07E-10	0.00000009	0.00000839	0.00000848
Farmer Child	Fmax	8.92E-13	6.06E-11	6.15E-11	0.00000019	0.00000839	0.00000859
Acute Exposure	Amax	--	--	--	--	0.00001038	--

**Table 6-3  
Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	COPC	Max HQ	COPC
Adult Resident	inhalation	3.02E-10	H	8.38E-06	H
	oral	1.92E-12	H	8.33E-08	H
	soil	4.35E-19	H	1.88E-14	H
	produce	4.98E-16	H	2.16E-11	H
Child Resident	inhalation	6.03E-11	H	8.38E-06	H
	oral	8.60E-13	H	1.86E-07	H
	soil	8.13E-19	H	1.76E-13	H
	produce	2.43E-16	H	5.26E-11	H
Fisher	inhalation	3.02E-10	H	8.38E-06	H
	oral	2.07E-12	H	8.97E-08	H
	soil	4.35E-19	H	1.88E-14	H
	produce	4.98E-16	H	2.16E-11	H
	fish	1.47E-13	H	6.37E-09	H

**Table 6-3  
Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	COPC	Max HQ	COPC
Fisher Child	inhalation	6.03E-11	H	8.38E-06	H
	oral	8.80E-13	H	1.91E-07	H
	soil	8.13E-19	H	1.76E-13	H
	produce	2.43E-16	H	5.26E-11	H
	fish	2.07E-14	H	4.49E-09	H
Farmer	inhalation	4.02E-10	H	8.38E-06	H
	oral	2.69E-12	H	8.73E-08	H
	soil	1.09E-20	H	1.88E-14	H
	produce	2.01E-15	H	8.78E-11	H
	beef	2.62E-14	H	8.53E-10	H
	milk	9.37E-14	H	3.05E-09	H
	pork	9.96E-16	H	3.27E-11	H
	egg	4.26E-21	H	7.38E-15	H
	chicken	6.57E-21	H	1.14E-14	H

**Table 6-3**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	COPC	Max HQ	COPC
Farmer Child	inhalation	6.03E-11	H	8.38E-06	H
	oral	8.86E-13	H	1.92E-07	H
	soil	8.13E-19	H	1.76E-13	H
	produce	9.78E-16	H	2.12E-10	H
	beef	2.42E-15	H	5.24E-10	H
	milk	2.34E-14	H	5.06E-09	H
	pork	1.15E-16	H	2.50E-11	H
	egg	2.45E-20	H	5.31E-15	H
	chicken	3.58E-20	H	7.76E-15	H
Acute Exposure	inh	NA	NA	0.0000	Methane

**Table 6-4**  
**Total Carcinogenic Risk and Non-carcinogenic Hazard – DAVINCH Technology**

Exposure Scenario	Scenario Location	Cancer Risk (Benchmark = 1E-05)			Total Hazard Index (Benchmark = 0.25)		
		Oral	Inhalation	Total	Oral	Inhalation	Total
Adult Resident	Rmax	4.80E-10	1.96E-08	2.01E-08	0.000021	0.000660	0.000681
Child Resident	Rmax	2.29E-10	3.93E-09	4.16E-09	0.000050	0.000660	0.000710
Fisher	Rmax	4.81E-10	1.96E-08	2.01E-08	0.000021	0.000660	0.000681
Fisher Child	Rmax	2.29E-10	3.93E-09	4.16E-09	0.000050	0.000660	0.000710
Farmer	Fmax	6.41E-09	2.62E-08	3.26E-08	0.000208	0.000660	0.000868
Farmer Child	Fmax	1.50E-09	3.93E-09	5.43E-09	0.000325	0.000660	0.000985
Acute Exposure	Amax	--	--	--	--	0.000246	--

