Final

Feasibility Study Addendum for Soil, Sediment, and Surface Water at RVAAP Load Lines 1, 2, 3, 4, and 12

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912QR-12-D-0020
Delivery Order No. 0008

Prepared for:

U.S. Army Corps of Engineers
Louisville District
600 Martin Luther King, Jr. Place
Louisville, Kentucky 40202

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June 21, 2017

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
21-06-2017	Technical	1941 to 2016

4. TITLE AND SUBTITLE

Final
Feasibility Study Addendum for Soil, Sediment, and Surface Water at RVAAP Load Lines 1, 2, 3, 4, and 12
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

5a. CONTRACT NUMBER
W912QR-12-D-0020

5b. GRANT NUMBER
NA

5c. PROGRAM ELEMENT NUMBER
NA

6. AUTHOR(S)

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5d. PROJECT NUMBER
Delivery Order No. 0008

5e. TASK NUMBER
NA

5f. WORK UNIT NUMBER
NA

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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Reston, Virginia 20190

8. PERFORMING ORGANIZATION REPORT NUMBER
NA

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

USACE - Louisville District
U.S. Army Corps of Engineers
600 Martin Luther King Jr., Place
PO Box 59
Louisville, Kentucky 40202-0059

10. SPONSOR/MONITOR'S ACRONYM(S)
USACE

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
NA

12. DISTRIBUTION/AVAILABILITY STATEMENT

Reference distribution page.

13. SUPPLEMENTARY NOTES

None.

14. ABSTRACT

Leidos has been contracted by the U.S. Army Corps of Engineers (USACE), Louisville District to complete an approved Feasibility Study (FS) Addendum for specified environmental media at five areas of concern (Load Lines 1, 2, 3, 4, and 12) at Camp Ravenna, in Ravenna, Ohio. The purpose of the FS Addendum is to conduct an evaluation of residual contaminated soil, sediment, and surface water at Load Lines 1 through 4 and soil at Load Line 12 that pose a potential risk to human health and the environment. At Load Line 12, surface water and sediment are currently being evaluated under a separate RI report; therefore, additional evaluation in this FS Addendum is not required. Tasks associated with this FS include: identifying remedial action objectives and appropriate remedial goal options, screening remedial technologies, developing remedial alternatives to meet the RAOs and attain RGOs, and performing a detailed evaluation of remedial alternatives to identify a preferred remedy. The recommended alternative for this FS Addendum is Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs.

15. SUBJECT TERMS

CERCLA, Feasibility Study (FS), Cleanup Goals, Alternatives, Load Line 1, Load Line 2, Load Line 3, Load Line 4, and Load Line 12.

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	U	2,957	Nathaniel Peters II
					19b. TELEPHONE NUMBER *(Include area code)*
					502-315-2624

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CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Leidos has completed the Feasibility Study Addendum for Soil, Sediment, and Surface Water at RVAAP Load Lines 1, 2, 3, 4, and Soil at Load Line 12 at the Former Ravenna Army Ammunition Plant. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing U.S. Army Corps of Engineers (USACE) policy.

Vasu Peterson, P.E., PMP Project Manager	June 21, 2017 Date
Rupa Price Study/Design Team Leader	June 21, 2017 Date
Selvam Arunachalam, P.E. Independent Technical Review Team Leader	June 21, 2017 Date

Significant concerns and the explanation of the resolution are as follows:

Internal Leidos Independent Technical Review comments are recorded on a Document Review Record per Leidos standard operating procedure ESE A3.1 Document Review. This Document Review Record is maintained in the project file. Changes to the report addressing the comments have been verified by the Study/Design Team Leader. As noted above, all concerns resulting from independent technical review of the project have been considered.

Lisa Jones-Bateman, PMP, REM Senior Program Manager	June 21, 2017 Date

Ohio Environmental Protection Agency

John R. Kasich, Governor
Mary Taylor, Lt. Governor
Craig W. Butler, Director

July 21, 2017

Mr. Mark Leeper
Army Nation Guard Directorate
ARNGD-ILE Clean Up
111 South George Mason
Arlington, VA 22203

Re: US Army Ravenna Ammunition Plt RVAAP
DFFO
Correspondence
Remedial Response
Portage County
267000859030

Subject: Ohio EPA Approval Final Feasibility Study Addendum for Soil, Sediment and Surface Water at Load Lines 1, 2, 3, 4 and 12 at RVAAP-Restoration Program (267-000859-030), Dated June 22, 2017.

Dear Mr. Leeper:

The Ohio Environmental Protection Agency (Ohio EPA) approves the Feasibility Study Addendum for Soil, Sediment and Surface Water at Load Lines 1,2,3,4 and 12 at RVAAP Restoration Program, dated June 22, 2017.

If you have any questions or concerns, please do not hesitate to contact me at (330) 963-1201, susan.netzly-watkins@epa.ohio.gov

Sincerely,

Sue Netzly-Watkins, Site Coordinator
Division of Environmental Response and Revitalization

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DOCUMENT DISTRIBUTION
for the
Final Feasibility Study Addendum
for Soil, Sediment, and Surface Water
at RVAAP Load Lines 1, 2, 3, 4, and 12
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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ARNG = Army National Guard.
CO = Central Office.
DERR = Division of Environmental Response and Revitalization.
ILE = Installation, Logistics, and Environment.
NEDO = Northeast District Office.
OHARNG = Ohio Army National Guard.
Ohio EPA = Ohio Environmental Protection Agency.
REIMS = Ravenna Environmental Information Management System.
SWDO = Southwest District Office.
USACE = U.S. Army Corps of Engineers.

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ACRONYMS AND ABBREVIATIONS

amsl	Above Mean Sea Level
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
BERA	Baseline Ecological Risk Assessment
bgs	Below Ground Surface
Camp Ravenna	Camp Ravenna Joint Military Training Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMCOC	Contaminant Migration Chemical of Concern
CMCOPC	Contaminant Migration Chemical of Potential Concern
COC	Chemical of Concern
COI	Chemical of Interest
COEC	Chemical of Ecological Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSM	Conceptual Site Model
DAF	Dilution Attenuation Factor
DERP	Defense Environmental Restoration Program
DERR	Division of Environmental Response and Revitalization
DFFO	Director’s Final Findings and Orders
DLA	Defense Logistics Agency
DNT	Dinitrotoluene
DQO	Data Quality Objective
EBG	Erie Burning Grounds
EE/CA	Engineering Evaluation/Cost Analysis
EO	Executive Order
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESV	Ecological Screening Value
EU	Exposure Unit
FA	Functional Area
FFS	Focused Feasibility Study
FR	Federal Register
FS	Feasibility Study
FSP	Field Sampling Plan
FWBWQS	Facility-wide Biological and Water Quality Study
FWCUG	Facility-wide Cleanup Goal
FWERWP	Facility-wide Ecological Risk Work Plan
FWGWMP	Facility-wide Groundwater Monitoring Program
FWHHRAM	Facility-wide Human Health Risk Assessors Manual

ACRONYMS AND ABBREVIATIONS (continued)

GIS	Geographic Information System
gpm	Gallons per Minute
GRA	General Response Action
HASP	Health and Safety Plan
HDPE	High-density Polyethylene
HHRA	Human Health Risk Assessment
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HRR	Historical Records Review
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
IROD	Interim Record of Decision
IRP	Installation Restoration Program
ISM	Incremental Sampling Methodology
LDR	Land Disposal Restriction
L-QHEI	Lake/Lacustrine Qualitative Habitat Evaluation Index
LUC	Land Use Control
LUCRD	Land Use Control Remedial Design
MC	Munitions Constituents
MCL	Maximum Contaminant Level
MD	Munitions Debris
MDC	Maximum Detected Concentration
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
NAVD88	North American Vertical Datum of 1988
NPL	National Priorities List
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	Operations and Maintenance
OAC	Ohio Administrative Code
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
P.E.	Professional Engineer
PAH	Polycyclic Aromatic Hydrocarbon
PBA13	Performance-based Acquisition 2013
PBR	Permit-By-Rule
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PF	Parshall Flume
PMP	Project Management Plan
PP	Proposed Plan
PPE	Personal Protective Equipment

ACRONYMS AND ABBREVIATIONS (continued)

RAO	Remedial Action Objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
REM	Registered Environmental Manager
REIMS	Ravenna Environmental Information Management System
RGO	Remedial Goal Option
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SERA	Screening-level Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment
SOR	Sum-of-Ratios
SRC	Site-related Contaminant
SRV	Sediment Reference Value
SSL	Soil Screening Level
SVOC	Semi-volatile Organic Compound
TBC	To-Be-Considered
TCLP	Toxicity Characteristic Leaching Procedure
TNT	2,4,6-Trinitrotoluene
TR	Target Risk
UHC	Underlying Hazardous Constituent
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USP&FO	U.S. Property and Fiscal Officer
UST	Underground Storage Tank
UTS	Universal Treatment Standards
VEG©	Vapor Energy Generation
VOC	Volatile Organic Compound
WOE	Weight-of-Evidence

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION AND SCOPE

This document was prepared by Leidos under the U.S. Army Corps of Engineers (USACE), Louisville District Contract No. W912QR-12-D-0020, Delivery Order No. 0008. This Feasibility Study (FS) Addendum addresses soil, sediment, and surface water at Load Lines 1 through 4 and soil at Load Line 12 within the former Ravenna Army Ammunition Plant (RVAAP) (now known as Camp Ravenna Joint Military Training Center [Camp Ravenna]) in Portage and Trumbull counties, Ohio. The areas of concern (AOCs) addressed in this FS Addendum are presented in Table ES-1.

Table ES-1. FS Addendum AOCs

Load Line	AOC Designation
Load Line 1	RVAAP-08
Load Line 2	RVAAP-09
Load Line 3	RVAAP-10
Load Line 4	RVAAP-11
Load Line 12	RVAAP-12

AOC = Area of Concern.

This report has been prepared in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) *Director's Final Findings and Orders* (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP) to develop an FS Report by evaluating remedial alternatives to address contamination presenting unacceptable risk to human health and the environment, present a preferred alternative in a Proposed Plan (PP), and document stakeholder selection and acceptance of the preferred final remedy in a Record of Decision (ROD). The following sections present the site history, scope of this report, and an explanation of the evaluation of future use.

ES.1.1 Site History

Since 1978, Load Lines 1 through 4 and 12 have been the subject of multiple investigations and/or assessments leading to CERCLA decisions and remedial actions at the AOCs. The Preliminary Assessment conducted in 1996 concluded that all five AOCs were high-priority AOCs requiring future environmental investigations. Subsequently, Phase I Remedial Investigations (RIs) were conducted for each AOC, and recommendations included additional investigations in a Phase II RI. Based on the results of the human health risk assessment (HHRA) and ecological risk assessment (ERA) in the Phase II RIs, each site was recommended for further evaluation in an FS.

A Focused Feasibility Study (FFS) was developed for Load Lines 1 through 4 (Shaw 2005) and recommended excavation with off-site disposal as an interim remedy to address soil contamination and achieve Military Training Land Use. Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007. The buildings also were removed in 2007; however, the floor slab and associated foundation walls were not completed until 2009. An investigation of the sub slab soil identified additional areas requiring soil removal, which was completed around 2010.

At Load Line 12, building demolition and slab removal occurred from 1998 to 2000. The *Feasibility Study for Load Line 12 (RVAAP-12)* (USACE 2006) concluded that remediation of contaminated dry sediment in the Main Ditch would attain Military Training Land Use for soil and dry sediment. Remediation was completed in 2010.

Additional characterization sampling took place for soil from 2010 through 2011 and for surface water and sediment in 2016 to complete this FS Addendum.

ES.1.2 Objectives and Scope

In accordance with the NCP and 40 Code of Federal Regulations (CFR) 300.430(e)(1), the primary objective of the FS Addendum is to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action options can be presented to a decision-maker and an appropriate remedy selected. Therefore, the purpose of the FS Addendum is to conduct an evaluation of residual contaminated soil, sediment, and surface water at Load Lines 1 through 4 and soil at Load Line 12 that pose a potential risk to human health and the environment. At Load Line 12, surface water and sediment are currently being evaluated under a separate RI report; therefore, additional evaluation in this FS Addendum is not required.

In this FS Addendum, remedial action objectives (RAOs) and appropriate remedial goal options (RGOs) are identified, remedial technologies are screened, remedial alternatives are developed to meet the RAOs and attain RGOs, and a detailed evaluation of remedial alternatives is performed to identify a preferred remedy.

ES.1.3 Evaluation of Future Use

Following signature of the respective RODs, activities at Load Lines 1 through 4 and 12 included completion of remedial actions addressing soil contamination identified for the National Guard Trainee receptor. In February 2014, the U.S. Department of the Army (U.S. Army) and Ohio EPA amended the risk assessment process to address changes in the RVAAP restoration program. The *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the RVAAP Installation Restoration Program* (hereafter referred to as the Technical Memorandum) (ARNG 2014) identified three Categorical Land Uses and Representative Receptors to be considered during the CERCLA process. These three Land Uses and Representative Receptors are:

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer),
2. Military Training Land Use – National Guard Trainee, and
3. Commercial/Industrial Land Use – Industrial Receptor (U.S. Environmental Protection Agency [USEPA] Composite Worker).

At Load Lines 1 through 4 and 12, soil was previously remediated for chemicals of concern (COCs) that exceeded human health Facility-wide Cleanup Goals (FWCUGs) established for the National Guard Trainee. After the removal actions were completed to attain concentrations protective of Military Training Land Use, multiple characterization activities occurred to identify the extent of residual contamination in soil. The Army elected to complete this FS Addendum to summarize all data collected since remedial activities occurred, provide updated risk assessments, and evaluate the Resident Receptor (Adult and Child) and the Industrial Receptor (USEPA Composite Worker) to be protective of full-time occupational exposures, including Military Training Land Use.

