8.0 SUMMARY AND CONCLUSIONS

The Load Line 4 Phase II RI Report presents a detailed analysis of the environmental data collected during the Phase I and II RI field efforts. The following sections present an overview of the major findings of the nature and extent of contamination, modeling of contaminant fate and transport, and human health and ERAs. A revised site-specific conceptual model is presented to integrate results of the evaluations presented in this report. The CSM denotes, based on available data, where source areas occur, the mechanisms for contaminant migration from source areas to receptor media (e.g., streams and groundwater), and exit pathways from the AOC. The conclusions of the Phase II RI are presented by media, with an emphasis on the degree of contamination and the potential risks to human receptors.

8.1 SUMMARY

8.1.1 Contaminant Nature and Extent

The Phase II RI evaluated the nature and extent of contamination in surface soil from 0 to 0.3 m (0 to 1 ft) bgs, subsurface soil from 0.3 to 0.9 m (1 to 3 ft) bgs, sediment, surface water, groundwater, storm and sanitary sewers, and selected buildings and structures.

8.1.1.1 Data aggregates/exposure units and data reduction

Surface and subsurface soil, sediments, and surface water were further divided into spatial aggregates based on AOC operational history, proximity of sampling stations to source areas, drainage patterns, and viability of aquatic habitat. These aggregates form the basis for EUs evaluated in the human health and ecological risk evaluations (Chapters 6.0 and 7.0, respectively). Surface soil and subsurface soil were divided into six aggregates based on the criteria above. The aggregates demarcate areas believed to be impacted by different process-related activities, as well as areas believed to be relatively non-contaminated.

Sediment and surface water were grouped based on drainage patterns (e.g., upstream versus downstream) and to focus on the receptor exposure points for the human health and ecological risk evaluations. Sediments collected from intermittent, primarily dry drainage conveyances were addressed as surface soil media in the nature and extent evaluation and risk evaluations. A few surface water samples collected from intermittent ditches or puddles were considered as non-viable ecological habitat and addressed as a separate miscellaneous surface water aggregate. Groundwater was evaluated on an AOC-wide basis. Storm and sanitary sewer systems, and samples from buildings and structures, were also considered separately in the nature and extent evaluation; these samples were not subjected to risk evaluations, as they are not representative of the exposure scenarios (e.g., recreational, NGB, or residential) evaluated in this RI.

Summary statistics for data within each aggregate were calculated for the purposes of identifying SRCs. SRCs were identified by screening data against frequency of detection criteria, essential human nutrient criteria, and RVAAP facility-wide background values for inorganics. The nature and extent evaluation focused on only those constituents identified as site-related.

8.1.1.2 Surface soil

A total of 82 surface soil samples from 0- to 0.3-m (0- to 1-ft) depth were collected for the purpose of determining nature and extent of surface soil contamination across Load Line 4. Within the production area of the load line, sampling locations were biased to the building perimeters and drainage conveyances where contaminants most likely would have accumulated over time. Random-grid sampling was applied in non-production areas (Perimeter Area Aggregate).

Explosive and propellant compounds in surface soil at Load Line 4 are relatively few in number, concentrations are comparatively low relative to Load Lines 1 through 3, and extent is limited to the immediate proximity of source areas. Pervasive inorganic SRCs in surface soil include barium, cadmium, chromium, copper, lead, thallium, and zinc. SVOCs detected in surface soil were primarily PAHs, which were observed frequently although at generally low concentrations. Few VOCs were detected in surface soil samples from Load Line 4 and concentrations were generally low. PCBs are not nearly as widespread as compared to the other melt-pour load lines at RVAAP. Some pesticides were detected sporadically at low concentrations.

Explosives Handling Area Aggregate

This EU contained the highest concentrations and most extensive SRCs within Load Line 4. Explosives within this aggregate are limited in extent to the proximity of the major production and processing buildings. Concentrations were generally low, with a maximum detected value of 19 mg/kg for RDX near Building G-8. Numerous inorganic SRCs were identified in this aggregate; aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, and zinc were most pervasive. SVOCs were detected frequently, although the highest concentrations were clustered near Building G-8 and along the walkway between Building G-8 and Building G-12. VOCs are generally absent in this aggregate. Generally low concentrations of PCBs were detected at a number of samples with the highest concentrations (up to 28 mg/kg) clustered in the vicinity of the former production buildings. Low concentrations of pesticides were detected.

Preparation and Receiving Areas Aggregate

Contaminants in surface soil in this aggregate were limited primarily to inorganics. Explosives were not detected in samples submitted for laboratory analysis. Nitrocellulose was present at low concentrations at one location north of Building G-1A. Pervasive inorganic SRCs include arsenic, barium, chromium, cobalt, copper, cyanide, lead, manganese, nickel, vanadium, and zinc. Although their distribution is widely variable, the highest overall concentrations of inorganics appear to be clustered on the south side of Building G-4. Low concentrations of a few PAHs were detected; most observed detections were clustered near Building G-4. PCBs appear to be clustered near Building G-4 at concentrations up to 48 mg/kg. VOCs are generally absent. No pesticides were detected.

Packaging and Shipping Areas Aggregate

Contaminants in surface soil in this aggregate were also limited primarily to inorganics. Explosives were not detected in this aggregate. Nitrocellulose was detected in one sample south of Building G-19. Pervasive inorganic SRCs include barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, thallium, and zinc. SVOCs (primarily PAHs) were detected in only two samples with the highest concentrations occurring near Building G-19. Low levels of PCBs (up to 1.3 mg/kg) and trace levels of pesticides were observed in the vicinity of Building G-19. VOCs, with exception of trace levels of toluene, were not detected.

Change Houses Aggregate

Surface soil in this EU is relatively uncontaminated. No explosives compounds greater than 1 mg/kg were detected during field analyses. Few inorganic results exceeded RVAAP background values; lead occurred at the highest concentrations. Low estimated concentrations of 16 PAHs and 3 VOCs were detected on the east side of Building G-6. PCB-1260 was detected once at an estimated concentration of 0.059 mg/kg in a sample collected on the east side of Building G-6. Pesticides were not detected in this aggregate.

Perimeter Area Aggregate

Surface soil in this EU contained little contamination, with the exception of the immediate vicinity of the WW-23 Water Tower Area. Field analyses of samples collected near the WW-23 Water Tower detected TNT at concentrations up to 2.8 mg/kg. Few background exceedances for inorganics were observed in the Perimeter Area Aggregate. Inorganics greater than background were clustered in the vicinity of the WW-23 Water Tower with lead occurring most frequently at concentrations up to 1,340 mg/kg. Low, estimated concentrations of several PAHs and bis(2-ethylhexyl)phthalate were detected at station LL4-068, near the WW-23 Water Tower. VOCs, with the exception of trace levels of toluene, were not detected.

Melt-Pour Drainage Ditches Aggregate

Surface soil in this EU also exhibited little contamination. No explosives compounds were detected at a concentration of 1.0 mg/kg or greater during field analyses. Extent and distribution of inorganic SRCs in this aggregate were limited and maximum concentrations rarely exceeded background values by factors of more than 2 times. Low, estimated concentrations of several PAHs were detected in one sample. VOCs, with exception of trace levels of acetone, were not detected.