**Table 6-5  
Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – DAVINCH Technology**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Adult Resident	inhalation	1.96E-08	H	5.45E-04	H
	oral	4.80E-10	H	2.08E-05	H
	soil	2.92E-16	H	1.26E-11	H
	produce	4.19E-10	H	1.81E-05	H
Child Resident	inhalation	3.93E-09	H	5.45E-04	H
	oral	2.29E-10	H	4.96E-05	H
	soil	5.45E-16	H	1.18E-10	H
	produce	2.02E-10	H	4.37E-05	H
Fisher	inhalation	1.96E-08	H	0.00055	H
	oral	4.81E-10	H	2.08E-05	H
	soil	2.92E-16	H	1.26E-11	H
	produce	4.19E-10	H	1.81E-05	H
	fish	7.47E-13	H	3.23E-08	H

**Table 6-5**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – DAVINCH Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Fisher Child	inhalation	3.93E-09	H	5.45E-04	H
	oral	2.29E-10	H	4.96E-05	H
	soil	5.45E-16	H	1.18E-10	H
	produce	2.02E-10	H	4.37E-05	H
	fish	1.05E-13	H	2.28E-08	H
Farmer	inhalation	2.62E-08	H	5.45E-04	H
	oral	6.41E-09	H	2.08E-04	H
	soil	6.07E-18	H	1.26E-11	H
	produce	8.20E-10	H	2.67E-05	H
	beef	1.20E-09	H	3.90E-05	H
	milk	4.28E-09	H	1.39E-04	H
	pork	2.84E-11	H	9.23E-07	H
	egg	2.38E-18	H	4.95E-12	H
	chicken	3.66E-18	H	7.64E-12	H

**Table 6-5**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – DAVINCH Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Farmer Child	inhalation	3.93E-09	H	5.45E-04	H
	oral	1.50E-09	H	3.25E-04	H
	soil	5.45E-16	H	1.18E-10	H
	produce	2.96E-10	H	6.41E-05	H
	beef	1.11E-10	H	2.40E-05	H
	milk	1.07E-09	H	2.31E-04	H
	pork	3.26E-12	H	7.05E-07	H
	egg	1.65E-17	H	3.57E-12	H
	chicken	2.40E-17	H	5.21E-12	H
Acute Exposure	inh	NA	NA	2.13E-04	hydrogen chloride

**Table 6-6  
Total Carcinogenic Risk and Non-carcinogenic Hazard – TDC Technology**

Exposure Scenario	Scenario Location	Cancer Risk (Benchmark = 1E-05)			Total Hazard Index (Benchmark = 0.25)		
		Oral	Inhalation	Total	Oral	Inhalation	Total
Adult Resident	Rmax	1.60E-10	2.41E-08	2.42E-08	0.000007	0.001194	0.001201
Child Resident	Rmax	7.17E-11	4.81E-09	4.89E-09	0.000015	0.001194	0.001209
Fisher	Rmax	1.72E-10	2.41E-08	2.42E-08	0.000007	0.001194	0.001201
Fisher Child	Rmax	7.33E-11	4.81E-09	4.89E-09	0.000015	0.001194	0.001209
Farmer	Fmax	8.19E-09	3.21E-08	4.03E-08	0.000060	0.001194	0.001254
Farmer Child	Fmax	1.78E-09	4.81E-09	6.60E-09	0.000093	0.001194	0.001287
Acute Exposure	Amax	--	--	--	--	0.000831	--

**Table 6-7**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – TDC Technology**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Adult Resident	inhalation	2.32E-08	H	6.45E-04	H
	oral	1.50E-10	H	6.48E-06	H
	soil	3.52E-15	bis(2-ethylhexyl)-phthalate	8.60E-09	mercuric chloride
	produce	6.35E-12	1,4-dioxane	1.17E-07	mercuric chloride
Child Resident	inhalation	4.64E-09	H	6.45E-04	H
	oral	6.69E-11	H	1.45E-05	H
	soil	6.58E-15	bis(2-ethylhexyl)-phthalate	8.03E-08	mercuric chloride
	produce	2.82E-12	1,4-dioxane	2.61E-07	mercuric chloride
Fisher	inhalation	2.32E-08	H	6.45E-04	H
	oral	1.61E-10	H	6.98E-06	H
	soil	3.52E-15	bis(2-ethylhexyl)-phthalate	8.60E-09	mercuric chloride
	produce	6.35E-12	1,4-dioxane	1.17E-07	mercuric chloride
	fish	1.14E-11	H	4.92E-07	H