ES.2 CONCEPTUAL SITE MODEL FOR LOAD LINES 1 THROUGH 4 AND 12

The conceptual site model (CSM) provides a concise summary of residual contamination distribution, exposure pathways, migration routes, and assessment of the affects to human health and ecological receptors that supports development of RAOs and the FS. This section summarizes the chemicals of interest (COIs), fate and transport, HHRA, and ERA.

ES.2.1 Chemicals of Interest

The COIs for exposure of Resident Receptor (Adult and Child) to soil, sediment, and surface water at Load Lines 1 through 4 and soil only at Load Line 12 are shown in Table ES-2. The Phase II RIs completed for each of the five AOCs presented the results of human health screening evaluations that identified COCs exceeding residential screening criteria. These COCs were compiled for each medium under investigation in this FS Addendum and identified as COIs. Following screening, constituents exceeding criteria were carried to the FS as COIs requiring additional analysis.

ES.2.2 Summary of Contaminant Fate and Transport

Fate and transport analysis was conducted to assess the potential for COIs to leach from surface and subsurface soil and sediment at Load Lines 1 through 4 and 12 and impact groundwater beneath the sources and downgradient receptor locations. The analyses also evaluate the potential for site-related contaminants (SRCs) to leach from sediment sources at Load Lines 1 through 4 and impact groundwater beneath the sources and downgradient receptor locations. Modeling results were included in the decision-making process to determine whether performing remedial actions may be necessary to protect groundwater resources.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any contaminant migration chemicals of concern (CMCOCs) are present in soil and sediment at these AOCs that may impact the groundwater beneath their respective source or at the downstream receptor locations. This qualitative assessment concluded that other than hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) from Load Line 1, there were no other CMCOCs present in soil and sediment that may impact the groundwater beneath their respective sources or at the downstream receptor locations. Therefore, no further action is required of soil and sediment at Load Lines 2 through 4 and 12 for the protection of groundwater. For Load Line 1, RDX contamination in surface and subsurface soil could potentially impact the groundwater beneath the site; therefore, a remedial action is required for the surface and subsurface soil at Load Line 1 for the protection of groundwater.

Table ES-2. Chemicals of Interest

COIs	Soil	Surface Water	Sediment
Load Line 1			
Metals	X	X	X
Explosives	X	X	X
PCBs	X	X	X
Pesticides	X	X	X
PAHs	X	X	X
Load Line 2			
Metals	X	X	X
Explosives	X	X	X
PCBs	X	X	X
Pesticides	X	X	X
PAHs	X	X	X
Load Line 3			
Metals	X	X	X
Explosives	X	X	X
PCBs	X	X	X
Pesticides	X	X	X
PAHs	X	--	--
Load Line 4			
Metals	X	X	X
PCBs	X	X	X
PAHs	X	X	X
Load Line 12			
Metals	X	NA	NA
Explosives	X	NA	NA
PCBs	X	NA	NA
Pesticides	X	NA	NA
PAHs	X	NA	NA

-- = Chemical is not a chemical of interest for specified media.
NA = Load Line 12 surface water and sediment are being addressed in a separate RI Report.

COI = Chemical of Interest.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.

ES.2.3 Summary of Human Health Risk Assessment

The HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to residual contamination in surface soil (0-1 ft below ground surface [bgs]), subsurface soil (1-13 ft bgs), sediment, and surface water at Load Lines 1 through 4 and surface soil (0-1 ft bgs) and subsurface soil (1-13 ft bgs) at Load Line 12. The methodology of comparing COI exposure concentrations to RGOs and determining COCs generally follows guidance presented in the Position Paper for Human Health Cleanup Goals (USACE 2012b) and Technical Memorandum (ARNG 2014) and includes calculating a sum-of-ratios (SOR) for all non-carcinogenic and carcinogenic COIs. The reported concentration in each discrete or incremental sampling methodology (ISM) sample was compared to RGOs (i.e., the exposure point concentration [EPC] is the concentration in each individual sample). COIs are identified as COCs for a given receptor if:

- The EPC exceeds the most stringent RGO for either the 1E-05 target cancer risk or the 1 target hazard quotient (HQ); or
- The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than 1; chemicals contributing at least 5% to an SOR greater than 1 are also considered COCs.

Metals present at concentrations consistent with naturally occurring background concentrations are not identified as COCs.

The HHRA identified COCs and conducted risk management analysis to determine if COCs pose unacceptable risk to the Industrial and Resident Receptors. If there is no unacceptable risk to the Industrial or Resident Receptor, it can be concluded that no further action is required from a human health perspective. The results of the HHRA by Load Line are provided below:

- **Load Line 1**
  - Unrestricted (Residential) Land Use – The soil COCs recommended for remediation include metals (lead and antimony), explosives (2,4,6- trinitrotoluene [2,4,6-TNT] and RDX), polychlorinated biphenyl (PCB)-1254, and polycyclic aromatic hydrocarbons (PAHs). No COCs were identified in sediment or surface water.
  - Commercial/Industrial Land Use – The soil COCs recommended for potential remediation include metals (lead and antimony), explosives (2,4,6-TNT and RDX), and PCB-1254. No COCs were identified in sediment or surface water.
- **Load Line 2**
  - Unrestricted (Residential) Land Use – The soil COCs recommended for remediation include metals (lead and antimony), explosives (2,4,6-TNT and 2,4-DNT), PCBs (PCB-1254 and PCB-1260), and PAHs. In Kelly's Pond sediment, PAHs were identified as COCs. No COCs were identified in surface water.
  - Commercial/Industrial Land Use – Only 2,4,6-TNT was identified as a COC to be carried forward for potential remediation in soil. No COCs were recommended for remediation in sediment or surface water.
- **Load Line 3**
  - Unrestricted (Residential) Land Use – The soil COCs recommended for remediation include lead; 2,4,6-TNT; PCB-1254; PCB-1260; and PAHs. No COCs were identified in sediment or surface water.
  - Commercial/Industrial Land Use – The soil COCs recommended for remediation include 2,4,6-TNT; PCB-1254; PCB-1260; and PAHs. No COCs were identified in sediment or surface water.
- **Load Line 4**
  - Unrestricted (Residential) Land Use – The soil COCs recommended for remediation include lead, PCBs, and PAHs. No COCs were identified in sediment or surface water.

- Commercial/Industrial Land Use – The soil COCs recommended for remediation include lead, PCB-1260, and PAHs. No COCs were identified in sediment or surface water.

- **Load Line 12**
  - Unrestricted (Residential) Land Use – The soil COCs recommended for remediation include explosives (2,6-dinitrotoluene [DNT]; 2,4,6-TNT; and RDX), PCB-1260, and PAHs.
  - Commercial/Industrial Land Use – The soil COCs recommended for remediation include explosives (2,6-DNT and 2,4,6-TNT), PAHs, and PCB-1260.

ES.2.4 Summary of Ecological Risk Assessment

Soil was evaluated for ecological receptors for all five Load Lines (1 through 4 and 12) during the initial RI/FSs. As concluded in the Interim Record of Decision (IROD) at Load Lines 1 through 4 (USACE 2007) and the Final ROD at Load Line 12 (USACE 2009), remediation to meet human health cleanup goals would reduce overall contaminant concentrations and ecological risk. As a result, ecological cleanup goals were not required to achieve RAOs.

To reassess the potential ecological risk at Load Lines 1 through 4, this FS Addendum includes an ERA for surface water and sediment in accordance with the Level I Scoping ERA and Level II Screening ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) with specific application of components from other ecological risk guidance such as *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997). An ERA was not conducted for Load Line 12 in this FS Addendum; surface water and sediment are currently being evaluated under another contract and, based on conclusions documented in the ROD, additional ecological risk evaluation in soil was not required at Load Line 12.

A Level I ERA was conducted for Load Lines 1 through 4 to determine the presence/absence of important ecological places and resources and the presence of contamination. Perennial surface water in streams and/or ponds and wetlands are important ecological resources at these four load lines and chemical contamination is present based on the historical ERAs. Because there is contamination and important/significant ecological resources at each of the load lines, the ERAs continued to a Level II Screening Level ERA.

The Level II ERA identified procedures to determine integrated COIs for each load line and defined habitats/environmental setting, suspected contaminants, and possible exposure pathways. Technical and refinement factors were then used to refine the integrated COIs from the Level II Screening ERA. The factors included use of mean exposure concentrations, discussion of approved ecological screening values (ESVs), and other topics. This type of assessment is Step 3A in the ERA process (USEPA 1997). Step 3A refined the list of integrated COIs to determine if: (1) there are chemicals of ecological concern (COECs) requiring further evaluation in Level III or remediation to protect ecological receptors, or (2) integrated COIs can be eliminated from further consideration. This evaluation is an important part of Level II and is adapted from USEPA Step 3A, outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting*

Ecological Risk Assessments (USEPA 1997) and *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c).

For Load Lines 1 through 4, the evaluation in Step 3A showed there is no further evaluation necessary for integrated COIs, and there is no ecological concern requiring remediation. Consequently, the ERAs for Load Lines 1 through 4 concluded with Level II that no further action is necessary to be protective of important ecological resources.

ES.3 SUMMARY AND RECOMMENDATION OF THE FEASIBILITY STUDY

To address COCs in surface and subsurface soil and sediment, an FS was prepared. This FS developed an RAO, identified appropriate cleanup goals for remedial actions, identified applicable and relevant or appropriate requirements (ARARs), screened potential remedial technologies and process options, and developed and evaluated remedial alternatives.

ES.3.1 Remedial Action Objective

Extensive investigations of each load line concluded that substantial areas of each load line did not require further action to attain Unrestricted (Residential) Land Use. Limited areas of surface and subsurface soil at each load line were identified as posing unacceptable risk to the Industrial Receptor and/or Resident Receptor. The RAO for Load Lines 1 through 4 and 12 is as follows: Reduce risk from COCs in surface and subsurface soil and sediment to acceptable levels (RGOs) for the likely future land use (i.e., Industrial and/or Military Training) that are protective of human health at Load Lines 1 through 4 and 12.

The soil volume estimates summarized for Load Lines 1 through 4 and 12 to meet RAOs are presented in Tables ES-3 and ES-4.

Table ES-3. Estimated Volume Requiring Remediation for Commercial/Industrial Land Use

Commercial/Industrial						
			In-situ		Ex-situ	
Remediation Area	**Area (ft^2)**	**Impacted Interval (ft bgs)**	**Volume (yd^3)**	**Volume with Constructability[a] (yd^3)**	**Volume[b] (yd^3)**	**Weight (tons)**
Load Line 1	11,815	varies (max depth = 5 ft bgs)	1,491	1,864	2,236	2,795
Load Line 2	400	0-2	30	37	46	56
Load Line 3	25,056	varies (max depth = 6 ft bgs)	1,649	2,062	2,474	3,093
Load Line 4	5,994	varies (max depth = 7 ft bgs)	474	592	710	888
Load Line 12	2,633	varies (max depth = 4.5 ft bgs)	248	310	372	465
Total	**45,898**		**3,892**	**4,865**	**5,838**	**7,297**

[a]Constructability factor accounts for over excavation, sloping of sidewalls, and addresses limitations of removal equipment. The in-situ volume is increased by 25% for a constructability factor.
[b]Includes 20% swell factor.

bgs = Below Ground Surface.
ft = Feet.
ft^2 = Square Feet.
yd^3 = Cubic Yards.

Table ES-4. Estimated Volume Requiring Remediation for Unrestricted (Residential) Land Use

Unrestricted (Residential)						
			In-situ		Ex-situ	
Remediation Area	Area (ft^2)	Impacted Interval (ft bgs)	Volume (yd^3)	Volume with Constructability[a] (yd^3)	Volume[b] (yd^3)	Weight (tons)
Load Line 1	49,017	varies (max depth = 8 ft bgs)	4,584	5,730	6,876	8,595
Load Line 2 soil	31,616	varies (max depth = 6 ft bgs)	1,972	2,465	3,081	3,698
Load Line 2 sediment	53,027	0-1	1,966	2,457	3,071	3,686
Load Line 3	69,435	varies (max depth = 7 ft bgs)	8,865	11,082	13,298	16,622
Load Line 4	31,337	varies (max depth = 7 ft bgs)	2,940	3,674	4,409	5,512
Load Line 12	4,233	varies (max depth = 4.5 ft bgs)	475	593	712	890
Total	**238,665**		**20,802**	**26,001**	**31,447**	**39,003**

[a]Constructability factor accounts for over excavation, sloping of sidewalls, and addresses limitations of removal equipment. The in-situ volume is increased by 25% for a constructability factor.
[b]Includes 20% swell factor.

bgs = Below Ground Surface.
ft = Feet.
ft^2 = Square Feet.
yd^3 = Cubic Yards.

ES.3.2 Remedial Alternatives

Remedial technologies and process options were screened to identify potential remedial alternatives that can achieve the RAO. The remedial alternatives developed are presented below:

- Alternative 1: No Action.
- Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs.
- Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs.
- Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment.
- Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment.

Alternative 1: No Action – This alternative is required for evaluation under the NCP and provides the baseline against which other remedial alternatives are compared.

Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs – This alternative would include removing surface and subsurface soil to achieve RGOs for the Industrial Receptor COCs. Implementation of Alternative 2 would result in excavation and off-site disposal of approximately 5,838 cubic yards of soil from Load Lines 1 through 4 and 12. Excavations would be backfilled with approved, clean soil. Unacceptable risk will remain on site for the Resident Receptor in portions of each of the load lines; therefore, this alternative also will rely on land use controls (LUCs) and 5-year reviews to prevent Resident Receptor exposure to COCs in soil in those areas.

Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs – This alternative would include removing surface and subsurface soil to achieve RGOs for the Industrial Receptor COCs. Implementation of Alternative 3 would include excavation and ex-situ thermal treatment of 5,683 cubic yards of soil and excavation and off-site disposal of approximately 156 cubic yards of lead-contaminated soil from Load Lines 1 through 4 and 12. The treatment system, such as the Vapor Energy Generation (VEG©) treatment system, will be pre-heated to the optimal treatment temperature based on results of past bench- and pilot-scale tests previously conducted using VEG© technology at the former RVAAP. Excavations would be backfilled with thermally treated soil. LUCs and 5-year reviews will be conducted as described in Alternative 2.

Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment – This alternative would include removing surface and subsurface soil and sediment (Kelly's Pond) to achieve RGOs for the Resident Receptor COCs. Similar to Alternative 2, but for a significantly larger volume of soil, implementation of Alternative 4 would include excavation and off-site disposal of approximately 31,447 cubic yards of soil from Load Lines 1 through 4 and 12. Excavations would be backfilled with approved, clean soil. Remediation would also include temporary dewatering and sediment removal from the bottom of Kelly's Pond. No LUCs or 5-year reviews pursuant to CERCLA would be required because this alternative attains a level of protection for unrestricted use of the AOC.

Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment – This alternative would include removing surface and subsurface soil and sediment (Kelly's Pond) to achieve RGOs for the Resident Receptor COCs. This alternative would utilize ex-situ thermal treatment, such as the VEG© treatment, for soil with PAH, explosives, or PCB contamination above Residential RGOs in conjunction with excavation and off-site disposal of soil with metals concentrations above the cleanup goals. Similar to Alternative 3, but for a significantly larger volume of soil, implementation of Alternative 5 would result in thermal treatment of 30,121 cubic yards of soil and excavation and off-site disposal of approximately 1,327 cubic yards of soil from Load Lines 1 through 4 and 12. Excavations would be backfilled with approved, clean soil from a local commercial supplier. Disturbed areas would be restored to grade and re-vegetated using an Ohio Army National Guard (OHARNG)-approved seed mixture and mulched. No LUCs or 5-year reviews pursuant to CERCLA would be required because this alternative attains a level of protection for unrestricted use of the AOC.

The four alternatives were compared to CERCLA threshold and balancing criteria, and a comparative analysis was completed to justify the selection of a recommended alternative. Table ES-5 summarizes the comparative analysis of the alternatives.

Table ES-5. Summary of Comparative Analysis of Remedial Alternatives for Load Lines 1 Through 4 and 12

NCP Evaluation Criteria	Alternative 1: No Action	Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs	Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs	Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment	Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment
Threshold Criteria	***Result***	***Result***	***Result***	***Result***	***Result***
1. Overall Protectiveness of Human Health and the Environment	Not protective	Protective	Protective	Protective	Protective
2. Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant	Compliant
Balancing Criteria	***Score***	***Score***	***Score***	***Score***	***Score***
3. Long-term Effectiveness and Permanence	Not applicable	2	2	3	3
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Not applicable	1	2	1	3
5. Short-term Effectiveness	Not applicable	2	3	1	2
6. Implementability	Not applicable	3	3	2	2
7. Cost	Not applicable ($0)	3 $2,011,655	3 $1,649,093	1 $6,990,292	1 $4,702,011
Balancing Criteria Score	*Not applicable*	*11*	*13*	*8*	*11*

Any alternative considered "not protective" for overall protectiveness of human health and the environment or "not compliant" for compliance with ARARs, it is not eligible for selection as the recommended alternative. Therefore, that alternative is not ranked as part of the balancing criteria evaluation.

Scoring for the balancing criteria is as follows: Most favorable = 3, second most favorable = 2, least favorable = 1. The alternative with the highest total balancing criteria score is considered the most feasible.

ARAR = Applicable or Relevant and Appropriate Requirement.

LUC = Land Use Control.

NCP = National Contingency Plan.

ES.3.3 Conclusion/Recommended Alternative

Investigations of each load line concluded that substantial areas of each load line do not require further action to attain Commercial/Industrial Land Use. Limited areas of surface and subsurface soil at each load line were identified as posing unacceptable risk to the Industrial Receptor. Unrestricted (Residential) Land Use was evaluated in this FS Addendum in accordance with Defense Environmental Restoration Program (DERP) Manual 4715.20 (DoD 2012) in order to make appropriate risk management decisions. Consequently, five alternatives were developed and evaluated to determine the most feasible remedial alternative at Load Lines 1 through 4 and 12.

Except Alternative 1, all of the other alternatives were determined to be protective and compliant with the NCP threshold criteria. Thus, Alternatives 2 through 5 were compared against one another to provide information of sufficient quality and quantity to justify the selection of a remedy.

Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs is recommended to address residual contamination and unacceptable risk. Alternative 3 meets the threshold and primary balancing criteria, is protective of the likely future land user (Industrial Receptor), and is a green and highly sustainable alternative. The total cost of Alternative 3 at all five load lines is $1,649,093, making it the most cost-effective alternative.

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1.0 INTRODUCTION

This document was prepared by Leidos under the U.S. Army Corps of Engineers (USACE), Louisville District Contract No. W912QR-12-D-0020, Delivery Order No. 0008. This Feasibility Study (FS) Addendum addresses soil, sediment, and surface water at Load Lines 1 through 4 and soil at Load Line 12 within the former Ravenna Army Ammunition Plant (RVAAP) (now known as Camp Ravenna Joint Military Training Center [Camp Ravenna]) in Portage and Trumbull counties, Ohio (Figures 1-1 and 1-2). The areas of concern (AOCs) addressed in the FS are presented in Table 1-1.

Table 1-1. Feasibility Study AOCs

Load Line	AOC Designation
Load Line 1	RVAAP-08
Load Line 2	RVAAP-09
Load Line 3	RVAAP-10
Load Line 4	RVAAP-11
Load Line 12	RVAAP-12

AOC = Area of Concern.

This report has been prepared in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) *Director's Final Findings and Orders* (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to develop an FS Report by evaluating remedial alternatives to address contamination presenting unacceptable risk to human health and the environment, present a preferred alternative in a Proposed Plan (PP), and document stakeholder selection and acceptance of the preferred final remedy in a Record of Decision (ROD).

1.1 OBJECTIVES AND SCOPE OF THE FEASIBILITY STUDY

In accordance with the NCP and 40 Code of Federal Regulations (CFR) 300.430(e)(1), the primary objective of the FS is to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action options can be presented to a decision maker and an appropriate remedy selected. The preferred alternative will be presented to the public in the PP stage in accordance with 40 CFR 300.430(f)(2). Therefore, the purpose of this FS Addendum is to conduct an evaluation of contaminated media at Load Lines 1 through 4 and Load Line 12 that pose a potential risk to human health and the environment and identify remedial action objectives (RAOs) and appropriate remedial goal options (RGOs), screen remedial technologies, develop remedial alternatives to meet the RAOs and attain RGOs, and perform a detailed evaluation of remedial alternatives to identify a preferred remedy. The specific objectives of the FS are as follows:

- Summarize findings and recommendations from the previous site characterizations for each site and determine if further action is necessary;
- Identify and evaluate chemicals of concern (COCs) at each site, identify areas requiring remedial action, and develop remediation goals;

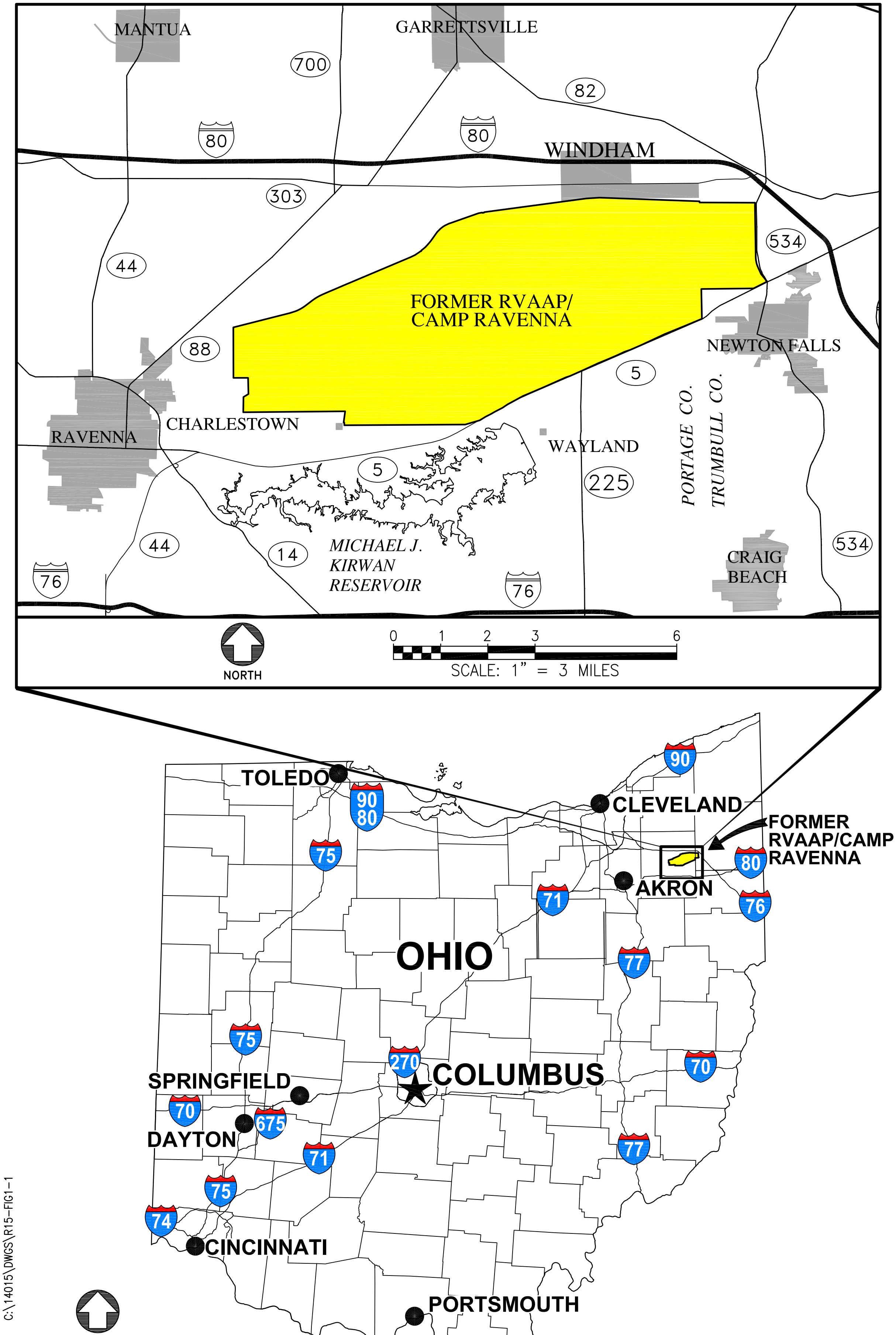

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Figure 1-1. General Location and Orientation of Camp Ravenna

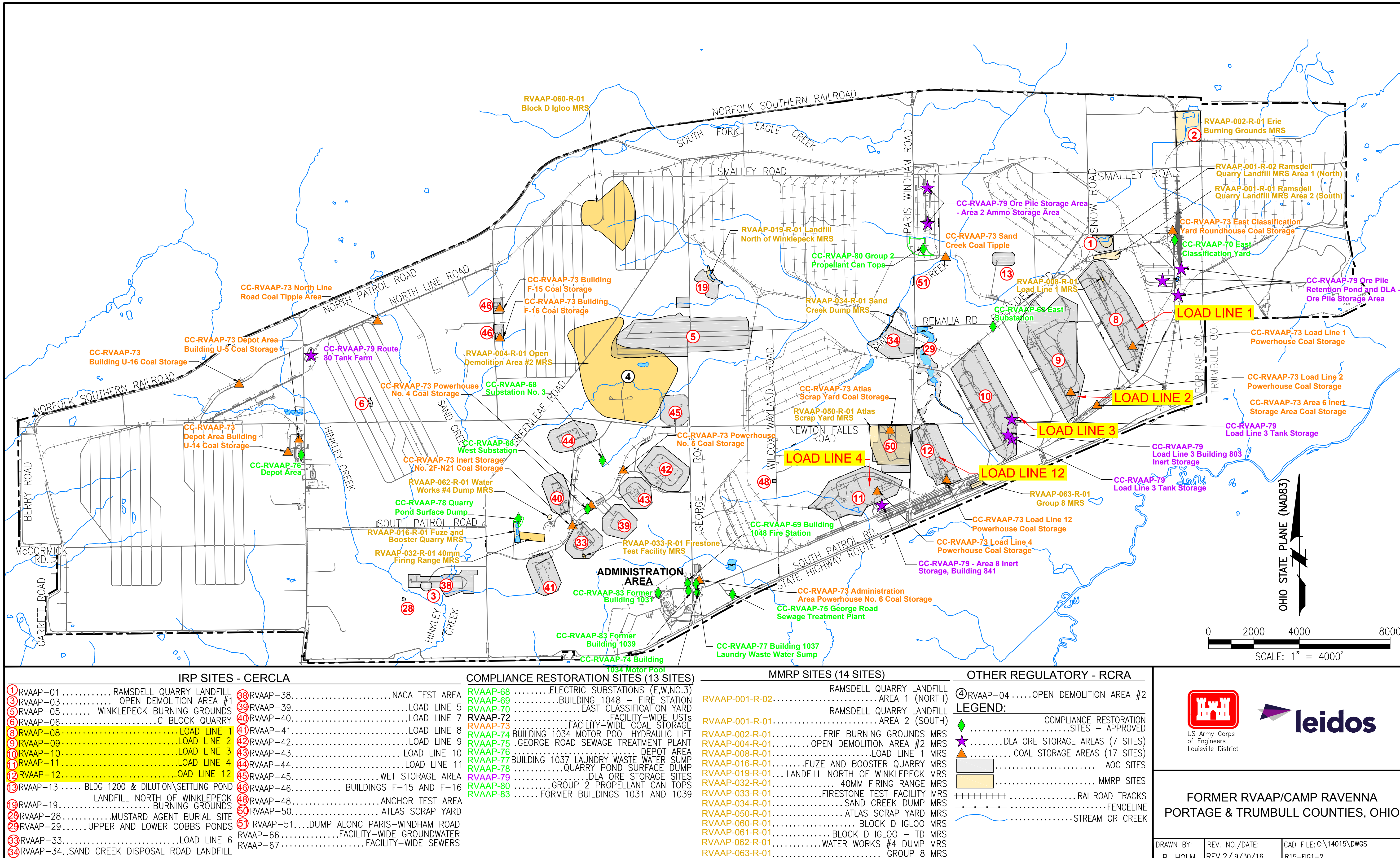

Figure 1-2. Location of AOCs at Camp Ravenna

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- Identify, evaluate, and select the appropriate technologies for incorporation as components of the remedial alternatives;
- Perform a detailed and comparative analysis of alternatives using the nine evaluation criteria; and
- Recommend a preferred alternative for each site.