8.1.1.3 Subsurface soil

A total of 11 soil samples from 0.3- to 0.9-m (1- to 3-ft) depths were collected based on field analyses of explosives to determine the nature and extent of subsurface soil contamination and to assess vertical migration. Based on Phase II RI data, contamination in subsurface soil within Load Line 4 is limited, with inorganics representing the primary SRCs. Explosives and propellants were not detected. Metals detected at concentrations exceeding background criteria include barium, beryllium, cadmium, lead, and zinc. The highest concentrations of metals above background occur in the vicinity of Building G-1A in the Preparation and Receiving Areas Aggregate and Building G-9 in the Explosives Handling Areas Aggregate.

8.1.1.4 Sediment and surface water

Sediment in Main Stream and Settling Pond Exposure Units

Explosive compounds were detected in sediment samples, although at concentrations less than 1 mg/kg. Inorganic SRCs were identified in sediment; however, the maximum concentrations for all detected constituents were only between 2 and 3 times established background criteria. Cadmium was detected in sediment collected from all three EUs established within the main stream and settling pond, although all values were estimated concentrations of 1 mg/kg or less. The number and concentrations of inorganics are greatest in sediment within the settling pond. One PCB compound was detected at a concentration of less than 0.5 mg/kg. Pesticides and SVOCs were not detected in sediment. VOCs were only sporadically detected at low concentrations.

Surface Water in Main Stream and Settling Pond Exposure Units

Explosives were not detected in water samples collected from any of the three EUs established within the main stream and settling pond. Vanadium and manganese were the only two inorganic SRCs detected consistently in surface water above background criteria; maximum concentrations of manganese occurred within the aggregate upstream of the Load Line 4 Perimeter Road. The pesticide 4,4’-DDT was detected in one water sample from the settling pond; no SVOCs or PCBs were detected. VOCs were only sporadically detected at low concentrations.

8.1.1.5 Groundwater

Groundwater at Load Line 4 contains few contaminants that can be related to historical operations. Explosives, propellants, pesticides, and PCBs were not detected. Low concentrations of metals identified as SRCs were observed; however, their occurrence and distribution above background criteria were sporadic. One SVOC and two VOCs were detected at low, estimated concentrations detected in three groundwater samples collected from monitoring wells in Load Line 4.

8.1.1.6 Storm and sanitary sewer system

Accumulation of explosives in sediment within the storm and sanitary sewer systems is not evident based on Phase II RI results. Trace levels of RDX; 2-amino-4,6-DNT and 4-amino-2,6-DNT were detected in water collected from three manholes. Sediment collected from several manholes contained inorganic SRCs at concentrations between 5 and 9 times RVAAP background values for sediment. Associated water samples from several of these manholes contained inorganics that were also elevated in the associated sediment samples. Low levels of PAHs, PCBs, and pesticides were detected in the sewer system sediment samples; these constituents were not detected in corresponding water samples. VOCs are generally absent in sediment and water within the storm and sanitary sewer systems.

8.1.1.7 Buildings and structures

Soil collected from beneath building sub-floors is generally uncontaminated, based upon a limited number of samples collected from beneath building floor slabs.

Sediment collected from the Building G-8 washout basin contained elevated levels of metals, explosives, propellants, PCBs, and pesticides. The associated water sample contained elevated levels of many constituents observed at high concentrations in sediment.

Sediment collected from the Building G-16 sedimentation basin contained elevated concentrations of several metals related to historical processes (chromium, copper, and lead). No water was present within this basin.

Floor sweep samples were comprised of a high percentage of iron. Copper, cadmium, chromium, and lead were present at high concentrations. Low concentrations of explosives were detected only in samples collected from Buildings G-8 and G-19. Low concentrations of PCBs, pesticides, and various PAHs were also detected. Cadmium and lead were detected in TCLP extracts; however, no constituent exceeded their respective criteria for characteristically hazardous wastes.

8.1.2 Contaminant Fate and Transport

Contaminant fate and transport modeling performed as part of the Phase II RI included leachate modeling (SESOIL) at the source area within Load Line 4 demonstrating the highest levels of process-related contaminants (Building G-8 vicinity). Groundwater modeling (AT123D) was conducted from this source to selected receptors or exit points from the AOC. The receptor and exit points selected for groundwater transport modeling included the main stream at its closest point to Building G-8; the main stream is the nearest presumed groundwater baseflow discharge point. In addition, groundwater transport modeling from the source area to the RVAAP facility boundary was conducted to evaluate the potential for off-site migration of any identified CMCOPCs.

SESOIL Modeling

Chromium, selenium, and RDX were the only chemicals identified as initial CMCOPCs based on source loading predicted by the leachability analysis near the selected primary source (Building G-8). The SESOIL modeling results indicate that all of these three constituents may leach from surface soil to groundwater with concentrations beneath the source area above groundwater MCLs or RBCs. The timeframe for RDX to exceed its criteria is 6 years, suggesting that such leaching has already occurred. The timeframes for chromium and selenium are 411 and 119 years, respectively, suggesting that concentrations may increase in the future. None of these constituents were detected in groundwater at Load Line 4. The leaching modeling is conservative and migration of these constituents may be attenuated because of moderate to high retardation factors for these constituents.

AT123D Modeling

Modeling of contaminant transport in shallow groundwater was conducted for five identified CMCOPCs (chromium, selenium, and RDX from SESOIL modeling results, and iron and manganese based on observed groundwater concentration) from the Building G-8 source area (Table L-13) to two endpoints. The first endpoint evaluated was the main stream at the closest point to the source area; the main stream is presumed to be a discharge area for shallow groundwater based on potentiometric data. The second endpoint modeled was the RVAAP facility boundary at its closest point downgradient of the source area.

AT123D modeling results indicate that migration of RDX to the main stream endpoint may occur with concentrations at the endpoint above RBCs. None of the metals (chromium, iron, manganese, and selenium) were predicted to exceed RBCs or MCLs at the main stream within the 1,000-year model period. Modeling results indicated that migration of the five CMCOPCs to the RVAAP boundary endpoint at concentrations exceeding MCLs or RBCs will not occur within the 1,000-year modeling period.

8.1.3 Human Health Risk Evaluation

A SHHRA was conducted to identify COCs and RGOs for contaminated media at the RVAAP Load Line 4 AOC for three potential future use scenarios: National Guard use, recreational use, and residential use. Results have been presented for all scenarios and exposure pathways. The following steps were used to generate conclusions regarding human health risks and hazards associated with contaminated media at Load Line 4:

- identification of COPCs,
- calculation of EPCs for COPCs,
- calculation of screening RGOs,
- identification of COCs, and
- calculation of risk-based RGOs to move forward to the FS.

COCs are determined for National Guard receptors (Trainee, Security Guard/Maintenance Worker, and Fire/Dust Suppression Worker), recreational receptors (Hunter/Trapper/Fisher), and residential receptors (Resident Subsistence Farmer Adult and Child). A COC summary is presented in Table 8-1, with results discussed below for each medium. Risk-based RGOs have been calculated and presented for all medium-specific COCs (see Tables 6-5 through 6-10). Risk-based RGOs are calculated for all chemicals identified as COCs for any receptor [e.g., arsenic is identified as a COC in surface water for the National Guard Trainee and for the Resident Farmer (adult and child), but not for the Fire/Dust Suppression Worker or the Hunter/Trapper/Fisher; however, risk-based RGOs are calculated for this metal for all five receptors exposed to surface water].