**Table 6-7**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – TDC Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Fisher Child	inhalation	4.64E-09	H	6.45E-04	H
	oral	6.85E-11	H	1.48E-05	H
	soil	6.58E-15	bis(2-ethylhexyl)-phthalate	8.03E-08	mercuric chloride
	produce	2.82E-12	1,4-dioxane	2.61E-07	mercuric chloride
	fish	1.60E-12	H	3.46E-07	H
Farmer	inhalation	3.10E-08	H	6.45E-04	H
	oral	7.97E-09	bis(2-ethylhexyl)-phthalate	4.98E-05	bis(2-ethylhexyl)-phthalate
	soil	9.84E-17	bis(2-ethylhexyl)-phthalate	8.60E-09	mercuric chloride
	produce	1.99E-11	bis(2-ethylhexyl)-phthalate	1.63E-06	mercuric chloride
	beef	1.72E-09	bis(2-ethylhexyl)-phthalate	1.08E-05	bis(2-ethylhexyl)-phthalate
	milk	6.16E-09	bis(2-ethylhexyl)-phthalate	3.85E-05	bis(2-ethylhexyl)-phthalate
	pork	6.49E-11	bis(2-ethylhexyl)-phthalate	4.06E-07	bis(2-ethylhexyl)-phthalate
	egg	2.67E-17	bis(2-ethylhexyl)-phthalate	2.58E-09	mercuric chloride
	chicken	4.11E-17	bis(2-ethylhexyl)-phthalate	2.27E-09	mercuric chloride

**Table 6-7**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – TDC Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Farmer Child	inhalation	4.64E-09	H	6.45E-04	H
	oral	1.71E-09	bis(2-ethylhexyl)-phthalate	7.12E-05	bis(2-ethylhexyl)-phthalate
	soil	6.58E-15	bis(2-ethylhexyl)-phthalate	8.03E-08	mercuric chloride
	produce	7.24E-12	bis(2-ethylhexyl)-phthalate	3.90E-06	mercuric chloride
	beef	1.59E-10	bis(2-ethylhexyl)-phthalate	6.62E-06	bis(2-ethylhexyl)-phthalate
	milk	1.53E-09	bis(2-ethylhexyl)-phthalate	6.39E-05	bis(2-ethylhexyl)-phthalate
	pork	7.44E-12	bis(2-ethylhexyl)-phthalate	3.10E-07	bis(2-ethylhexyl)-phthalate
	egg	1.37E-16	bis(2-ethylhexyl)-phthalate	1.86E-09	mercuric chloride
	chicken	2.00E-16	bis(2-ethylhexyl)-phthalate	1.55E-09	mercuric chloride
Acute Exposure	inh	NA	NA	5.22E-04	elemental mercury

**Table 6-8**  
**Total Carcinogenic Risk and Non-carcinogenic Hazard – SDC Technology**

Exposure Scenario	Scenario Location	Cancer Risk (Benchmark = 1E-05)			Total Hazard Index (Benchmark = 0.25)		
		Oral	Inhalation	Total	Oral	Inhalation	Total
Adult Resident	Rmax	2.48E-12	4.62E-10	4.65E-10	0.00000010	0.00001121	0.00001131
Child Resident	Rmax	1.11E-12	9.24E-11	9.35E-11	0.00000022	0.00001121	0.00001144
Fisher	Rmax	2.67E-12	4.62E-10	4.65E-10	0.00000011	0.00001121	0.00001132
Fisher Child	Rmax	1.14E-12	9.24E-11	9.36E-11	0.00000023	0.00001121	0.00001144
Farmer	Fmax	7.65E-10	6.16E-10	1.38E-09	0.00000496	0.00001121	0.00001617
Farmer Child	Fmax	1.64E-10	9.24E-11	2.57E-10	0.00000716	0.00001121	0.00001838
Acute Exposure	Amax	--	--	--	--	0.00039477	--