Following signature of an Interim ROD (IROD) for Load Lines 1 through 4 in 2007 and Load Line 12 in 2009, activities at the five AOCs included completion of remedial actions addressing soil contamination identified for the National Guard Trainee receptor. In February 2014, the U.S. Department of the Army (Army) and Ohio EPA amended the risk assessment process to address changes in the RVAAP restoration program. The *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the RVAAP Installation Restoration Program* (hereafter referred to as the Technical Memorandum) (ARNG 2014) identified three Categorical Land Uses and Representative Receptors to be considered during the CERCLA process. These three Land Uses and Representative Receptors are:

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer),
2. Military Training Land Use – National Guard Trainee, and
3. Commercial/Industrial Land Use – Industrial Receptor (U.S. Environmental Protection Agency [USEPA] Composite Worker).

At Load Lines 1 through 4 and 12, soil was previously remediated for COCs that exceeded Facility-wide Cleanup Goals (FWCUGs) established for the National Guard Trainee. After the removal actions were completed to attain concentrations protective of Military Training Land Use, multiple characterization activities occurred to identify the extent of residual contamination in soil. The Army elected to complete this FS Addendum to summarize all data collected since remedial activities occurred, provide updated human health risk assessments (HHRAs), and evaluate remediation scenarios for the Resident Receptor (Adult and Child) and the Industrial Receptor (USEPA Composite Worker) to be protective of full-time occupational exposures, including Military Training Land Use.

The scope of this FS Addendum also includes an ecological screening evaluation of surface water and sediment at Load Lines 1 through 4 only. At Load Line 12, surface water and sediment is currently being evaluated under a separate Remedial Investigation (RI)/FS report; therefore, additional evaluation in this FS Addendum is not required.

Potential impacts to groundwater from soil (i.e., contaminant leaching) are evaluated in this report, as protectiveness to groundwater is included in the fate and transport analysis and evaluation of remedial alternatives for these media. However, groundwater will be evaluated as an individual AOC for the entire facility (designated as RVAAP-66) and addressed in a separate RI/FS Report.

Soil was evaluated for ecological receptors for all five Load Lines (1 through 4 and 12) during the initial RI/FSs. As concluded in the IROD at Load Lines 1 through 4 (USACE 2007) and the Final

ROD at Load Line 12 (USACE 2009a), remediation to meet human health cleanup goals would reduce overall contaminant concentrations and ecological risk. As a result, ecological cleanup goals were not required to achieve RAOs.

1.2 REPORT ORGANIZATION

This report is organized in accordance with Ohio EPA and USEPA CERCLA FS guidance and applicable USACE guidance. The following is a summary of the components of the report and a list of appendices:

- ***Section 1.0 Introduction***—The remainder of this section presents the facility description, history, and land use; discusses the environmental setting for the facility; and summarizes the methodology used to evaluate data at each site.
- ***Section 2.0 Site Characterization***—This section provides the operational history and environmental setting of each load line, a summary of previous investigations, recent sampling activities, data assembly and use, and the conceptual site model (CSM).
- ***Section 3.0 Remedial Action Objectives, Cleanup Goals, and Volume Calculations***—This section presents the RAOs, appropriate cleanup goals for remedial actions, and volume estimates of media requiring remediation to attain specific Land Use scenarios.
- ***Section 4.0 Applicable or Relevant and Appropriate Requirements***—This section discusses the chemical-, location-, and action-specific applicable or relevant and appropriate requirements (ARARs) for these sites.
- ***Section 5.0 Technology Types and Process Options***—This section identifies and describes general response actions (GRAs) that may be implemented to achieve RGOs. In addition, this section summarizes the remedial technologies and 1-process options available based on the technology status and site-specific conditions.
- ***Section 6.0 Development of Remedial Alternatives***—This section presents the alternatives developed based on technologies retained during the screening process.
- ***Section 7.0 Analysis of Remedial Alternatives***—This section presents the detailed analysis of alternatives using the nine evaluation criteria.
- ***Section 8.0 Comparative Analysis Of Remedial Alternatives***—This section presents the results of the comparative analysis for the evaluated alternatives.
- ***Section 9.0 Conclusions and Recommended Alternative***—This section presents the recommended action for Load Lines 1 through 4 and 12.
- ***Section 10.0 References***—The section provides updated references for all cited documents.
- ***Appendices:***
  - Appendix A. Previous Investigations at Load Lines 1 Through 4 and 12
  - Appendix B. FS Addendum Field Summary
  - Appendix C. Sample Forms and Photo Log
  - Appendix D. Data Quality Control Summary Report
  - Appendix E. FS Addendum 2016 Sampling Results
  - Appendix F. Investigation-Derived Waste Management Reports
  - Appendix G. Fate and Transport Modeling Results
  - Appendix H. Human Health Risk Assessment
  - Appendix I. Ecological Risk Assessment Information and Data

- o Appendix J. Detailed Cost Estimates
- o Appendix K. Ohio EPA Comments and Responses.

1.3 FACILITY-WIDE BACKGROUND INFORMATION

This section summarizes the facility history, demographics, and current land use.

1.3.1 Facility Background

The facility, consisting of 21,683 acres, is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (3 miles) east/northeast of the city of Ravenna and approximately 1.6 kilometers (1 mile) northwest of the city of Newton Falls (Figure 1-1). The facility, previously known as RVAAP, was formerly used as a load, assemble, and pack facility for munitions production. As of September 2013, administrative accountability for the entire acreage of the facility has been transferred to the U.S. Property and Fiscal Officer (USP&FO) for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a military training site (Camp Ravenna). References in this document to RVAAP relate to previous activities at the facility as related to former munitions production activities or to activities being conducted under the restoration/cleanup program.

Industrial operations at the former RVAAP consisted of 12 munitions-assembly facilities referred to as “load lines.” Load Lines 1 through 4 were used to melt and load 2,4,6-trinitrotoluene (TNT) and Composition B into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls were cleaned with water and steam. Following cleaning, the waste water, containing TNT and Composition B, was known as “pinkwater” for its characteristic color. Pink water was collected in concrete holding tanks, filtered, and pumped into unlined ditches for transport to earthen settling ponds. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. From 1946 to 1949, Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers prior to use as a weapons demilitarization facility.

In 1950, the facility was placed in standby status and operations were limited to renovation, demilitarization, and normal maintenance of equipment, along with storage of munitions. Production activities were resumed from July 1954 to October 1957 and again from May 1968 to August 1972. In addition to production missions, various demilitarization activities were conducted at facilities constructed at Load Lines 1, 2, 3, and 12. Demilitarization activities included disassembly of munitions and explosives melt-out and recovery operations using hot water and steam processes. Periodic demilitarization of various munitions continued through 1992.

In addition to production and demilitarization activities at the load lines, other facilities at RVAAP include AOCs that were used for the burning, demolition, and testing of munitions. These burning and demolition grounds consist of large parcels of open space or abandoned quarries. Other types of

AOCs present at RVAAP include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities.

A detailed description of historical operations, potential contamination sources, and previous investigation and remediation efforts for each AOC (Load Lines 1 through 4 and 12), along with a timeline that illustrates associated remedial and demolition activities, is presented in Section 2 and Appendix A.

1.3.2 Demography and Land Use

Camp Ravenna occupies east-central Portage County and southwestern Trumbull County. Census projections for 2010 indicated the populations of Portage and Trumbull counties are 161,419 and 210,312, respectively. Population centers closest to Camp Ravenna are Ravenna, with a population of 11,724, and Newton Falls, with a population of 4,795.

The facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55% of Portage County, in which the majority of Camp Ravenna is located, consists of either woodland or farmland acreage. The closest major recreational area, the Michael J. Kirwan Reservoir (also known as West Branch Reservoir), is located adjacent to the western half of Camp Ravenna, south of State Route 5.

Camp Ravenna is federally owned and is licensed to the OHARNG for use as a military training site. Restoration activities at Camp Ravenna are managed by the Army National Guard and OHARNG. Training and related activities at Camp Ravenna include field operations and bivouac training, convoy training, equipment maintenance, C-130 aircraft drop zone operations, helicopter operations, and storing heavy equipment.

1.4 ENVIRONMENTAL SETTING

This section summarizes the environmental setting for the installation. The environmental setting incorporates aspects of the physiography and topography, climate, geology and hydrogeology, and ecology for the installation and surrounding areas.

1.4.1 Physiographic Setting

Camp Ravenna is located within the southern New York Section of the Appalachian Plateaus physiographic province (USGS 1968). This province is characterized by elevated uplands underlain primarily by Mississippian and Pennsylvanian age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography, with incised streams having dendritic drainage patterns. The southern New York Section has been modified by glaciation, which rounded ridges, filled major valleys, and blanketed many areas with glacially derived unconsolidated deposits (e.g., sand, gravel, and finer-grained outwash deposits). As a result of glacial activity in this section, old stream drainage patterns were disrupted in many locales, and extensive wetland areas developed.

1.4.2 RVAAP Surface Features

The topography of Camp Ravenna is gently undulating, with an overall decrease in ground elevation from a topographic high of approximately 1,220 ft above mean sea level (amsl) in the far western portion of the facility to low areas at approximately 930 ft amsl in the far eastern portion of the facility.

USACE mapped the facility topography in February 1998 using a 2-ft contour interval with an accuracy of 0.02 ft. USACE based the topographic information on aerial photographs taken during the spring of 1997.

1.4.3 Geology and Hydrogeology

This section describes the regional geology, soil and glacial deposits, regional hydrogeology, and regional surface water features.

1.4.3.1 Regional Geology

The regional geology at Camp Ravenna consists of horizontal to gently dipping bedrock strata of Mississippian and Pennsylvanian age, overlain by varying thicknesses of unconsolidated glacial deposits. The bedrock and unconsolidated geology at Camp Ravenna is presented in the following subsections.

1.4.3.2 Soil and Glacial Deposits

Bedrock at Camp Ravenna is overlain by deposits of the Wisconsin-age Lavery Till in the western portion of the facility and the younger Hiram Till and associated outwash deposits in the eastern two-thirds of the facility. Unconsolidated glacial deposits vary considerably in their character and thickness across Camp Ravenna, from zero ft in some of the eastern portions of the facility to an estimated 150 ft in the south-central portion.

Thin coverings of glacial material have been completely removed as a consequence of human activities at locations such as Ramsdell Quarry. Bedrock is present at or near the ground surface in locations such as at Load Line 1 and the Erie Burning Grounds (EBG) (USACE 2001). Where this glacial material is still present, its distribution and character indicate its origin as ground moraine. These tills consist of laterally discontinuous assemblages of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments. Lacustrine sediment from bodies of glacial-age standing water has also been encountered in the form of deposits of uniform light gray silt greater than 50-ft thick in some areas (USACE 2001).

Soil at Camp Ravenna is generally derived from the Wisconsin-age silty clay glacial till. Distributions of soil types are discussed and mapped in the *Soil Survey of Portage County, Ohio*, which describes soil as nearly level to gently sloping and poor to moderately well drained (USDA 1978). Much of the native soil in production and operational areas at former Camp Ravenna was disturbed during construction activities.

The Sharon Member of the Pennsylvanian Pottsville Formation is the primary bedrock beneath Camp Ravenna. In the western half of the facility, the upper members of the Pottsville Formation, including the Connoquenessing Sandstone (also known as the Massillon Sandstone), Mercer Shale, and uppermost Homewood Sandstone, have been found. The regional dip of the Pottsville Formation measured in the western portion of Camp Ravenna is between 5 and 11.5 ft per mile to the south.

1.4.3.3 Regional Hydrogeology

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County, as described in the *Phase I Remedial Investigation Report for High-Priority Areas of Concern* (USACE 1998). Generally, these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies; however, yields are sufficient for residential water supplies. Lateral continuity of these aquifers is unknown. Recharge of these units is derived from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at Camp Ravenna have not been delineated.

The thickness of the unconsolidated interval at Camp Ravenna ranges from thin to absent in the eastern and northeastern portion of Camp Ravenna, to an estimated 150 ft in the central portion of the facility. The groundwater table occurs within the unconsolidated zone in many areas of the facility. Because of the heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns are difficult to determine with a high degree of accuracy. Vertical recharge from precipitation likely occurs via infiltration along root zones, desiccation cracks, and partings within the soil column. Laterally, most groundwater flow likely follows topographic contours and stream drainage patterns, with preferential flow along pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities than surrounding clay or silt-rich material.

Within bedrock units at Camp Ravenna, the principal water-bearing aquifer is the Sharon Sandstone/Conglomerate. Depending on the existence and depth of overburden, the Sharon Sandstone/Conglomerate ranges from an unconfined to a leaky artesian aquifer. Water yields from on-site water supply wells completed in the Sharon Sandstone/Conglomerate ranged from 30 to 400 gallons per minute (gpm) (USATHAMA 1978). Well yields of 5 to 200 gpm were reported for on-site bedrock wells completed in the Sharon Sandstone/Conglomerate (Kammer 1982). Other local bedrock units capable of producing water include the Homewood Sandstone, which is generally thinner and only capable of well yields less than 10 gpm, and the Connoquenessing Sandstone. Wells completed in the Connoquenessing Sandstone in Portage County have yields ranging from 5 to 100 gpm but are typically less productive than the Sharon Sandstone/Conglomerate due to lower permeabilities (Winslow et al. 1966).