Table 8-1. Chemicals Exceeding RGOs (COCs) by Receptor/Medium/Exposure Unit Combination at Load Line 4

COC	Groundwater			Surface Water					Sediment				
	National Guard Trainee	Resident Farmer Adult	Resident Farmer Child	Dust/Fire Control Worker	National Guard Trainee	Hunter/ Trapper/ Fisher	Resident Farmer Adult	Resident Farmer Child	Dust/Fire Control Worker	National Guard Trainee	Hunter/ Trapper/ Fisher	Resident Farmer Adult	Resident Farmer Child
Inorganics													
Aluminum										MS			MS
Arsenic	LL4	LL4	LL4		MU		MU	MU					
Manganese	LL4	LL4	LL4		MU		MU	MU					
Thallium													MS
Organic PCBs													
PCB-1254													
PCB-1260													
Organic Pesticides													
4,4'-DDT					MS		MS	MS					
Organic Semivolatiles													
Benz(*a*)anthracene													
Benzo(*a*)pyrene													
Benzo(*b*)fluoranthene													
Dibenz(*a,h*)anthracene													
Indeno(1,2,3-*cd*)pyrene													

Table 8-1. Chemicals Exceeding RGOs (COCs) by Receptor/Medium/Exposure Unit Combination at Load Line 4 (continued)

	Shallow Surface Soil					Deep Surface Soil	Subsurface Soil	
COC	Security Guard/ Maintenance Worker	Dust/Fire Control Worker	Hunter/ Trapper/ Fisher	Resident Farmer Adult	Resident Farmer Child	National Guard Trainee	Resident Farmer Adult	Resident Farmer Child
Inorganics								
Aluminum					EH	EH,PR		PR
Arsenic	EH,MP,PR			EH,MP,PR	EH,MP,PR	EH,MP,PR		
Manganese					EH,PA,PR,PS	EH,PA,PR,PS	PR	PR
Thallium					CH,EH,MP,PR			
Organic PCBs								
PCB-1254	EH,PR			EH,PR,PS	EH,PR,PS	PR		
PCB-1260	EH,PR			EH,PR,PS	EH,PR,PS			
Organic Pesticides								
4,4'-DDT								
Organic Semivolatiles								
Benz(*a*)anthracene				EH				
Benzo(*a*)pyrene	CH,EH,PA			CH,EH,PA,PS	CH,EH,PA,PS			
Benzo(*b*)fluoranthene	EH			CH,EH	EH			
Dibenz(*a,h*)anthracene	EH			CH,EH	EH			
Indeno(1,2,3-*cd*)pyrene				EH				

COCs are shown for each medium/receptor/area of concern combination. Chemicals whose exposure point concentration exceeds its screening risk-based RGO are COCs. Area of concern codes are as follows:

- LL4 = Load Line 4.
- CH = Change Houses Aggregate.
- ED = Exit Drainage Aggregate.
- EH = Explosives Handling Areas Aggregate.
- MP = Melt-Pour Area Drainage Ditches Aggregate.
- MS = Main Stream Segment and Settling Pond Aggregate.
- MU = Main Stream Segment Upstream of Perimeter Road Aggregate.
- PA = Perimeter Area Aggregate.
- PR = Preparation and Receiving Areas Aggregate.
- PS = Packaging and Shipping Areas Aggregate.

COC = Chemical of concern.
DDT = Dichlorodipheyltrichloroethane.
PCB = Polychlorinated biphenyl.
RGO = Remedial goal option. Screening risk-based RGOs are based on a cancer risk level of 10^{-6} or a hazard level of 0.1 (whichever is smaller) and are shown in Tables Q-10 through Q-15. Screening of Load Line 3 data to determine COCs is shown in Tables Q-16 through Q-21.

8.1.3.1 Groundwater

Two COCs (arsenic and manganese) were identified for the National Guard Trainee exposed via potable use of groundwater; these COCs were also identified for the On-Site Residential Farmer scenarios. For these groundwater COCs, ratios of EPCs to RGOs indicate that estimated cancer risks would be slightly greater than 10^{-5} for the National Guard Trainee and slightly greater than 10^{-4} for the residential farmer scenarios. These are hypothetical future scenarios; no receptors are currently using groundwater from the AOC for any purpose.

8.1.3.2 Surface water and sediment

Exposure to surface water and sediment was evaluated for five receptor scenarios: National Guard Fire/Dust Suppression Worker, National Guard Trainee, Hunter/Trapper/Fisher, and Resident Farmer (adult and child). The following summarizes the resulting COCs in surface water and sediment at Load Line 4.

- Three Load Line 4 COCs were identified for the National Guard Trainee exposed to surface water, including two metals (arsenic and manganese) and one pesticide (4,4'-DDT). All three COCs were also identified for the On-Site Residential Farmer scenarios. Two COCs (arsenic and manganese) were identified for the Main Stream Segment Upstream of Perimeter Road Bridge Aggregate and one COC (4,4'-DDT) was identified for the Main Stream Segment Downstream of Perimeter Road Bridge and the Settling Pond Aggregate; no surface water COCs were identified for the Exit Drainage Aggregate. For the surface water COCs, ratios of EPCs to RGOs indicate that estimated cancer risks would be less than 10^{-6} for the Fire/Dust Suppression Worker and the Hunter/Trapper/Fisher and between 10^{-6} and 10^{-5} for the National Guard Trainee and the residential farmer scenarios.

- Aluminum was the only COC identified for the National Guard Trainee exposed to sediment; this COC and thallium were also identified for the On-Site Residential Farmer Child. Both COCs were identified for the Main Stream Segment Downstream of Perimeter Road Bridge and the Settling Pond Aggregate; no sediment COCs were identified for the Main Stream Segment Upstream of Perimeter Road Bridge or the Exit Drainage Aggregates. Aluminum and thallium are both non-carcinogenic chemicals.

8.1.3.3 Soil

Soil was evaluated at six EUs. Direct contact (ingestion, dermal contact, and inhalation) with surface and subsurface soils was evaluated for six receptors: National Guard Security Guard/Maintenance Worker (shallow surface soil), National Guard Fire/Dust Suppression Worker (shallow surface soil), National Guard Trainee (deep surface soil), Hunter/Trapper/Fisher (shallow surface soil), and Resident Farmer (adult and child) (shallow surface soil and subsurface soil). The following summarizes the resulting COCs in soil at Load Line 4.

Shallow surface soil

Eleven Load Line 4 COCs were identified for shallow surface soil, including four metals (aluminum, arsenic, manganese, and thallium), two PCBs (PCB-1254 and PCB-1260), and five PAHs [benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene]. The number of shallow surface soil COCs varied for each receptor: none for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher; six COCs for the Security Guard/Maintenance Worker; eight COCs for the Resident Farmer Adult; and nine COCs for the Resident Farmer Child. The number of shallow surface soil COCs identified for each EU also varied: 2 for both the Melt-Pour Drainage Ditches and Perimeter Area Aggregates; 4 for both the Packaging and Shipping Areas and the Change Houses Aggregates; 5 for the Preparation and Receiving Areas Aggregate; and 11 for the Explosives Handling Areas Aggregate.

Ratios of EPCs to RGOs provide an indication of estimated cancer risks. All estimated risks for shallow surface soil COCs would be less than 10^{-6} for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher. For the Security Guard/Maintenance Worker, most COCs would produce a cancer risk at or slightly above 10^{-6}, with one exception: the estimated cancer risk would be slightly larger than 10^{-5} for PCB-1254 in the Preparation and Receiving Areas Aggregate. For the resident farmer scenarios, estimated cancer risks would exceed 10^{-5} for several shallow surface soil COCs, including arsenic in the Explosives Handling Areas, the Preparation and Receiving Areas, and the Melt-Pour Drainage Ditches Aggregates; PCB-1254 in the Preparation and Receiving Areas Aggregate; PCB-1260 in the Explosives Handling Areas Aggregate; and benzo(*a*)pyrene in the Explosives Handling Areas Aggregate.