**Table 6-9  
Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – SDC Technology**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Adult Resident	inhalation	3.40E-10	H	9.45E-06	H
	oral	2.20E-12	H	9.52E-08	H
	soil	2.85E-16	bis(2-ethylhexyl)-phthalate	2.84E-12	bis(2-ethylhexyl)-phthalate
	produce	1.72E-13	bis(2-ethylhexyl)-phthalate	1.44E-09	bis(2-ethylhexyl)-phthalate
Child Resident	inhalation	6.80E-11	H	9.45E-06	H
	oral	9.82E-13	H	2.13E-07	H
	soil	5.33E-16	bis(2-ethylhexyl)-phthalate	2.65E-11	bis(2-ethylhexyl)-phthalate
	produce	8.26E-14	bis(2-ethylhexyl)-phthalate	3.47E-09	bis(2-ethylhexyl)-phthalate
Fisher	inhalation	3.40E-10	H	9.45E-06	H
	oral	2.36E-12	H	1.02E-07	H
	soil	2.85E-16	bis(2-ethylhexyl)-phthalate	2.84E-12	bis(2-ethylhexyl)-phthalate
	produce	1.72E-13	bis(2-ethylhexyl)-phthalate	1.44E-09	bis(2-ethylhexyl)-phthalate
	fish	1.66E-13	H	7.21E-09	H

**Table 6-9**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – SDC Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Fisher Child	inhalation	6.80E-11	H	9.45E-06	H
	oral	1.01E-12	H	2.18E-07	H
	soil	5.33E-16	bis(2-ethylhexyl)-phthalate	2.65E-11	bis(2-ethylhexyl)-phthalate
	produce	8.26E-14	bis(2-ethylhexyl)-phthalate	3.47E-09	bis(2-ethylhexyl)-phthalate
	fish	2.34E-14	H	5.07E-09	H
Farmer	inhalation	4.54E-10	H	9.45E-06	H
	oral	7.62E-10	bis(2-ethylhexyl)-phthalate	4.76E-06	bis(2-ethylhexyl)-phthalate
	soil	6.23E-18	bis(2-ethylhexyl)-phthalate	2.84E-12	bis(2-ethylhexyl)-phthalate
	produce	1.87E-12	bis(2-ethylhexyl)-phthalate	1.18E-08	bis(2-ethylhexyl)-phthalate
	beef	1.65E-10	bis(2-ethylhexyl)-phthalate	1.03E-06	bis(2-ethylhexyl)-phthalate
	milk	5.89E-10	bis(2-ethylhexyl)-phthalate	3.68E-06	bis(2-ethylhexyl)-phthalate
	pork	6.21E-12	bis(2-ethylhexyl)-phthalate	3.88E-08	bis(2-ethylhexyl)-phthalate
	egg	1.69E-18	bis(2-ethylhexyl)-phthalate	7.70E-13	bis(2-ethylhexyl)-phthalate
	chicken	2.60E-18	bis(2-ethylhexyl)-phthalate	1.19E-12	bis(2-ethylhexyl)-phthalate

**Table 6-9**  
**Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – SDC Technology (Continued)**

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	From COPC	Max HQ	From COPC
Farmer Child	inhalation	6.80E-11	H	9.45E-06	H
	oral	1.63E-10	bis(2-ethylhexyl)-phthalate	6.80E-06	bis(2-ethylhexyl)-phthalate
	soil	5.33E-16	bis(2-ethylhexyl)-phthalate	2.65E-11	bis(2-ethylhexyl)-phthalate
	produce	6.78E-13	bis(2-ethylhexyl)-phthalate	2.83E-08	bis(2-ethylhexyl)-phthalate
	beef	1.52E-11	bis(2-ethylhexyl)-phthalate	6.33E-07	bis(2-ethylhexyl)-phthalate
	milk	1.47E-10	bis(2-ethylhexyl)-phthalate	6.11E-06	bis(2-ethylhexyl)-phthalate
	pork	7.11E-13	bis(2-ethylhexyl)-phthalate	2.96E-08	bis(2-ethylhexyl)-phthalate
	egg	1.11E-17	bis(2-ethylhexyl)-phthalate	5.55E-13	bis(2-ethylhexyl)-phthalate
	chicken	1.62E-17	bis(2-ethylhexyl)-phthalate	8.09E-13	bis(2-ethylhexyl)-phthalate
Acute Exposure	inh	NA	NA	3.00E-04	H