A bedrock potentiometric map developed for RVAAP shows a more uniform and regional eastward flow direction than the unconsolidated zone, which is more affected by local surface topography. Due to the lack of well data in the western portion of Camp Ravenna, general flow patterns are difficult to discern. For much of the eastern half of Camp Ravenna, bedrock potentiometric elevations are higher than the overlying unconsolidated potentiometric elevations, indicating an upward hydraulic gradient. This evidence suggests there is a confining layer that separates the two aquifers. In the far eastern area, the two potentiometric surfaces are at approximately the same elevation, suggesting hydraulic communication between the two aquifers is occurring.

1.4.3.4 Regional Surface Water

Camp Ravenna resides within the Mahoning River watershed, which is part of the Ohio River basin. The west branch of the Mahoning River is the main surface stream in the area. The west branch flows adjacent to the west end of the facility, generally in a north to south direction, before flowing into the Michael J. Kirwan Reservoir, located to the south of State Route 5. The west branch flows out of the reservoir and parallels the southern Camp Ravenna boundary before joining the Mahoning River east of Camp Ravenna. The western and northern portions of Camp Ravenna display low hills and a dendritic surface drainage pattern. The eastern and southern portions are characterized by an undulating to moderately level surface, with less dissection of the surface drainage. The facility is marked with marshy areas and flowing and intermittent streams whose headwaters are located in the upland areas of the facility.

The three primary watercourses that drain Camp Ravenna are (Figure 1-2):

- South Fork of Eagle Creek,
- Sand Creek, and
- Hinkley Creek.

These watercourses have many associated tributaries. Sand Creek, with a drainage area of 13.9 square miles, generally flows in a northeast direction to its confluence with the south fork of Eagle Creek. In turn, the south fork of Eagle Creek continues in a northerly direction for 2.7 miles to its confluence with Eagle Creek. The drainage area of the South Fork of Eagle Creek is 26.2 square miles, including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Route 88 and State Route 303 to the north of the facility. Hinkley Creek, with a drainage area of 11 square miles, flows in a southerly direction through the facility and converges with the west branch of the Mahoning River south of the facility (USACE 2001).

Jurisdictional wetland delineation surveys have been conducted over approximately one-quarter (5,680 acres) of Camp Ravenna. Of the surveyed area, 715 acres meet the regulatory definition of a wetland, with the majority of the wetland areas located in the eastern portion of the facility. Wetland areas at Camp Ravenna include seasonal wetlands, wet fields, and forested wetlands. Many of the wetland areas are the result of natural drainage or beaver activity; however, some wetland areas are associated with anthropogenic settling ponds and drainage areas.

Approximately 28 ponds are scattered throughout the facility (OHARNG 2014). Many were constructed within natural drainage ways to function as settling ponds or basins for process effluent and runoff. Others are natural in origin, resulting from glacial action or beaver activity. Storm water runoff is controlled primarily by natural drainage, except in former operations areas where an extensive storm sewer network helps to direct runoff to drainage ditches and settling ponds. In addition, the storm sewer system was one of the primary drainage mechanisms for process effluent while production facilities were operational.

1.4.4 Climate

The general climate of the Camp Ravenna area is continental and is characterized by moderately warm and humid summers, reasonably cold and cloudy winters, and wide variations in precipitation from year to year. The climate data presented below for the Camp Ravenna area were obtained from available National Weather Service records for the 30-year period of record from 1981–2010 at the Youngstown Regional Airport, Ohio (http://www.weather.gov/climate/xmacis.php?wfo=cle). Wind speed data for Youngstown, Ohio, are from the National Climatic Data Center (http://www1.ncdc.noaa.gov/pub/data/ccd-data/wndspd14.txt) for the available 30-year period of record from 1984–2014.

Average annual rainfall at Camp Ravenna area is 38.86 inches, with the highest monthly average occurring in July (4.31 inches) and the lowest monthly average occurring in February (2.15 inches). Average annual snowfall totals approximately 62.9 inches, with the highest monthly average occurring in January (17.1 inches). Due to the influence of lake-effect snowfall events associated with Lake Erie (located approximately 35 miles to the northwest of Camp Ravenna), snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the Camp Ravenna area is 49.3ºF, with an average daily high temperature of 70.9ºF and an average daily low temperature of 26.1ºF. The record high temperature of 100ºF occurred in July 1988, and the record low temperature of -22ºF occurred in January 1994. The prevailing wind direction at Camp Ravenna is from the southwest, with the highest average wind speed occurring in January (10.3 miles per hour) and the lowest average wind speed occurring in August (6.5 miles per hour). Thunderstorms occur on approximately 35 days per year and are most abundant from April through August. Camp Ravenna is susceptible to tornadoes; minor structural damage to several buildings on facility property occurred as the result of a tornado in 1985.

1.5 DATA EVALUATION

The general decision rules that applied to the data evaluation for all AOCs are presented in the following section. Each AOC is proceeding through the CERCLA process individually and varies in regard to historical use, previous investigations, and areas requiring additional evaluation in the FS. Therefore, the general decision rules are applied to each AOC individually.

This section presents the procedure followed to complete the data analysis for soil, surface water, and sediment to determine areas that require additional evaluation to meet Unrestricted (Residential) Land Use criteria. The steps used in the data gap analysis procedure are presented in detail below:

- Assemble all previously collected data stored in the Ravenna Environmental Information Management System (REIMS).
- Perform a data use assessment by reviewing all data to ensure that the medium sampled is still present and has not been removed during remediation, and ensuring that the data approved for use meet the data quality objectives (DQOs) established for the data gap analysis.
- Identify AOC-specific chemicals of interest (COIs) that will be evaluated for this AOC, including the COCs presented in the IROD or ROD, as applicable, and historical RIs that evaluated the Residential Scenario.
- Perform the data screen on a sample-by-sample basis using the current residential RGOs (all media). The residential RGOs are the residential FWCUGs at a target risk (TR) level of 1E-05 and a target hazard quotient (HQ) of 1.
- Perform a data screen on a sample-by-sample basis using the current ecological screening criteria followed by a weight-of-evidence (WOE) evaluation (surface water and sediment only).
- Perform a detailed evaluation of each location that exceeds residential RGOs and/or ecological screening criteria to determine if additional evaluation is required.

1.5.1 Data Assembly and Use Assessment

Data were selected spatially to ensure that all samples in the vicinity of the AOC were included regardless of the project for which they were collected. A list of all samples associated with each AOC was generated, and the characteristics of each sample in the list were reviewed to determine if the sample was representative of that medium in the FS Addendum.

Sediment samples were categorized as wet or dry based on the following definition:

> *Unconsolidated inorganic and organic material on the surface of the ground that occasionally may be covered with water, usually following a precipitation event. Dry sediments are not covered with water for extended periods and typically are dry within seven days. Dry sediments do not function as permanent habitat for aquatic organisms although they may serve as a natural medium for the growth of terrestrial organisms. These sediments are essentially soil that due to its location may be covered with water occasionally.*

Based on this definition, dry sediment samples will be evaluated with the "soil" samples and wet sediment samples will be evaluated as "sediment." Sediment and surface water samples associated with the Facility-wide Sewer RI/FS were excluded from the data set and all surface water and sediment samples from Load Line 12 were excluded from analysis as they were evaluated under a separate RI/FS.

A geographic information system (GIS) was used to identify soil sample locations within remediated areas, which were subsequently removed from the evaluation on that premise. Discrete sample locations that were targeted for remediation based on the maps in the remedial action completion reports for Load Lines 1 through 4 also were removed from the evaluation. Remediation confirmation samples were retained and treated as subsurface soil with the starting depth of the sample set to the average excavation depth, unless the area was subsequently remediated.

Samples collected during the Phase I RI in 1996 were excluded due to the uncertainty in characterizing such old samples. Only primary samples were used in the evaluation. Field duplicates and split samples were excluded to ensure locations were not over represented. Field screening results were excluded from the FS Addendum data set because of the uncertainty associated with those results. However, field screening conducted during building slab removal and following excavation activities was considered qualitatively in the data gap analysis in cases where analytical samples were not collected due to field screening results demonstrating COIs were no longer present.

1.5.1.1 Determination of AOC-specific Chemicals of Interest

The data analysis utilizes sample data for COIs only. COIs are defined in this report as the COCs identified in previous RIs or RODs for Unrestricted (Residential) Land Use.

1.5.1.2 Human Health COIs

The Phase II RIs completed for each of the five AOCs presented the results of human health screening evaluations that identified COCs exceeding residential screening criteria. These COCs were compiled for each medium under investigation in the FS Addendum Report and identified as COIs. The COIs selected for human health concern in the Phase II RIs to be further evaluated in this FS Addendum are presented in Section 2 for each medium. Following screening, constituents exceeding criteria are carried through the data gap analysis as COIs requiring additional analysis.

1.5.1.3 Ecological COIs

The Phase II RIs completed for Load Lines 1 through 4 presented the results of ecological risk evaluations that identified chemicals of ecological concern (COECs) or chemicals of potential ecological concern (COPECs). These COECs and COPECs were compiled for surface water and sediment and identified as COIs. The COIs selected for ecological concern in the Phase II RIs to be further evaluated in this FS Addendum are presented in Section 2 for each medium. Following the ecological screening, constituents exceeding criteria are carried through the data gap analysis as COIs requiring additional analysis.

1.5.1.4 Soil Leaching COIs

COIs for evaluation of the potential for leaching from soil to groundwater (soil leaching COIs) are identified as:

- Contaminant migration chemicals of potential concern (CMCOPCs) identified in the Phase II RIs for each AOC. CMCOPCs were identified in the Phase II RIs as (1) chemicals predicted by Seasonal Soil Compartment (SESOIL) modeling to reach the water table at a concentration greater than the federal maximum contaminant level (MCL) or risk-based concentration (RBC) within 1,000 years, and (2) chemicals detected in groundwater above the MCL/RBC.
- Groundwater COCs for residential potable water use, identified in the Phase II RIs that were also identified in the Phase II RIs as present in soil above USEPA generic soil screening levels (SSLs).
- Chemicals detected above the MCL/Regional Screening Level (RSL) in the most recent groundwater sampling event (generally in 2014) unless eliminated for other reasons (e.g., soil concentrations were below background levels).

1.5.2 Identification of COCs for Potential Remediation

COCs are identified as any COI having a concentration greater than an applicable RGO or contributing more than 5 to 10% to a sum-of-ratios (SOR) greater than one. For inorganic chemicals with RGOs below background concentrations, the background concentration was used as the point of comparison. The TR for the RGOs used to identify COCs is 1E-05 per the Ohio EPA Division of Environmental Response and Revitalization (DERR) program, which has adopted a human health cumulative incremental lifetime cancer risk (ILCR) goal of 1E-05 to be used as the level of acceptable excess cancer risk and for developing site remediation goals.

The results of the COC screening are combined with the results of the uncertainty assessment to identify COCs to be carried forward for remediation.

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2.0 SITE CHARACTERIZATION

This section provides a summary of each load line's operational history, environmental setting, co-located or proximate sites, previous investigations, summary of June 2016 surface water/sediment sampling at Load Lines 1 through 3, data assembly and use assessment, and the conceptual site model (CSM).

2.1 LOAD LINE 1

Load Line 1 is located in the southeastern portion of the facility and was in operation from 1941 until 1971. From 1941 through 1945 and from 1951 to 1957, Load Line 1 was used to melt and load TNT and Composition B explosives into large-caliber shells, which took place at the major melt pour buildings (CB-4 and CB-4A). From 1941 to 1945, Load Line 1 produced 26,770,822 ammunition shells and 2,536,950 projectiles, and from 1951 to 1957, Load Line 1 produced 7,642,166 cartridges, shells, and charges. From 1947 to 1949, demilitarization projects occurred at Load Line 1. In 1949, the TNT washout plant and debanding equipment were moved from Load Line 1 to Load Line 12.

From 1950 to 1952, Load Line 1 reclaimed cartridge bases for reuse. Sulfuric acid, sodium orthosilicate, chromic acid, and alkali were used in the annealing process. From 1961 to 1967, Load Line 1 was the site of munitions rehabilitation activities and the demilitarization of 500,000 90mm projectiles. During this time, Buildings CB-13 and CB-14 were used for activities such as dismantling, replacing components, and repainting mines. In 1965 and 1966, Load Line 1 was used for demilitarizing propellant charges and cartridges. In 1973 and 1974, demilitarization operations on 455,475 90mm cartridges occurred at the load line. The melt out operation for the cartridges was conducted at Load Line 12. Wash-down water and wastewater from the load line operations were collected in concrete sumps; pumped through sawdust filtration units; and discharged to the unlined settling ponds, Charlie's Pond and Criggy's Pond. The Load Line 1 dilution/settling ponds were in operation from 1941 to 1971. Water from the settling ponds was discharged to a surface stream (Sand Creek) that exited the installation. Load Line 1 was rehabilitated in 1951 to remove and replace soil contaminated with accumulated explosives and to remove and replace wastewater lines.

All buildings and structures at Load Line 1 have been demolished. Each building formerly located at Load Line 1 is presented below with a summary of its historical use and potential contamination source description. Former production buildings are included in Table 2-1, and the non-production buildings are listed in Table 2-2. Figure 2-1 presents the Load Line 1 AOC features.

2.1.1 Environmental Setting

This section provides a summary of the environmental setting of Load Line 1 as presented in the Phase II RI Report for Load Line 1 (USACE 2003) and includes surface features and site topography, geologic setting, and local hydrogeology.