Deep surface soil

Four Load Line 4 COCs were identified for the National Guard Trainee exposed to deep surface soil, including three metals (aluminum, arsenic, and manganese), and one PCB (PCB-1254). The number of deep surface soil COCs identified for each EU varied: none for the Change Houses Aggregate; one for the Melt-Pour Drainage Ditches, the Packaging and Shipping Areas, and the Perimeter Area Aggregates; three for the Explosives Handling Areas Aggregate; and four for the Preparation and Receiving Areas Aggregate.

Ratios of EPCs to RGOs indicate that estimated cancer risks would be below 10^{-6} for most deep surface soil COCs; two COCs would result in estimated cancer risk to the National Guard Trainee of slightly larger than 10^{-6} at the Explosives Handling Areas Aggregate (arsenic); at the Preparation and Receiving Areas Aggregate (arsenic and PCB-1254); and at the Melt-Pour Drainage Ditches Aggregate (arsenic).

Subsurface soil

Two metals were identified as Load Line 4 subsurface soil COCs for the resident farmer scenarios: aluminum and manganese. The COCs were identified for the Preparation and Receiving Areas Aggregate only; no subsurface soil COCs were identified for the Explosives Handling Areas, Packaging and Shipping Areas, and the Perimeter Area Aggregates. Aluminum and manganese are both non-carcinogenic chemicals.

8.1.4 Ecological Risk Evaluation

The Load Line 4 site contains sufficient terrestrial and aquatic (surface water and sediment) habitat to support various classes of ecological receptors such as vegetation, small and large mammals, and birds. Due to the presence of suitable habitat and observed receptors at the site, a SERA was performed. The SERA was performed in accordance with written guidance from the USACE, Louisville District and Ohio EPA, and also utilized Ohio's water quality standard. Following the SERA, a Level III BERA was performed on the preliminary COPECs. The methods followed the Army and Ohio EPA protocols and resulted in COECs. Groundwater was not evaluated considering that direct exposure to receptors would be expected to occur as discharge to surface water features. Soil deeper than 0.3 m (1 ft) was also not evaluated considering that contaminant concentrations in surface soil represent the probable worst-case exposures for most contaminants. (See Section 7.11.4, in which a comparison is made and a conclusion reached of no influence to HQs.) A BERA followed the SERA. BERA activities depended on the following ecological receptors: vegetation, soil invertebrates, cottontail rabbits, shrews, foxes, and hawks.

8.1.4.1 Soil

Risks were evaluated for five EUs for surface soil based on historical use and geographic proximity, as described in Section 4.1.2 and Chapter 7.0. At all EUs, except the Melt-Pour Area Drainage Ditches Aggregate, most preliminary COPECs were identified by comparing the maximum detection to the ESV. Few constituents were identified as COPECs due to lack of an ESV; only PCB-1254 at three of the four EUs. All of these preliminary COPECs were further evaluated by having HQs calculated (Section 7.7). There were no new analytes detected at Load Line 4 compared to Load Line 1.

The Explosives Handling Areas Aggregate contained the most preliminary COPECs for soil (16 metals, 2 pesticides, and 1 PCB), whereas the Perimeter Area Aggregate had the fewest preliminary COPECs for soil (5 metals). The Preparation and Receiving Areas Aggregate and Packaging and Shipping Areas Aggregate tied for having the second highest number of preliminary COPECs (seven metals and one PCB). The Melt-Pour Area Drainage Ditches Aggregate had eight metals that were identified as preliminary COPECs. A summary of the Load Line 4 soil preliminary COPECs, organized by EUs, and the rationales for why the analytes were preliminary COPECs is presented in Chapter 7.0, Table 7-8. BERA activities reduced the number of COPECs in all locations. The Explosives Handling Areas Aggregate had 10 COECs (down from 19 COPECs in the SERA), the Preparation and Receiving Areas Aggregate showed 7 (was previously 8), and the Packaging and Shipping Areas Aggregate had 7 (previously 8). The Melt-Pour Area Drainage Ditches Aggregate remained one of the two lowest locations with four COECs (down from eight) and the Perimeter Area Aggregate was also intermediate with four (previously five). A summary of Load Line 4 soil COECs is provided in Table 7-12.

8.1.4.2 Sediment and Surface Water

Sediment

The Main Stream Segment and Settling Pond Aggregate contained the most preliminary COPECs for sediment (11 metals and 1 explosive), whereas the Exit Drainages Aggregate had the fewest preliminary COPECs for sediment (1 metal and 1 PCB). The Main Stream Segment Upstream of Perimeter Road Aggregate had the second highest number of preliminary COPECs (four metals and one explosive). At all EUs, except the Exit Drainage Aggregate, the rationale that was responsible for identifying the most preliminary COPECs was no ESV. The rationale that was responsible for identifying the fewest preliminary COPECs was maximum detection > ESV, which only identified cadmium and nickel at the Main Stream Segment and Settling Pond Aggregate. All of these preliminary COPECs were further evaluated by having HQs calculated. A summary of the Load Line 4 sediment preliminary COPECs and the rationales for why the analytes were preliminary COPECs is presented in Chapter 7.0, Table 7-9. BERA activities utilized the following ecological receptors: benthic invertebrates, riparian herbivores (muskrats and mallards), and riparian carnivores (mink and herons). BERA activities reduced the number of COPECs in all three locations. For example, at the Main Stream Segment and Settling Pond Aggregate there were 4 COECs (down from 12 COPECs from the SERA). Further, at the Main Stream Segment Upstream of Perimeter Road Aggregate there is one COEC (down from five) and at the Exit Drainage Aggregte there is one COEC (previously two COPECs). A summary of Load Line 4 sediment COECs is provided in Table 7-12.

Surface Water

The Main Stream Segment Upstream of Perimeter Road Aggregate contained the most preliminary COPECs for surface water (seven metals), whereas the Main Stream Segment and Settling Pond Aggregate and the Exit Drainages Aggregate each had two preliminary COPECs. At all EUs, except the Main Stream Segment and Settling Pond Aggregate, the rationale that was responsible for identifying the most preliminary COPECs was no ESV. The rationale that was responsible for identifying the fewest preliminary COPECs was maximum detection > ESV, which only identified two metals at one EU, one pesticide at another EU, and no preliminary COPECs at the Exit Drainages Aggregate. All of these preliminary COPECs were further evaluated by having HQs calculated. A summary of the Load Line 4 surface water preliminary COPECs and the rationales for why the analytes were preliminary COPECs is presented in Chapter 7.0, Table 7-10. BERA activities used the following ecological receptors: aquatic life, riparian herbivores (muskrats and mallards), and riparian carnivores (mink and herons). BERA activities further screened the seven COPECs to two COECs at the Main Stream Segment Upstream of Perimeter Road Aggregate. Further, at the Main Stream Segment and Settling Pond Aggregate there were two COECs (same as the previously listed two COPECs) and at the Exit Drainage Aggregate there were no COECs (down from two COPCEs). A summary of Load Line 4 surface water COECs is provided in Table 7-13.