**Table 6-10**  
**Summary of Incremental EDT Impacts and Cumulative BGCAPP Impacts**

Hazard and Risk Characterization from EDT Facility Only									
Exposure Scenario	Scenario Location	Total Cancer Risk (Benchmark = 1E-05)				Total Hazard Index (Benchmark = 0.25)			
		Davinch	EDS	TDC	SDC	Davinch	EDS	TDC	SDC
Adult Resident	Rmax	2.01E-08	3.05E-10	2.42E-08	4.65E-10	0.000681	0.0000085	0.00120	0.000011
Child Resident	Rmax	4.16E-09	6.15E-11	4.89E-09	9.35E-11	0.000710	0.0000086	0.00121	0.000011
Fisher	Rmax	2.01E-08	3.05E-10	2.42E-08	4.65E-10	0.000681	0.0000085	0.00120	0.000011
Fisher Child	Rmax	4.16E-09	6.15E-11	4.89E-09	9.36E-11	0.000710	0.0000086	0.00121	0.000011
Farmer	Fmax	<b>3.26E-08</b>	<b>4.07E-10</b>	<b>4.03E-08</b>	<b>1.38E-09</b>	0.000868	0.0000085	0.00125	0.000016
Farmer Child	Fmax	5.43E-09	6.15E-11	6.60E-09	2.57E-10	<b>0.000985</b>	<b>0.0000086</b>	<b>0.00129</b>	<b>0.000018</b>
Acute Exposure	Amax	--	--	--	--	0.000246	0.0000104	<b>0.00083</b>	0.000395
Worst-Case Hazard and Risk Characterization from EDT Facility and BGCAPP Facility									
Farmer	Fmax	2.13E-07	1.80E-07	<b>2.20E-07</b>	1.81E-07				
Farmer Child	Fmax					0.013385	0.0124086	<b>0.01369</b>	0.012418
Acute Exposure	Amax	--	--	--	--	0.025846	0.0256104	<b>0.02643</b>	0.025995

Notes:

- <sup>a</sup> US EPA Region 6 recommends that a hazard index benchmark of 0.25 be utilized to account for COPCs (compounds of potential concern) in areas with industrial activity. Although significant industrial activities do not exist near BGCAPP, this very conservative benchmark was used for comparison to emissions to ensure risks were not underestimated.
- <sup>b</sup> The acute risk assessment scenario evaluates short-term 1-hour maximum air concentrations based on hourly emission rates. Inhalation is the route of exposure.

**Table 6-11**  
**Summary Results of Multi-Pathway Human Health Risk Assessment**

<b>Effect</b>	<b>Maximum Calculated Value</b>	<b>Benchmark for Comparison</b>	<b>Exposure with Highest Value</b>
Non-carcinogenic Chronic Health Effect	HQ=0.01369	HI=0.25 <sup>a</sup>	Farmer Child
Non-carcinogenic Acute Health Effect	AHQ=0.02643	HI=0.25 <sup>a</sup>	Acute Risk <sup>b</sup>
Increased Carcinogenic Risk	2.2x10 <sup>-7</sup>	1.0x10 <sup>-5</sup>	Adult Farmer

Notes:

- <sup>a</sup> U.S. EPA Region 6 recommends that a hazard index benchmark of 0.25 be utilized to account for COPCs (compounds of potential concern) in areas with industrial activity. Although significant industrial activities do not exist near BGCAPP, this very conservative benchmark was used for comparison to emissions ensure risks were not underestimated.
- <sup>b</sup> The acute risk assessment scenario evaluates short-term 1-hour maximum air concentrations based on hourly emission rates. Inhalation is the route of exposure.