Table 2-1. Former Production Buildings at Load Line 1

Production Buildings		
Building ID	**Purpose**	**Description of Potential Sources**
CA-6	Explosive Preparation Building	Used to screen bulk TNT flake prior to transport to the melt pour building. A washout collection tank was located adjacent to building (west) for pinkwater collection.
CA-6A	Explosive Preparation Building	Used to screen bulk TNT flake prior to transport to the melt pour building. A washout collection tank located adjacent to building for pinkwater collection.
CA-28	Elevator Machine House	Takes screened TNT from Building CA-6 and transports to CB-4 for melt pour operations.
CA-28A	Elevator Machine House	Takes screened TNT from Building CA-6A and transports to CB-4A for melt pour operations.
CB-4	Melt Load Building	Located in the production area, this building was a primary melt pour building for explosives. Contamination was noted to be prevalent around doorways, drains, and vacuum pumps.
CB-4-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes pulled from the melt pour building.
CB-4-WN	Washout Annex	Concrete settling tanks adjacent to Building 4 to containerize explosives washout water (pinkwater).
CB-4-WS	Washout Annex	Concrete settling tanks adjacent to Building 4 to containerize explosives washout water (pinkwater).
CB-4A	Melt Load Building	Located in the production area, this primary melt pour building was for explosives. Contamination was noted to be prevalent around doorways, drains, and vacuum pumps.
CB-4A-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes pulled from the melt/pour building.
CB-4A-WN	Washout Annex	Concrete settling tanks adjacent to Building 4A to containerize explosives washout water (pinkwater).
CB-4A-WS	Washout Annex	Concrete settling tanks adjacent to Building 4A to containerize explosives washout water (pinkwater).
CB-10	Drilling and Assembly Building/Boostering Building	Utilized for booster installation and assembly during WWII. During the Vietnam War, this building was used for munitions rehabilitation, which included dismantling, replacing, and repairing munitions. Contamination, including explosives and propellants, was identified around this building.
CB-10-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes pulled from the boostering building (CB-10).
CB-10-VP2	Vacuum Pump House	The vacuum pump was associated with handling process wastes pulled from the boostering building (CB-10).
CB-10-VP3	Vacuum Pump House	The vacuum pump was associated with handling process wastes pulled from the boostering building (CB-10).
CB-13	Packing and Shipping Building	During WWII, CB-13 was utilized as a booster installation building. From 1961–1967, it was utilized as a munitions rehabilitation building. During this time, it was used for demilitarizing primers. During the RIs, bulk propellant pellet contamination was observed adjacent to the building popping furnace at CB-13.
CA-14	Propellant Charge Building	During WWII, CA-14 was utilized for final stages of munitions work (load-assemble-pack operations). From 1961–1967, this building was utilized as a munitions rehabilitation building for the demilitarizing primers. During the RIs, bulk propellant pellet contamination was observed.

Table 2-1. Former Production Buildings at Load Line 1 (continued)

Production Buildings		
Building ID	**Purpose**	**Description of Potential Sources**
CA-17	Propellant Charge Receiving/Smokeless Powder Building	During WWII, CA-17 was utilized for the final stages of munitions work (load-assemble-pack operations) for propellant pellets into ammunition. It also was used as a munitions rehabilitation building/demilitarization processing area from 61-67.
CB-3	Shell Receiving and Painting Building	Used for munitions painting operations.
CB-2	Paint and Oil Storage Building	Utilized for solvent storage.
CB-801	Inert Storage Building	Utilized for storage, potentially vehicle maintenance.

ID = Identification.
RI = Remedial Investigation.
TNT = Trinitrotoluene.
WWII = World War II.

Table 2-2. Former Non-production Buildings at Load Line 1

Non-production Buildings	
Building ID	**Purpose**
CA-21	TNT Box Building
CA-16	Primer Service Building
CA-5	Ammonium Nitrate Service Building
CA-7	TNT Service Area
CB-11	Fuse Service Building
CB-13-A	Car Barricade
CB-13-B	Shipping Warehouse Annex
CB-19	Electric Locomotive Service Building
CB-20	Small Tool Storage Building
CB-25	Shell Carrier Washout Building
CB-4B	Conveyor Drive Building
CB-9	Booster Service Building
CC-1	Power House
SD-2	Sewage Ejector Station
T-4801	Boiler House
WH-25	Well House
WH-26	Well House
WH-27	Well House
WH-86	Well House
WH-87	Well House
WH-88	Well House
WW-1	Pump and Filter Station
WW-1A	Filtered Water Reservoir
WW-21	Elevated Water Tank
1-51	Clock Alley
1-51-A	Load Line Office
CB-12	Change House
CB-8	Change House
CB-22	Change House
CB-23	Change House
CA-15	Change House

ID = Identification.
TNT = Trinitrotoluene.

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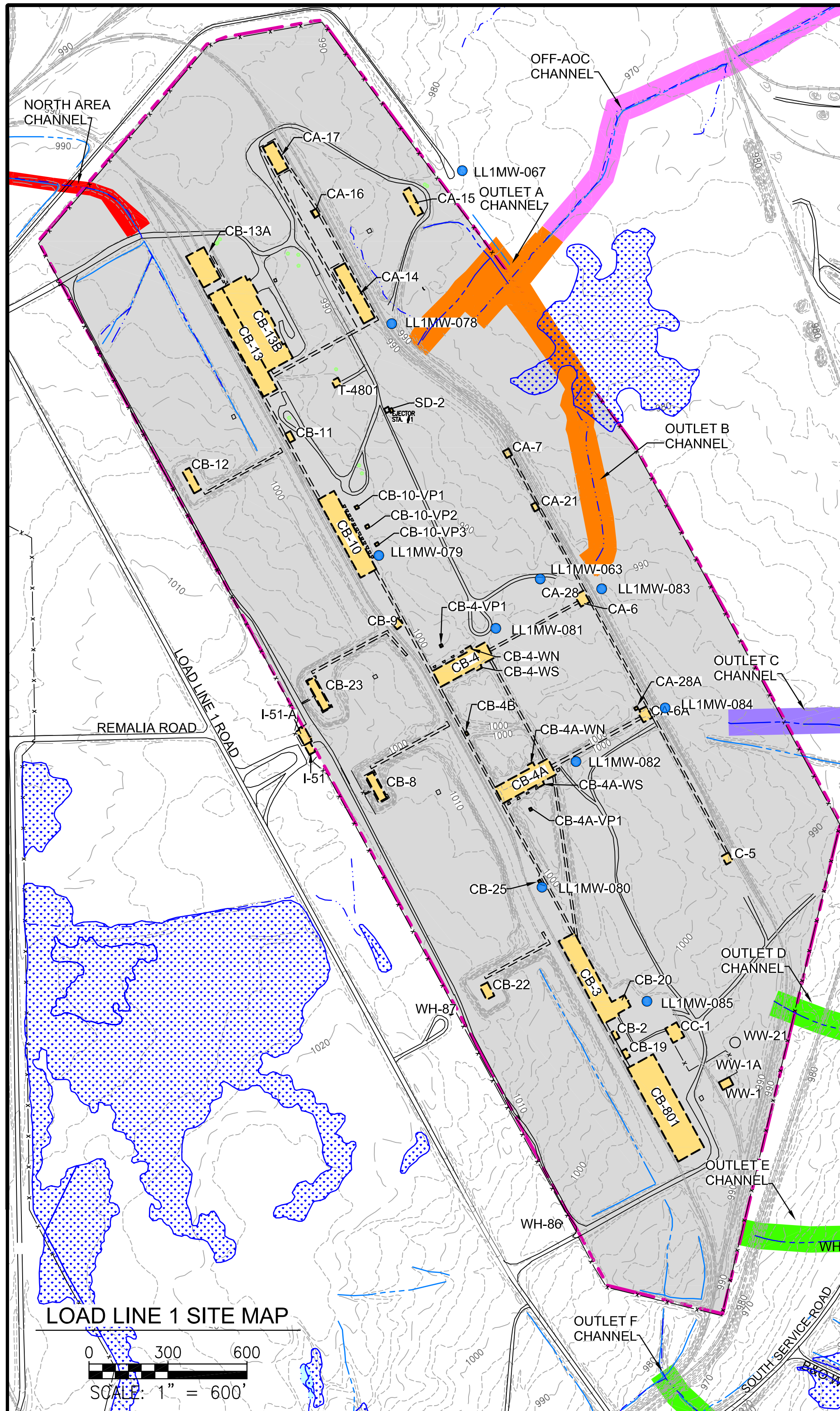
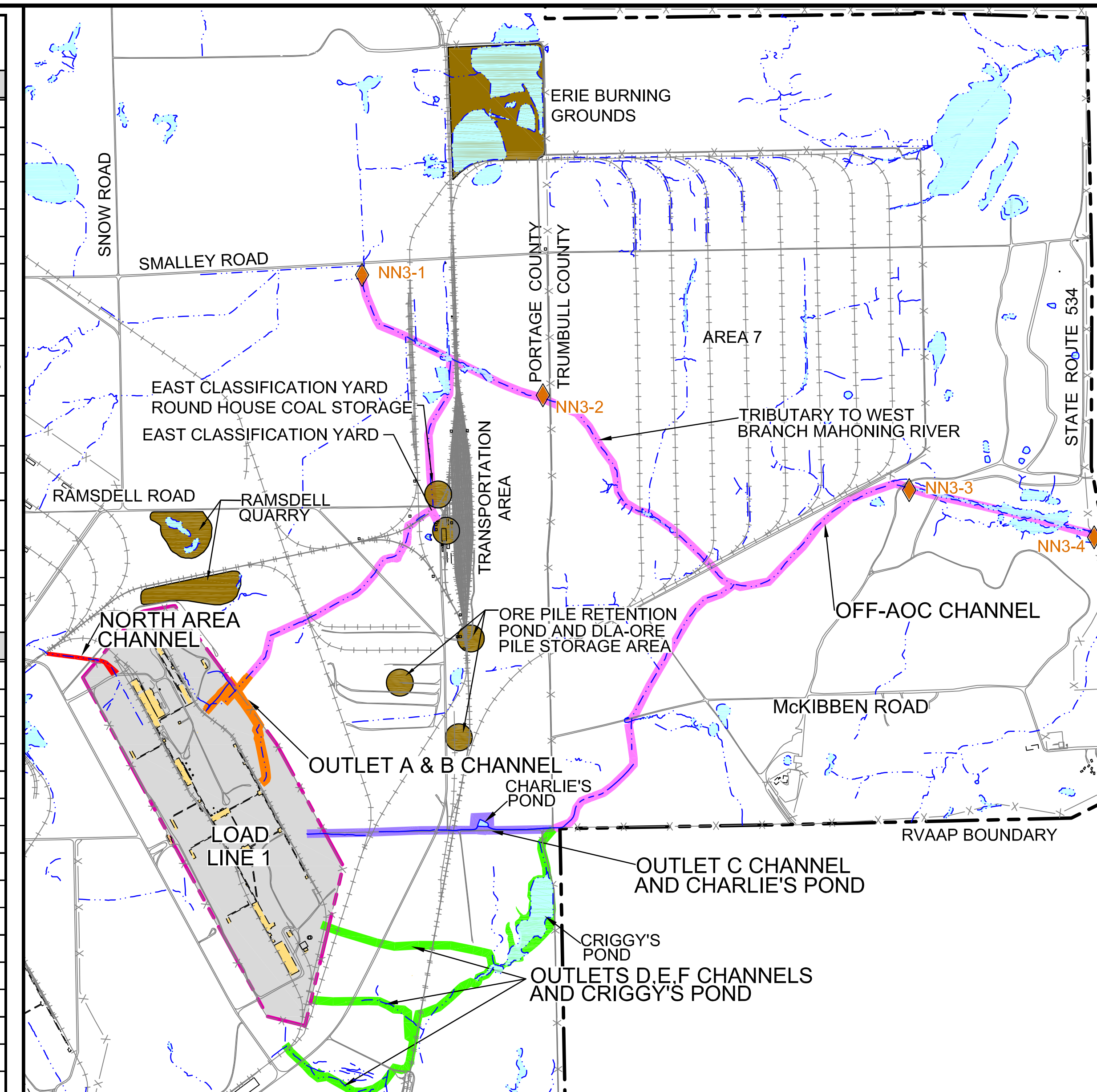


Building ID	Former Building Use and Description
Production Buildings:	
CA-6, CA-6A	Explosive Preparation Building
CA-28, CA-28A	Elevator Machine House
CB-4	Melt Load Building
CB-4-VP1	Vacuum Pump House
CB-4-WN, -WS	Washout Annex
CB-4A	Melt Load Building
CB-4A-VP1	Vacuum Pump House
CB-4A-WN	Washout Annex
CB-4A-WS	Washout Annex
CB-10	Drilling and Assembly Building/Boostering Building
CB-10-VP1, -VP2, -VP3	Vacuum Pump House
CB-13	Packing and Shipping Building
CA-14	Propellant Charge Building
CA-17	Propellant Charge Receiving/Smokeless Powder Building
CB-3	Shell Receiving and Painting Building
CB-2	Paint and Oil Storage Building
CB-801	Inert Storage Building
Non-Production Buildings:	
CA-21	TNT Box Building
CA-16	Primer Service Building
CA-5	Ammonium Nitrate Service Building
CA-7	TNT Service Area
CB-11	Fuse Service Building
CB-13-A	Car Barricade
CB-13-B	Shipping Warehouse Annex
CB-19	Electric Locomotive Service Building
CB-20	Small Tool Storage Building
CB-25	Shell Carrier Washout Building
CB-4B	Conveyor Drive Building
CB-9	Booster Service Building
CC-1	Power House
SD-2	Sewage Ejector Station
T-4801	Boiler House
WH-26,-86, -87	Well House (Note: WH-25,-27,-88 are SE of AOC)
WW-1	Pump and Filter Station
WW-1A	Filtered Water Reservoir
WW-21	Elevated Water Tank
I-51	Clock Alley
I-51-A	Load Line Office
CB-8,-12,-15,-22, -23	Change Houses

NOTE: ALL ABOVE GROUND STRUCTURES ARE DEMOLISHED



SURFACE WATER & SEDIMENT AGGREGATES

- NORTH AREA CHANNEL
- OUTLET A AND B CHANNELS
- OUTLET C CHARLIE'S PONDS
- OUTLET D/E/F CHANNELS AND CRIGGY'S POND
- OFF-AOC CHANNEL (Known as Tributary to West Branch Mahoning River in the FWBWQS [USACE 2005])

FACILITY-WIDE BIOLOGICAL AND WATER QUALITY STUDY SEDIMENT AND SURFACE WATER SAMPLE LOCATIONS (USACE 2005a)

0 1000 2000
SCALE: 1" = 2000'

LEGEND:

- DEMOLISHED BUILDING
- ASPHALT ROAD
- GRAVEL ROAD
- STREAM
- POND
- GROUND CONTOUR (10-FT)
- GROUND CONTOUR (2-FT)
- AOC BOUNDARY
- PLANNING LEVEL SURVEY WETLAND
- GROUNDWATER MONITORING WELL

OHIO STATE PLANE (NAD 83)

US Army Corps of Engineers Louisville District

leidos

LOAD LINE 1
FORMER RVAAP/CAMP RAVENNA
RAVENNO, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\14015\DWGS
P. HOLM	R0/ 6/5/17	R15-LL1-NEWFIG2-1

Figure 2-1. Load Line 1 AOC Features

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2.1.1.1 Surface Features and Site Topography

Load Line 1 is situated in the southeastern corner of the RVAAP facility. The AOC is characterized by moderately subdued topography on a reworked sandstone bedrock surface. It is surrounded by woodland and is less than 1 mile from the installation's southern and eastern boundaries.