8.2 CONCEPTUAL SITE MODEL

The preliminary Load Line 4 CSM, developed as part of the Phase II RI SAP Addendum, was summarized in Chapter 2.0. A revised CSM is presented in this section that incorporates Phase II RI data and the results of contaminant fate and transport modeling and risk evaluations. Elements of the CSM include

- primary contaminant source areas and release mechanisms,
- contaminant migration pathways and exit points, and
- data gaps and uncertainties.

An illustrated version of the revised CSM is provided in Figure 8-1 to assist in visualizing the concepts discussed below.

8.2.1 Source-Term and Release Mechanisms

Results of the Phase II RI soil sampling indicate that the Explosives Handling Areas Aggregate, particularly areas surrounding Building G-8, contain the greatest numbers and concentrations of contaminants. Metals, explosives, PAHs, and PCBs/pesticides are present in soil in these areas at concentrations greater than background or risk-screening criteria. Other source areas defined by Phase II RI data include the vicinity of Building G-4 (inorganics and PCBs), the WW-23 Water Tower (primarily elevated inorganics), and the vicinity of Building G-19 (PAHs, low levels of nitrocellulose, and inorganics). Inorganic contaminants and SVOCs were observed in other locations; however, their distribution is sporadic.

The majority of soil contamination at Load Line 4 is within the surface soil interval less than a depth of 0.3 m (1.0 ft). Explosives were not detected in subsurface soil; some inorganics in subsurface soil exceed background criteria to varying degrees, primarily in the vicinity of Building G-1A in the Preparation and Receiving Areas Aggregate and Building G-9 in the Explosives Handling Areas Aggregate.

Two primary mechanisms for release of contaminants from the source areas are identified (1) erosional and/or dissolved phase transport of contaminants from soil sources with transport into the storm drain network or drainage ditches, and (2) leaching of constituents to groundwater via infiltration of rainwater through surface and subsurface soils. Evaluation of these release mechanisms was done through sampling of storm drainage network (ditches and storm sewers) and numerical modeling of soil leaching processes. Discussion of the results of evaluation of data for preferred contaminant migration pathways and exit

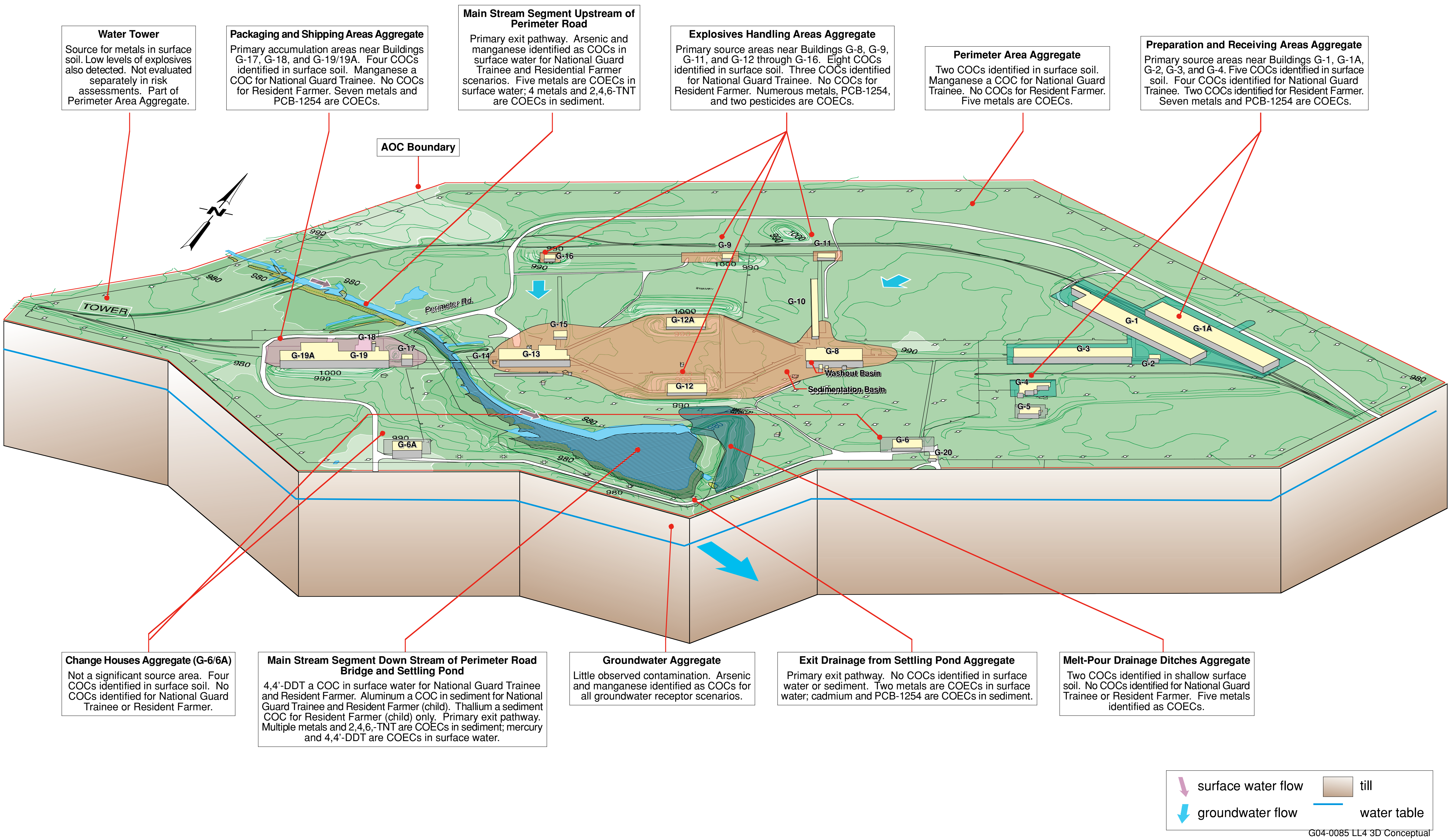

Figure 8-1 Conceptual Site Model for Load Line 4

points is presented below. Airborne dispersion of contaminants was not quantified or modeled. The chemical characteristics of the SRCs present high, annual precipitation levels, and heavy vegetation cover at Load Line 4 likely precludes any substantial dispersion of contaminants via this pathway.

8.2.2 Contaminant Migration Pathways and Exit Points

Surface Water Pathways

Migration of contaminants from soil sources via surface water occurs primarily by (1) movement of particle-bound (e.g., clays or colloids) contaminants in surface water runoff, and (2) transport of dissolved constituents in surface water. Surface runoff is directed to drainage ditches and the storm drainage network, most of which terminate at the main stream or settling pond within the AOC. The main stream flows from northwest to southeast across the AOC and eventually exits the facility at PF-8.

Upon reaching quiescent portions of surface water conveyances, flow velocities decrease and particle-bound contaminants are expected to settle out as sediment accumulation. Sediment-bound contaminants may be re-mobilized during storm events. Sediment-bound contaminants may also partition to surface water and be transported in dissolved phase. Sampling of the dry sediment from the Melt-Pour Area Drainage Ditches Aggregate indicates minimal contaminant accumulation from the Explosives Handling Areas and sedimentation basin through these conveyances into the main stream that exits the AOC to the south. Results of sediment and water sampling from the storm sewer network indicate very little accumulation of explosives in sediment and only trace concentrations in water; however, inorganics and low levels of PCBs do appear to have accumulated. Some inorganics in storm sewer sediment appear to be partitioning to water. The sanitary sewer system is a closed system (except where pipes may be cracked) and is not open to receiving substantial surface water runoff.