## **7.0 UNCERTAINTY IN HUMAN HEALTH RISK ASSESSMENT**

This section of the report includes a discussion on interpreting the inherent uncertainty associated with risk assessment activities. Since the potential for the introduction of uncertainty is evident at every step of the risk assessment process, conservatism is utilized for many point values and assumptions, to ensure that the overall risk and hazard estimation overestimates the potential for health effects. Based on this approach, there is great potential for overstating risk and hazard due to the integration of so many conservative approximations throughout the risk assessment. In general, if a risk assessment yields results that indicate greater than acceptable levels of risk or hazard, these conservative assumptions are reevaluated. If using site-specific information can minimize this uncertainty, the conservative assumptions may be replaced with more realistic site-specific data or conditions. A screening level risk assessment generally includes more conservative approximations than a complete multi-pathway site specific risk assessment. This MPHRA incorporates many layers of conservatism. The overall risk assessment results did NOT indicate a need to further refine these conservative assumptions to more closely approximate site-specific conditions. Therefore, all of the initial conservative assumptions will be maintained in the risk assessment and this section of the report will focus on the identification of the assumptions that may be responsible for the greatest areas of overestimation of risk and hazard.

Additionally, this section of the report discusses some of the types of uncertainty in any risk assessment, as well as uncertainties introduced as a result of unknowns for this specific project. A thorough discussion of the uncertainties inherent in the process enables the reviewer to more accurately evaluate the conservative nature of the SLHRA. The discussion includes the types of uncertainty, areas of introduction, and methods for qualitatively and quantitatively addressing uncertainty in the risk assessment.

### **7.1 Types of Uncertainty**

The four types of uncertainty are:

1. Variable uncertainty,
2. Model uncertainty,
3. Decision-rule uncertainty, and
4. Variability.

Each of these uncertainties is addressed in the sections that follow.

### 7.1.1 Variable Uncertainty

Variable uncertainty involves the conservatism resulting from the assumption of equation variables that cannot be measured with accuracy or precision. Model variables for each EDT are provided in the respective appendices to the report. Many variables are shown in the appendices that are assumed for processes regardless of the site conditions. Some of these variables are biotransfer coefficients for various food products and values related to erosion and soil characteristics. Variable uncertainty is discussed in Appendices B and C of the HHRAP guidance. In these appendices, variable uncertainty is addressed specifically for many of the equations. For example, in Table B-3-9 the uncertainty associated with the variable  $Br_{forage}$ , which is a plant-soil bio-concentration factor for forage, silage, and grain, includes the following: “U.S. EPA OSW recommends that uptake of organic COPCs from soil and transport of the COPCs to aboveground plant parts be calculated on the basis of a regression equation developed in a study of the uptake of 29 organic compounds. This regression equation, developed by Travis and Arms (1988), may not accurately represent the behavior of all classes of organic COPCs under site-specific conditions.”

The selection of emission rates for each of the EDT alternatives represents variable uncertainty specific to this MPHHR. For example, 0.2 times the VSL of mustard (H) was utilized as a continuous HD emission rate during the processing of overpacks and rejects. The EDT processes are not continuous operations, and therefore a continuous HD emission rate cannot be produced. Even given an HD leak, the HD emission would eventually be stopped when the leak was discovered or the munition treated. In the case of the EDS, overpacks are unpacked before processing, but this again cannot produce continuous emissions of the magnitude used in the MPHHR. Since the emissions of this individual COPC accounted for a number of the maximum impacts in the MPHHR (See Tables 6-3, 6-5, 6-7, and 6-9), the overestimation of this compound is a significant source of uncertainty and overestimation of risk/hazard.