Site elevations vary from approximately 12.2 m (40 ft) across the AOC, from 309.6 m (1,016 ft) amsl relative to the North American Vertical Datum of 1988 (NAVD88) near the main entrance to 297.2 m (975 ft) amsl near the east perimeter fence. Inside the production area, the ground surface is hummocky as a result of the extensive excavation of bedrock to accommodate the load lines buildings and infrastructure. Outside the production area and to the southeast, the terrain slopes more uniformly southeastward, with elevations ranging from 298.7 m (980 ft) amsl at the railroad track to 285.9 m (938 ft) amsl at the perimeter fence. This smoother topography reflects the presence of glacial sedimentary cover that has been relatively undisturbed throughout RVAAP's active life.

2.1.1.2 Load Line 1 Geologic Setting

The geologic setting subsections describe the soil and bedrock geology at Load Line 1 based on information from monitoring wells drilled for the Phase II RI.

Soil

At Load Line 1, soil cover is very thin to non-existent in the vicinity of Buildings CB-4, CB-4A, CA-6, CA-6A, and CB-14, as these buildings were constructed on excavated bedrock. The presence of soil greater than 0.15 m (0.5 ft) in thickness is observed at locations where fill material was brought in or reworked during either the active life of the load line or during demolition. Native soil in the vicinity of Load Line 1 belongs to the Mahoning silt loam series, which is one of the five major soil types found within the RVAAP facility.

Bedrock Geology

The Sharon Conglomerate is exposed at the ground surface throughout Load Line 1. Notably, the former change houses (CB-23, CB-22, CB-12, and CB-8), the melt pour buildings (CB-4 and CB-4A) and associated walkways to the change houses, Building CB-14, and railroad track to CB13A/13B are constructed on bedrock that was excavated to accommodate these structures. Monitoring wells drilled for the Phase II RI were all completed in the Sharon Conglomerate. Therefore, it is presumed that the thickness of the sandstone bedrock at Load Line 1 exceeds 12.2 m (40 ft). The Sharon Conglomerate was encountered at depths ranging from 0 to 5.7 ft bgs in monitoring wells installed inside the production area of Load Line 1.

2.1.1.3 Local Hydrogeology

The local hydrogeology section will describe the aquifer characteristics, bedrock hydrogeology, and surface water hydrology at Load Line 1.

Aquifer Characteristics

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County as described in the *Phase I RI Report for 11 High-Priority Sites at RVAAP* (USACE 1998). Generally, these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies. However, they are sufficient for residential water supplies. Lateral continuity of these aquifers is not known. Recharge of these units comes from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at RVAAP have not been delineated. Moderately high horizontal hydraulic conductivities were found in the unconsolidated materials at the south end of Load Line 1. The slug test performed at LL1mw-064 during the Phase I RI (USACE 1998) revealed a conductivity of 1.7×10^{-3} cm/sec. During the Phase II RI, however, none of the wells were completed in unconsolidated material.

Bedrock Hydrogeology

The sandstones of the Sharon Member, and in particular the Sharon Conglomerate, were the primary sources of groundwater during RVAAP's active phase, although some wells were completed in the Sharon Shale. Past studies of the Sharon Conglomerate indicate that the highest yields come from the true quartz-pebble conglomerate to facies and from jointed and fractured zones. Where it is present, the overlying Sharon Shale acts as a relatively impermeable confining layer for the sandstone. Depths to groundwater range from 19 to 35 ft below ground surface (bgs), with exception of one well (LL1mw-080) in the southwestern portion of the AOC (approximately 10 ft bgs) (EQM 2010). Monitoring wells completed in the Sharon Conglomerate at Load Line 1 in 1999 typically had hydraulic conductivities of 2.35×10^{-5} to 7.3×10^{-4} cm/s. No Load Line 1 wells were completed in the Sharon Shale, but wells in other areas of RVAAP completed in the Sharon Shale generally exhibit much lower hydraulic conductivities than those in the sandstone.

A potentiometric high exists in the vicinity of Building CB-4A, centered around well LL1mw-080, corresponding to a topographic high that exceeds 1,020 amsl. Potentiometric contours indicate radial flow away from this high and a potentiometric surface that is a subdued replica of the regional topography. Overall groundwater flow directions across the site are easterly with northeasterly and southeasterly components in the northern and southern half of the load line, respectively.

Surface Water Hydrology

Effluent and runoff from the main production area exited through ditches and storm sewers to discharge points along the perimeter of the load line identified as Outlets A, B, C, D, E, and F. An undesignated discharge point lies in the northwestern corner of the load line and receives drainage from the northern portions of Load Line 1 (North Area Channel for purposes of this report). Outlet A received settling tank effluent and storm sewer discharges from the northern point of LL 1, and flowed northeast to the confluence with the Outlet B channel. From the confluence of the Outlets A&B channels, flow continued in a drainage channel northeast until merging with an unnamed tributary that feeds the Outlet C Channel and Charlie's Pond. Outlets C, D, E, and F received runoff and storm sewer discharges from the central and southern points of the load line. Outlet C discharges into Charlie's Pond. Outlets D, E, and F discharge into Criggy's Pond. Outflow from Charlie's Pond and Criggy's Pond merge and ultimately exit RVAAP at Parshall Flume (PF) on Sand Creek at State Route 534 PF534. The drainage basin that discharges through PF534 also receives runoff from other potential contaminant sources in the easternmost part of RVAAP (e.g., EBG, ore piles, multiple rail beds).

2.1.2 Co-located or Proximate Sites

The following subsections summarize sites that are co-located or proximate to Load Line 1 but are addressed separately.

2.1.2.1 Facility-wide Sewers

The defunct sanitary and storm sewers within the perimeter of Load Line 1 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Sewer sediment, pipe bedding material, and sewer water were evaluated as currently summarized in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a). The sanitary sewers in the Load Line 1 Functional Area (FA) were part of the Sand Creek Sewage Treatment Plant Network. Load Line 1 also contains a discrete storm sewer network. Demolition activities at former Load Line 1 impacted numerous sewer structures, especially those associated with shallow storm sewers adjacent to buildings and walkways.

Sewer water and sediment samples were collected from storm and sanitary sewers during the Phase II RI (USACE 2003a); video surveys also were conducted. Inspections and explosives field screening tests were conducted at the Load Line 1 FA during a 2007 *Summary of CERL Findings, RVAAP Sewer System (*USACE-CERL 2007) and the *Explosive Evaluation of Sewers* (LES 2007a). The 2007 Explosive Evaluation of Sewers included a video survey of the sewer lines at Load Line 1. During both studies, wipe samples of sewer line inverts were collected for analysis of explosive residues, using field test kit methods (e.g., Expray® 24 and DropEx). Additionally, wipe samples were collected from video cameras used during the 2007 Explosive Evaluation of Sewers.

Analytical results showed detectable levels of explosives in sanitary and storm sewer sediment and sewer water samples at Load Line 1. The sporadic distribution of explosives and propellant site-related contaminants (SRCs), as compared to inorganic chemicals and polycyclic aromatic hydrocarbons (PAHs), reflects the fact that former production operations and primary sources of these compounds, especially the melt pour line at Load Line 1, ceased operations decades ago, and only residual secondary sources (e.g., contaminated soil and sediment) remain as contributors. Precipitation events and groundwater infiltration with associated flushing through the systems, along with degradation processes, appear to be reducing explosives concentrations over time.

All SRCs found in sewer media samples and evaluated through the stepwise fate and transport screening evaluation were eliminated as posing future impacts to groundwater. The HHRA did not identify a complete exposure pathway for any receptor and no further action was recommended from an ecological perspective. In summary, the Facility-wide Sewers RI recommended no further action for the Load Line 1 sewers.

2.1.2.2 Facility-wide Groundwater

As part of the Installation Restoration Program (IRP), the Army implements the Facility-wide Groundwater Monitoring Program (FWGWMP) in accordance with previous agreements made with Ohio EPA. The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP.

In 2015, for the FWGWMP, groundwater samples were collected from 7 of 15 monitoring wells associated with Load Line 1. Inorganics were detected at concentrations greater than site-specific screening levels at all seven monitoring well locations. Organic constituent concentrations were greater than site-specific screening levels at LL1mw-083 and LL1mw-084 and were below site-specific screening levels at LL1mw-064, LL1mw-065, LL1mw-086, LL1mw-087, and LL1mw-088.

An increasing concentration trend for 4-amino-2,6-DNT (dinitrotoluene) was observed at LL1mw-084. 4-Amino-2,6-DNT shows an increasing trend over the past 17 years with concentrations recently detected over 30 µg/L, and a maximum detection of 36 µg/L, as compared to a tap water RSL of 39 µg/L at a target HQ of 1.

One pesticide constituent along with several explosives and propellants were detected above screening criteria in the area of Load Line 1, Load Line 2, and Load Line 3. Based on the similarity of constituents, it is probable that the area within the isoconcentration contours constitutes one contiguous groundwater plume. All of the impacts to groundwater were detected in the Sharon Sandstone aquifer. Monitoring well samples from the unconsolidated aquifer did not have any exceedances for organic constituents. The Sharon Sandstone groundwater flow direction in this area of Camp Ravenna is toward the south-southeast (EQM 2016).

Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at Load Line 1 will be addressed as part of that facility-wide AOC.

2.1.2.3 Munitions Response Sites

RI activities were conducted at Load Line #1A (RVAAP-008-R-01) Munitions Response Site (MRS), located within Load Line 1, and included evaluation for explosives hazards and potential sources of munitions constituents (MC) that may pose threats to likely receptors. The following statements can be made for the Load Line #1A MRS based on the results of the RI field activities (USACE 2014):

- Instrument-assisted non-intrusive visual survey coverage was performed over the entire Load Line #1A MRS during the RI and no subsurface anomalies were detected.
- No physical evidence of munitions and explosives of concern (MEC) or munitions debris (MD) was found on the ground surface during the RI and no explosive hazard is anticipated to be present at the MRS.
- Although no MEC source was found during the RI, incremental sampling methodology (ISM) surface soil samples were analyzed for MC and represent 100 percent coverage of the MRS.

- Detected concentrations of SRCs in surface soil (0 to 0.5 ft) do not pose potential risks to human or ecological receptors; therefore, no further action is required for MC at this MRS.

No further action is warranted at the Load Line #1A MRS, as documented in the PP (USACE 2015a) and No Further Action Decision Document (USACE 2015b).

2.1.2.4 <u>Compliance Restoration Sites</u>

Underground storage tanks (USTs) RV-55 and RV-56 at Building CC-1 are covered under site CC-RVAAP-72 Facility-wide USTs. No further action is warranted based on the recommendation in the *Site Inspection for CC-RVAAP-72 Facility-wide USTs* (USACE 2015c).

The facility-wide coal storage site, the Power House No. 1, was assessed under site CC-RVAAP-73 as part of the Coal Sites AOC in the Historical Records Review (HRR) (USACE 2011a). As indicated in the HRR, evaluation of the historical data in soil at this site will be addressed in a future CERCLA action and therefore is included in this FS Addendum.

2.1.3 Previous Investigations, Decisions, and Actions

Since 1978, Load Line 1 has been the subject of multiple investigations and/or assessments leading to CERCLA decisions and/or remedial actions at the AOC. The Preliminary Assessment conducted in 1996 concluded that Load Line 1 was a high-priority AOC for future environmental investigations due to primary contaminant release mechanisms from process effluent discharges to surface water and surface soil. Subsequently, a Phase I RI was conducted and recommended additional investigation in a Phase II RI due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout soil and sediment at the AOC. During the Phase II RI, a total of 324 environmental samples were collected to determine the nature and extent of surface soil contamination at Load Line 1. Based on the results of the HHRA and ecological risk assessment (ERA), Load Line 1 was recommended for further evaluation in an FS. A Supplemental Baseline HHRA was performed to reflect land use changes made by OHARNG in 2004.

In 2003, USACE collected surface water and ISM sediment samples from four locations in the off-AOC channel for the *Facility-wide Biological and Water Quality Study 2003 Ravenna Army Ammunition Plant* (FWBWQS) (USACE 2005a), evaluated as the Tributary to West Branch Mahoning River (at river mile 0.01). Results from this investigation suggest that *any AOCs draining into the off-AOC channel are not considered to have impacted the off-AOC channel and further evaluation of the off-AOC channel is not warranted. However, the tributaries upstream of the FWBWQS sample stations where impacts from Load Line 1 process operations would be expected (Outlet A and B Channels, Outlet C Channel and Charlie's Pond, and Outlets D/E/F Channels and Criggy's Pond) are evaluated further in the FS Addendum.*

A Focused Feasibility Study (FFS) recommended excavation with off-site disposal as an interim remedy to address surface soil, subsurface soil, and dry sediment contamination at Load Line 1. Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007 (USACE 2008a). A total of 539 tons of hazardous (polychlorinated biphenyl [PCB]-

contaminated) soil and 3,126 tons of non-hazardous soil were removed from Load Line 1. A total of 51 discrete areas were excavated within Load Line 1. After the excavation was completed, ISM samples were collected and analyzed for Load Line 1 COCs: PCB-1254, benzo(a)pyrene, TNT, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), propellants, aluminum, antimony, arsenic, hexavalent chromium, lead, and manganese. Previous sample locations and previous remediation areas are presented in Plates 2-1 and 2-2 (located at the end of this section).