Substantial contaminant accumulation within the main stream and settling pond is not evident based on Phase I and II RI data. Accumulated explosive compounds were less than 1 mg/kg in stream and pond sediment and partitioning to water with subsequent dissolved phase transport is not evident. SVOCs and PCBs were not detected in stream and pond sediment. Inorganic SRCs were detected in stream and pond sediment and the highest concentrations appear to have accumulated within the settling pond. However, the magnitude of background exceedances is generally low and partitioning of contaminants from sediment to water is not evident based on available data. The highest observed concentrations for inorganics relative to background occurred in the Main Stream Segment Upstream of Perimeter Road Aggregate.

Leaching and Groundwater Pathways

Theoretical numerical modeling of leaching potential for soil source areas indicates that only chromium, selenium, and RDX may be expected to leach from the contaminated surface soil into the groundwater and reach concentrations exceeding groundwater MCLs or RBCs. The absence of these constituents and lack of overall substantial contamination in groundwater at Load Line 4 suggest that retardation processes (e.g., sorption, degradation, etc.) effectively attenuate contaminants within the vadose zone. Iron and manganese were observed in groundwater above secondary MCLs; therefore, they were also considered as CMCOPCs.

Shallow groundwater flow follows stream drainage and topographic patterns with flow to the south toward the AOC and RVAAP boundaries. Modeling results indicate that migration of RDX via shallow groundwater to the main stream closest to the major sources at concentrations above RBCs may occur. None of the metals (chromium, iron, manganese, and selenium) were predicted to exceed RBCs or MCLs at the main stream within the 1,000-year modeling period. Modeling results indicated that migration of the five CMCOPCs to the RVAAP boundary endpoint at concentrations exceeding MCLs or RBCs will not occur within the 1,000-year modeling period. However, the lack of detectable RDX in groundwater suggests that the conservative modeling results do not fully represent retardation and attenuation effects in the subsurface.

Given that a portion of the storm and sanitary sewer system at Load Line 4 is flooded, these utility networks may serve as preferential conduits for shallow groundwater movement. These systems were evaluated to determine if they facilitate transport of contaminants dissolved in groundwater or function as sources of dissolved phase contaminants to groundwater. As noted above, the storm drain network contains some accumulated inorganics and PCBs that appear to be partitioning to water, although concentrations are not grossly elevated relative to available background values. The storm drain network likely facilitates the movement of shallow groundwater in the vicinity of cracked or broken pipes where inflow or outflow may occur. The sanitary sewer system at Load Line 4 contains some accumulated inorganics and may contribute some level of contaminant flux to groundwater; however, the sanitary sewer system is a closed system (except where pipes may be cracked) and contaminant concentrations were not grossly elevated. Considering the relative lack of data and characteristics of the sewer systems, it is not conclusive if these systems are a primary source to groundwater or migration pathways.

8.2.3 Uncertainties

The CSM is developed based on available site characterization and chemical data. Uncertainties are inherent in the CSM where selected data do not exist or are sparse. The uncertainties within the CSM for Load Line 4 include the following.

- Groundwater monitoring wells installed during the Phase II RI targeted the water table interval only. The observed extent and magnitude of contamination in AOC soil and shallow groundwater do not indicate substantial contamination of groundwater within the AOC and conservative modeling results suggest that off-AOC migration of contaminants will not occur. However, groundwater within deeper flow zones was not characterized and conclusions regarding groundwater contaminant transport are representative of only the source areas modeled and hydrostratiographic intervals that were characterized.

- The exact source(s) of PAHs at Load Line 4 is unknown, although they may, in part, be anthropogenic combustion products derived from coal and/or fuel oil-fired power and boiler plant emissions.

- Leachate and transport modeling is limited by uncertainties in the behavior and movement of contaminants in the presence of multiple solutes. In addition, heterogeneity, anisotropy, and spatial distributions of permeable zones (e.g., sand or gravel zones) could not be fully characterized during the field investigation nor addressed in the modeling. Therefore, effects of these features on contaminant transport at Load Line 4 are uncertain and modeling results are considered as conservative representations.

- The exact source(s) of some inorganics (e.g., manganese) in surface water and sediment in the Main Stream Segment Upstream of Perimeter Road Aggregate is unknown. Data evaluated in the nature and extent and risk evaluations address all accumulated contamination within the main stream and settling pond, whether from natural or anthropogenic sources. Results of the evaluations may reflect, in part, contributions from sources other than Load Line 4.

8.3 CONCLUSIONS

The conclusions presented below, by medium, combine the findings of the contaminant nature and extent evaluation, fate and transport modeling, and the human health and ecological risk evaluations. To support remedial alternative selection and evaluation in future CERCLA documents (e.g., FS), the contaminant levels for identified COCs in surface soil, subsurface soil, surface water, sediment, and groundwater at Load Line 4 were compared to risk-based RGOs.

A target excess individual lifetime cancer risk for carcinogens of 1×10^{-5} and a target HI of 1 for non-carcinogens was identified as appropriate for calculating RGOs for Load Line 4 based on the small number of COC's identified for each exposure medium and the type of COCs (carcinogenic or non-carcinogenic). A summary of the results of the RGO comparisons is provided in Chapter 6.0, Tables 6-4, 6-6, and 6-9.

8.3.1 Surface and Subsurface Soil

Explosives Handling Areas Aggregate

The primary identified source areas in the Explosives Handling Areas Aggregate include Buildings G-8 and G-12. Metals, explosives, PAHs, and PCBs represent the most pervasive SRCs in the former production areas. The spatial distribution and concentrations of contaminants were highly variable in the vicinity of these source areas. With respect to vertical distribution, the numbers and concentrations of SRCs in subsurface soil at these source areas decreased substantially relative to surface soil.

Theoretical numerical modeling of leaching potential for soil source areas indicates that chromium, selenium, and RDX near Building G-8 may be expected to leach from the contaminated surface soils into the groundwater and reach concentrations exceeding groundwater MCLs or RBCs. The migration of metals constituents from the source areas to the closest groundwater baseflow discharge at concentrations in excess of risk-based criteria was not predicted to occur within a timeframe of 1,000 years from the Building G-8 source area. Migration of RDX from Building G-8 to the closest groundwater baseflow discharge point may occur with concentrations above RBCs. The predicted timeframe for migration is 1,000 years. Migration of most of the constituents is expected to be attenuated because of moderate to high retardation factors, as well as degradation of organic compounds; these processes are not reflected in the conservative modeling results.

Eleven shallow surface soil COCs were identified for the Security Guard/Maintenance Worker, and Resident Farmer (adult and/or child). These COCs included

- four metals: aluminum, arsenic, manganese, and thallium;
- two PCBs: PCB-1254 and PCB-1260; and
- five PAHs: benz(*a*)anthracene and indeno(1,2,3-*cd*)pyrene, both for the Resident Farmer Adult only; and benzo(*a*)pyrene, benzo(*b*)fluoranthene, and dibenz(*a,h*)anthracene.

For the Security Guard/Maintenance Worker, most COCs would produce a cancer risk at or slightly above 10^{-6}. For the resident farmer scenarios, estimated cancer risks would exceed 10^{-5} for arsenic, PCB-1260, and benzo(*a*)pyrene in the Explosives Handling Areas Aggregate.

Three metals were identified as deep surface soil COCs for the National Guard Trainee: aluminum, arsenic, and manganese. In deep surface soil, arsenic would result in an estimated cancer risk to the National Guard Trainee of slightly larger than 10^{-6}.