For the SDC and TDC emission rates, information provided by the equipment vendors and used for this MPHHR are based on the quantitation limit, reporting level, or detection level during the test in which that COPC was identified. Therefore, emission rates provided may significantly overestimate risks for those compounds. Likewise, TDC PCDD/PCDF emission rates were obtained by scaling up emission test data by an assumed factor of 4 to account for the ratio of agent feed rates for the 155-mm, while the true feed ratio for 155-mm munitions may be lower than that value. This assumption also introduces uncertainty and the potential for overestimation of the overall risk/ hazard result.

### *7.1.2 Model Uncertainty*

Model uncertainty includes a wide variety of uncertainty associated with the inaccuracies of using surrogates for actual real-world data. Some examples are:

1. Using animal surrogates for carcinogenicity in humans,
2. Extrapolation of values in dose-response models,
3. Estimating fate and transport values for COPCs by computer modeling, and
4. Simplification of environmental processes due to modeling limitations.

Specific examples of model uncertainty include existing health problems of area residents. For instance, lung function and susceptibility are altered by smoking and asthma. Because the model does not account for this, risk from direct inhalation may be underestimated.

This risk assessment utilizes the widely-accepted AERMOD air dispersion model instead of ISCST, which was historically used and has more direct guidance techniques for use as a companion to the risk model. Although it is widely accepted that AERMOD much more accurately predicts the behavior of pollutants in the atmosphere and their ground-level concentrations, the use of this model also introduces new techniques that have not been as thoroughly tested for use in risk assessments.

### *7.1.3 Decision-Rule Uncertainty*

Decision-rule uncertainty is related to the selection of compounds that are evaluated in the risk assessment and the use of recommended default values for inhalation, consumption, body mass, and health benchmarks.

### *7.1.4 Variability*

The use of Agency-verified cancer SFs and RfDs/RfCs are considered under both Decision-Rule Uncertainty and Variability. These health benchmarks are used as single-point estimates throughout the analysis; and uncertainty and variability are both associated with them. U.S. EPA has developed a process for setting verified health benchmark values to be used in all Agency risk assessments. This process is used to account for much of the uncertainty and variability associated with the health benchmarks. With the exception of the dioxin toxicity equivalency methodology, health benchmarks can be found on EPA-recommended toxicity databases. These sources (IRIS, in particular), have been verified through Agency work groups. Estimating the uncertainty in using Agency-verified health benchmarks or the dioxin toxicity equivalency methodology is beyond the scope of this MPHRA.

## **7.2 Qualitative Uncertainty**

Many of the uncertainties associated with risk assessment can be discussed qualitatively, but not quantitatively. Examples of qualitative uncertainty include: actual periods of exposure as compared to default values, use of COPCs with uncharacterized toxicity data, or a lack of data related to a particular modeled parameter.

## **7.3 Quantitative Uncertainty**

If a screening level risk assessment indicates that an unacceptable risk or hazard may result from the equipment, an attempt is made to quantify the uncertainties associated with the risk assessment that have known error levels.

Based on the availability of data, and the appropriateness of the specific process, one of two procedures is used to develop a quantitative result. Either statistical values, as deemed appropriate by sample type or size, are used; or, a probability distribution is created for this purpose. The end result of the process will be a calculated distribution of exposure, risk, or hazard. Probabilistic distributions will be presented in the risk assessment report, if appropriate, as Cumulative Probability Density Functions (CPF<sub>s</sub>). At this time, the results of the MPH<sub>2</sub>HRA do not indicate that such a thorough handling of uncertainty is needed so quantitative uncertainty estimates will not be performed.

## **8.0 CONCLUSION/RECOMMENDATION**

No further refinement of the risks/hazards of the proposed EDT facility (e.g., refinement of the air dispersion modeling parameters, nor additional risk evaluation) is needed due to the overall favorable results of this risk assessment. Calculations of risk/hazard developed using estimated facility emissions and the conservative assumptions made in this risk assessment also do not indicate that additional sampling to refine the concentration of pollutants in air emissions is necessary.