No COCs were identified in subsurface soil in the Explosives Handling Areas Aggregate.

Preparation and Receiving Areas Aggregate

The primary identified source areas in the Preparation and Receiving Areas Aggregate include Buildings G-1A and G-4. Metals, PAHs, and PCBs represent the most pervasive SRCs in these areas. The spatial distribution and concentrations of contaminants were highly variable. With respect to vertical distribution, the numbers and concentrations of SRCs in subsurface soil at these source areas decreased substantially relative to surface soil.

Five shallow surface soil COCs were identified for the Security Guard/Maintenance Worker, and Resident Farmer (adult and/or child). These COCs included

- three metals: manganese, thallium, and arsenic; and
- two PCBs: PCB-1254 and PCB-1260.

All estimated risks for shallow surface soil COCs would be less than 10^{-6} for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher. For the Security Guard/Maintenance Worker, most COCs would produce a cancer risk at or slightly above 10^{-6}, with the exception of PCB-1254. The estimated cancer risk for this COC would be slightly larger than 10^{-5}. For the resident farmer scenarios, estimated cancer risks would exceed 10^{-5} for arsenic and PCB-1254.

Four deep surface soil COCs were identified for the National Guard Trainee. These COCs included

- three metals: aluminum, arsenic, and manganese; and
- one PCB: PCB-1254.

Two deep surface soil COCs would result in estimated cancer risk to the National Guard Trainee of slightly larger than 10^{-6} at the Preparation and Receiving Areas Aggregate: arsenic and PCB-1254.

Two metals were identified as subsurface soil COCs at the Preparation and Receiving Areas Aggregate; aluminum (Resident Farmer Child Only) and manganese (for both the Resident Farmer Adult and Resident Farmer Child).

Packaging and Shipping Areas Aggregate

The primary identified source area in the Packaging and Shipping Areas Aggregate is Building G-19. Metals are the most pervasive SRCs in these areas; low concentrations of PAHs and PCBs were detected sporadically. The spatial distribution and concentrations of contaminants were highly variable. With respect to vertical distribution, the numbers and concentrations of SRCs in subsurface soil at these source areas decreased substantially relative to surface soil.

Four shallow surface soil COCs were identified for the Resident Farmer Adult and/or Child. These COCs include

- one metal: manganese;
- two PCBs: PCB-1254 and PCB-1260; and
- one PAH: benzo(*a*)pyrene.

All estimated risks for shallow surface soil COCs would be less than 10^{-6} for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher. For the Security Guard/Maintenance Worker, surface soil COCs would produce a cancer risk at or slightly above 10^{-6}.

One metal was identified as a deep surface soil COC for the National Guard Trainee: manganese. Estimated cancer risks for the deep surface soil COC (manganese) would be below 10^{-6}.

No COCs were identified in subsurface soil in the Packaging and Shipping Areas Aggregate.

Change Houses Aggregate

Surface soil in this EU is relatively uncontaminated. Few inorganic results exceeded RVAAP background values; the distribution of exceedances was very sporadic. No explosives compounds greater than 1 mg/kg were detected during field analyses. Accordingly, subsurface soil samples were not collected. Maximum levels of SRCs were detected in the vicinity of Building G-6.

Four shallow surface soil COCs were identified for the Security Guard/Maintenance Worker, and Resident Farmer (adult and/or child). These COCs included

- one metal: thallium; and
- three PAHs: benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and benzo(*a*)pyrene.

All estimated risks for shallow surface soil COCs would be less than 10^{-6} for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher. For the Security Guard/Maintenance Worker, surface soil COCs would produce a cancer risk at or slightly above 10^{-6}.

No deep surface soil COCs were identified for the Change Houses Aggregate, as all EPCs were less than their respective screening RGOs.

Subsurface soil samples were not collected at the Change Houses Aggregate.

Perimeter Area Aggregate

The only identified contaminant source in this aggregate is the WW-23 Water Tower vicinity. Low concentrations of TNT (field analyses only), inorganics (primarily lead), and PAHs were clustered in the vicinity of the water tower. Lead concentrations in subsurface soil decreased substantially from those observed in surface soil.

Two shallow surface soil COCs [manganese and benzo(a)pyrene] were identified for the Security Guard/Maintenance Worker, and Resident Farmer (adult and/or child). All estimated risks for shallow surface soil COCs would be less than 10^{-6} for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher. For the Security Guard/Maintenance Worker, benzo(*a*)pyrene would produce a cancer risk at or slightly above 10^{-6}.

One metal was identified as a deep surface soil COC for the National Guard Trainee: manganese. Ratios of EPCs to RGOs indicate that estimated cancer risks would be below 10^{-6} for the deep surface soil COC (manganese) in the Perimeter Area Aggregate.

No COCs were identified in subsurface soil in the Perimeter Area Aggregate.

Melt-Pour Area Drainage Ditches Aggregate

Surface soil in this EU exhibited little contamination. Explosives compounds were not detected at a concentration of 1.0 mg/kg or greater during field analyses. Inorganic SRCs rarely exceeded background values by factors of more than 2 times and only low concentrations of PAHs were observed. Subsurface soil samples were not collected from this aggregate due to the lack of detectable field explosives in surface soil.

Two metals were identified as shallow surface soil COCs for the Security Guard/Maintenance Worker, and Resident Farmer (adult and/or child): arsenic and thallium. All estimated risks for shallow surface soil COCs would be less than 10^{-6} for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher. For the Security Guard/Maintenance Worker, arsenic would produce a cancer risk at or slightly above 10^{-6}. For the resident farmer scenarios, arsenic would produce a cancer risk above 10^{-5}.

One metal was identified as a deep surface soil COC for the National Guard Trainee: arsenic. Ratios of EPCs to RGOs indicate that the estimated cancer risk to the National Guard Trainee would be slightly larger than 10^{-6} for the deep surface soil COC (arsenic) in the Melt-Pour Drainage Ditches Aggregate.

Subsurface soil samples were not collected from the Melt-Pour Drainage Ditches.

8.3.2 Sediment and Surface Water

Sediment

Explosives contamination in sediment in all three Load Line 4 main stream aggregates is not widespread. Concentrations of explosives are less than 1 mg/kg, inorganic SRCs exceeded background criteria by factors of only 2 to 3 times, and only trace concentrations of one PCB compound were detected. The number and concentrations of inorganics are greatest in the Main Stream and Settling Pond Aggregate.

Two metals were identified as sediment COCs at the aggregate designated as the Main Stream Segment Downstream of Perimeter Road Bridge and the Settling Pond. Both are non-carcinogenic chemicals.

- Aluminum, for the National Guard Trainee and Resident Farmer Child; and
- Thallium, for the Resident Farmer Child only.

No COCs were identified in the Main Stream Upstream of Perimeter Road Bridge or Exit Drainages Aggregates.

Surface Water

Explosives were not detected in water samples collected from any of the three EUs established within the main stream at Load Line 4. Vanadium and manganese were the only two inorganic SRCs detected consistently in surface water above background criteria; maximum concentrations of manganese occurred within the aggregate upstream of the Load Line 4 Perimeter Road. The pesticide 4,4'-DDT was detected in one water sample from the settling pond; no SVOCs or PCBs were detected. VOCs were only sporadically detected at low concentrations.

Three Load Line 4 COCs (arsenic; manganese; and 4,4'-DDT) were identified for the National Guard Trainee exposed to surface water. All three COCs were also identified for the On-Site Residential Farmer scenarios. Two COCs (arsenic and manganese) were identified for the Main Stream Segment Upstream of Perimeter Road Bridge Aggregate and one COC (4,4'-DDT) was identified for the Main Stream Segment Downstream of Perimeter Road Bridge and the Settling Pond Aggregate; no surface water COCs were identified for the Exit Drainage Aggregate. For the surface water COCs, ratios of EPCs to RGOs indicate that estimated cancer risks would be less than 10^{-6} for the Fire/Dust Suppression Worker and the Hunter/Trapper/Fisher and between 10^{-6} and 10^{-5} for the National Guard Trainee and the residential farmer scenarios.

8.3.3 Groundwater

Groundwater within the AOC contains few contaminants that can be related to historical operations. Low concentrations of metals identified as SRCs were observed; however, their occurrence and distribution above background criteria was sporadic. SVOCs and VOCs were detected in groundwater samples collected from monitoring wells in Load Line 4.

Two COCs were identified for the National Guard Trainee. One COC (arsenic) is a carcinogen and the other COC (manganese) is a non-carcinogen. These COCs were also identified for the On-Site Residential Farmer scenarios. For these groundwater COCs, ratios of EPCs to RGOs indicate that estimated cancer risks would be slightly greater than 10^{-5} for the National Guard Trainee and slightly greater than 10^{-4} for the residential farmer scenarios. These are hypothetical future scenarios; no receptors are currently using groundwater from the AOC for any purpose.

8.3.4 Storm and Sanitary Sewers

The storm sewer system does not contain accumulated explosives based on Phase II RI sampling results, although accumulated inorganics and low levels of PAHs, PCBs, and pesticides are present. Inorganics and PCBs appear to be partitioning to water at low concentrations. The storm drain network likely facilitates the movement of shallow groundwater in the vicinity of cracked or broken pipes where inflow or outflow may occur.

The sanitary sewer system does not contain accumulated explosives based on Phase II RI sampling results, although accumulated inorganics are present that may be partitioning to accumulated water within the system. The sanitary sewer system does not receive large influxes of storm runoff and is largely a closed system, except where pipes may be cracked. Considering the relative lack of data and the characteristics of the sewer system, it is not conclusive if these systems are a primary source to groundwater or migration pathways.

8.3.5 Buildings and Structures

Data collected during the Phase II RI indicate an overall absence of contamination in soil beneath building sub-floors. However, this is based on a limited number of samples collected from beneath building slabs.

Any future demolition of the Building G-8 washout basin should consider that sediment in this structure contained elevated levels of metals, explosives, propellants, PCBs, and pesticides. The associated water sample contained elevated levels of many constituents that were detected at high concentrations in sediment.

Any future demolition of the Building G-16 sedimentation basin should consider that sediment in this structure contained elevated concentrations of several metals related to historical processes (chromium, copper, and lead).

Floor sweeping samples collected from Buildings G-3, G-8, and G-19 were comprised of a high percentage of iron. Copper, cadmium, chromium, and lead were present at high concentrations, particularly in Buildings G-8 and G-19. Low concentrations of explosives were detected in samples from Buildings G-8 and G-19. Low concentrations of PCBs, pesticides, and various PAHs were also detected. Cadmium and lead were detected in TCLP extracts; however, no constituent exceeded their respective criteria for characteristically hazardous wastes.

8.4 LESSONS LEARNED

A key project quality objective for the Phase II RI at Load Line 4 is to document lessons learned so that future projects may benefit from lessons learned and constantly improve data quality and performance. Lessons learned are derived from process improvements that were implemented or corrective measures for nonconformances. The Phase II RIs for Load Lines 2, 3, and 4 were planned and implemented under one mobilization; therefore, the key lessons learned discussed below are applicable to all of the investigations conducted in 2001.

- The Phase II RI for Load Lines 2, 3, and 4 were integrated under a single SAP, QAPP, and Health and Safety Plan Addendum. Preparation for field efforts, including logbook preparation, sampling database pre-population, readiness reviews, and personnel training assignments were conducted under one combined mobilization. Field sampling operations for all three load lines were coordinated under one Field Operations Manager, Site Health and Safety Officer, and Sample Manager, and utilized the same sampling teams. Set up and operation of the field laboratory was likewise done once for all three investigations. The integrated effort allowed subcontractors (drilling, test pit excavation, video camera surveys, concrete coring, etc.) to conduct their operations under one mobilization. This integrated effort for multiple sites eliminated redundant start up operations, compressed the field investigation schedules, reduced costs, and improved data quality by utilizing staff familiar with the project DQOs and sampling procedures.

- The Phase II RI efforts for Load Lines 2, 3, and 4 were the first conducted by SAIC at RVAAP to designate a formal IDW Compliance Officer. A single person with waste operations and management experience was designated to coordinate the packaging, labeling, tracking, and disposition of all project IDW. This person reported directly to the Field Operations Manager and SAIC Project Manager. Implementation of this position resulted in greater efficiencies in IDW management and no compliance issues related to IDW during the course of the project.

- Analytical difficulties were encountered for some floor sweep and other sample types collected within or near buildings and railroad tracks were encountered due to the suspected presence of paint chips, creosotes, or other materials. Prior notification to the analytical laboratory is advised when such unusual samples may be collected so that they can adjust extraction or analytical protocols, as needed, to avoid gross contamination or even damage to instrumentation and to improve overall data quality.

- Use of field portable X-ray fluorescence (XRF) analyses for metals was not employed to help guide the placement of sampling locations, although the method may have provided useful information regarding the distribution of inorganic contaminants. Re-evaluation of previous applications of XRF at RVAAP is to be conducted, including implementation of a revised analytical method. Upon completion of the evaluation and testing of the new method(s), use of field XRF to help guide characterization sampling activities or conduct remediation verification sampling should be considered.

- Incorporation of undesignated contingency samples into the project planning provides a useful tool and flexibility to sample additional locations based on field observations. Examples of the application of contingency samples include small sedimentation basins discovered at Load Lines 3 and 4 near explosives preparation buildings and collection of Cr^{+6} at multiple stations at Load Line 2.

- The presence of Ohio EPA and USACE staff on-site during field operations was beneficial in that potential changes to the project work plan due to field conditions could be quickly discussed, resolved, and implemented.

- The availability of on-site facilities for use as a field staging area and to house the field explosives laboratory was extremely beneficial. Having high-quality shelter facilities for sample storage and management operations, equipment decontamination, and the field laboratory improves sample quality and project efficiency. The facility provides a central and secure location to store equipment and supplies, as well as to conduct safety meetings and other site-specific training.

- Field operations were temporarily suspended for 5 days beginning September 12, 2001, due to RVAAP security measures in response to the terrorist attacks of September 11, 2001. As a result, field operations were placed in a safe and compliant standby condition, including:

  – Communication of events and planned actions to the appropriate SAIC, USACE, and RVAAP management personnel;

  – Removal of environmental samples that were in refrigerated storage in order to deliver these to analytical laboratories;

  – Inspection and securing of IDW containers to ensure safe and compliant storage;

  – Removal of rental vehicles and rented field equipment; and

  – Sealing of project field records in coolers securing of the field staging building.

Future SAP Addenda for investigations at RVAAP may include a section containing instructions for unplanned events resulting in the immediate suspension of field operations.

THIS PAGE INTENTIONALLY LEFT BLANK.