Removal of buildings down to the floor slab at Load Line 1 was completed in 2007. Removal of the floor slab and associated foundation walls was completed in May 2009. Following the removal of the floor slabs, samples were collected beneath all building slabs at Load Line 1 and resulted in excavation and off-site disposal of contaminated surface and subsurface soil at Buildings CB-4A/CB-4AWS and CB-4/CB-4WN. A removal area estimated to be 20 ft by 20 ft by 5 ft was removed at each building location. A total of 175 cubic yards of soil were removed at Building CB-4/CB-4WN and 184 cubic yards of soil were removed at Building CB-4A/CB-4AWS. Confirmation sample results allowed all excavated areas to be backfilled with clean fill.

In 2009, USACE collected 30 surface soil and 53 subsurface soil ISM samples at Load Line 1 to characterize deeper subsurface soil beneath the former building slabs that was not previously investigated via subsurface soil ISM techniques. Additional surface soil ISM samples in the former coal storage area at Load Line 1 were collected and analyzed to provide preliminary data for future RIs.

Additional characterization sampling was completed at Load Line 1 to guide future soil remedial and administrative measures. The samples collected as part of this investigation helped eliminate soil data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010a). Subsurface soil horizontal ISM samples were collected at Load Line 1 to further refine ISM sample areas that had levels of contamination above FWCUGs utilized as part of the *Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 through 4 and 12* (herein referred to as the Characterization Sampling Report [USACE 2013]), to conduct ISM sampling on soil where previous discrete samples exceeded these FWCUGs, and to provide approved analytical documentation for backfill sources. Conclusions of this soil investigation indicated the area requiring remediation was reduced, several previous ISM areas exceeding FWCUGs identified in this report were further delineated, and one ISM area was not fully delineated for PCBs.

CERCLA activities completed at Load Line 1 are presented in the timeline illustrated in Figure 2-2, and additional details related to the previous investigations are provided in Appendix A.

2.1.4 June 2016 Sediment Sampling

Following the data gap analysis conducted during the Performance-based Acquisition 2013 (PBA13) Sampling and Analysis Plan (SAP) Addendum, additional samples for soil were determined to be unnecessary given the spectrum and density of existing ISM and discrete data available for soil. Surface water and sediment sampling outlined in the PBA13 SAP Addendum were based on the data gap analysis and defined by available historical surface water and sediment locations that exceeded human health and/or ecological screening criteria.

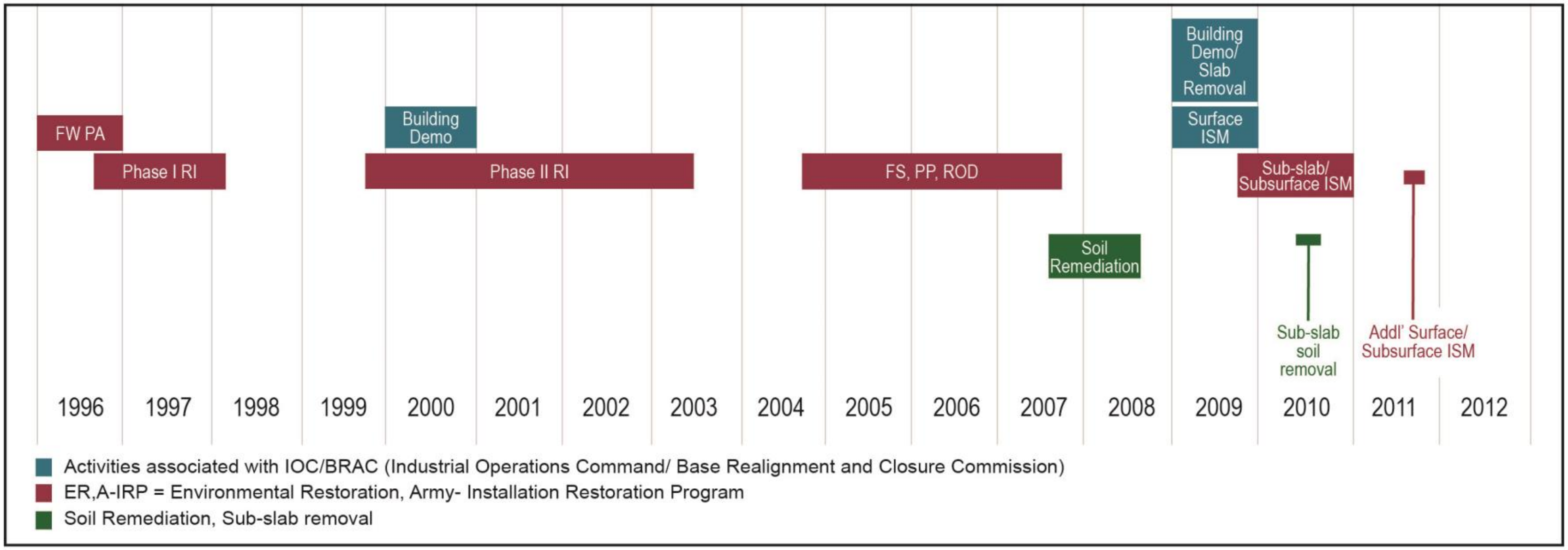

Figure 2-2. Timeline of Remedial Activities at Load Line 1

The Phase II RI Report (USACE 2003a) established surface water and sediment data aggregates at Load Line 1 by evaluating historical and current surface water flow directions and conveyances. This data gap evaluation uses the same data aggregates that were presented and approved in the Phase II RI as follows:

- North Area Channel,
- Outlets A&B Channels,
- Outlet C Channel and Charlie's Pond,
- Outlets D/E/F Channels and Criggy's Pond, and
- Off-AOC Channel (addressed in the FWBWQS (USACE 2005a).

Surface water and sediment aggregates are shown in Figure 2-1. The Phase II RI established a complete evaluation of surface water and sediment based on historical receptors. These same data aggregates were revaluated in the SAP Addendum to identify data gaps and any required action needed to meet the current receptors identified in the Technical Memorandum (ARNG 2014).

Based on the human health and ecological screening evaluations conducted in the SAP, additional sediment sampling to support the nature and extent evaluation of COECs within Load Line 1 was only recommended for two aggregates (Outlets A&B Channels and Outlet C Channel and Charlie's Pond). To satisfy data gaps, five sediment samples were collected during the 2016 field activities (LL1SD-731-2532-SD, LL1SD-732-2533-SD, LL1SD-733-2534-SD, LL1SD-734-2535-SD, and LL1SD-735-2536-SD). LL1SD-731-2532-SD, LL1SD-732-2533-SD, and LL1SD-733-2534-SD were analyzed for lead, and LL1SD-734-2535-SD and LL1SD-735-2536-SD were analyzed for copper. As presented in Appendix E, lead and copper were detected in each of their respective samples.

The general approach for investigation activities was presented in the SAP Addendum Field Sampling Plan (FSP). Appendix B provides further details on the June 2016 sampling event. Figure B-1 in Appendix B illustrates the sediment sample locations. The sampling results are provided in Appendix E.

2.1.5 Data Assembly and Use Assessment – Load Line 1

All data collected at Load Line 1 were extracted from the REIMS database. This includes data from investigations summarized in the following reports:

- RI Report for RVAAP-008-R-01 Load Line 1 MRS (USACE 2014),
- Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 through 4 and 12 (USACE 2013),
- Remediation Completion Report for Sub-Slab Soils at RVAAP-08 Load Line 1 (USACE 2011b),
- Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 through 4 (USACE 2011c),
- Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations (USACE 2010b),

- Remedial Action Completion Report for the Remediation of Soils and Dry Sediment at RVAAP 08-11 (Load Lines 1 through 4) (USACE 2008a),
- Phase II RI Report for the Load Line 1 (USACE 2003a), and
- Sampling of Potential Disposal Areas at Load Line 1 and Load Line 2 (USACE 2000).

A data use assessment was conducted by reviewing all data to ensure that the medium sampled is still present and has not been removed during remediation, and ensuring that the data approved for use meet the DQOs. The data from investigations summarized in the following reports were not used in this FS Addendum:

- *Phase I Remedial Investigation Report for the Phase I Remedial Investigation of High Priority Areas of Concern* (USACE 1998) – These data are more than 16 years old and are no longer considered representative of the site (e.g., buildings and slabs have been removed and/or remediated).
- RI/FS Report for RVAAP-67 Facility-wide Sewers (USACE 2012a) – The sewers are currently being evaluated under a separate RI. Data from the Facility-wide Sewers Investigation was evaluated qualitatively in consideration of the CSM.

Once the data were assembled and evaluated for use, COIs were identified specific to Load Line 1 media.

2.1.6 Load Line 1 Conceptual Site Model

The CSM is a site-specific, systematic planning tool. It provides a concise summary of residual contamination distribution, exposure pathways, migration routes, and assessment of the affects to human health and ecological receptors that supports development of RAOs and the FS. A graphical depiction of the CSM is presented in Figure 2-3. The following sections summarize the COIs identified in soil, surface water, and sediment, and provide results of the fate and transport analysis, HHRA, and ERA.

2.1.6.1 Load Line 1 COIs

Load Line 1 COIs were developed from the chemicals identified as exceeding residential risk in the Phase II RI Report (USACE 2003a) and *Supplemental Baseline Human Health Risk Assessment for Load Line 1 Alternative Receptors* (USACE 2004a). Load Line 1 COIs for exposure of Resident Receptors (Adult and Child) to soil, sediment, and surface water are shown in Table 2-3. The list of COIs shown in Table 2-3 is longer than the list of COCs included in the IROD (USACE 2007) because the IROD focused only on the National Guard Trainee Receptor and soil.

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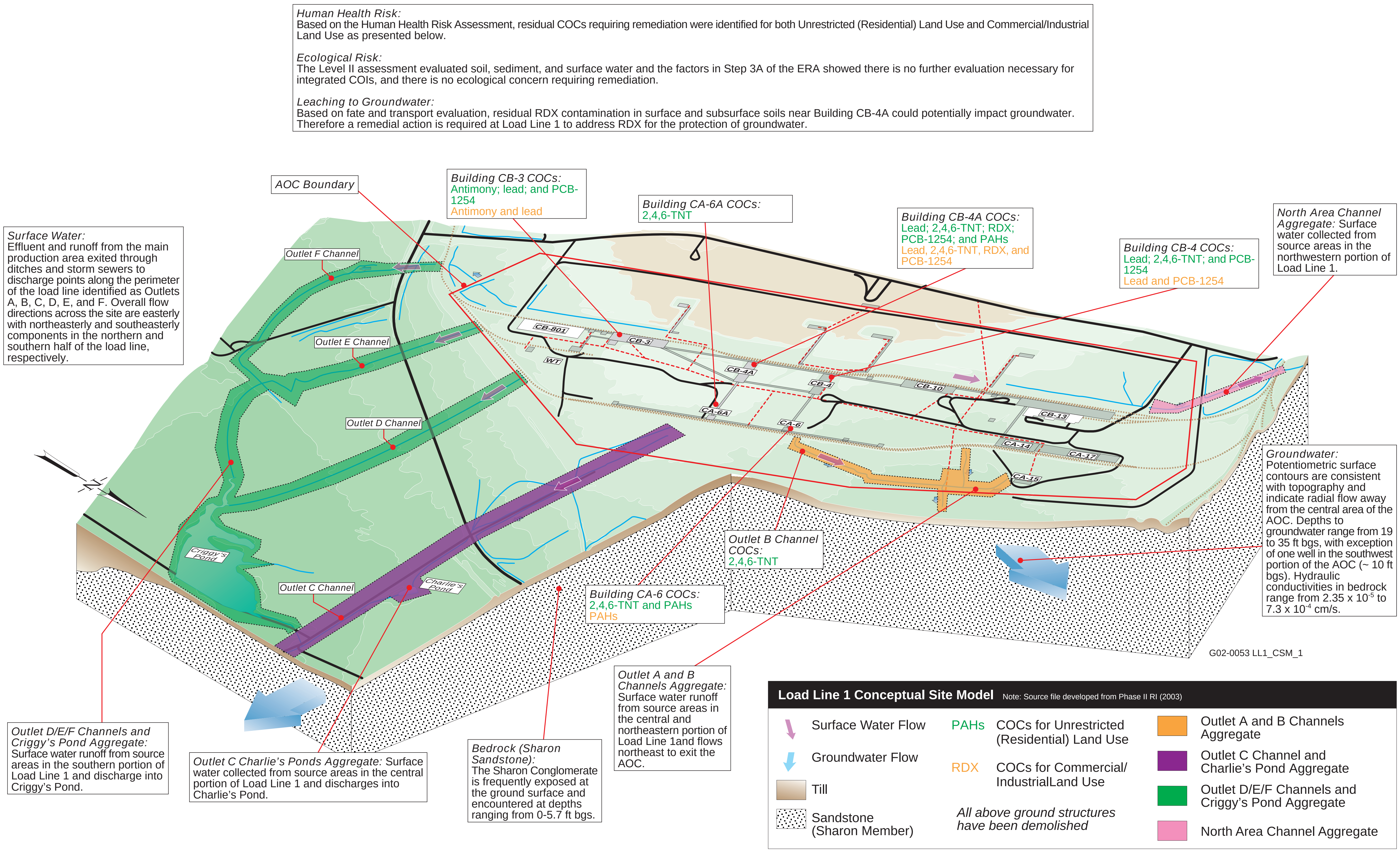

Figure 2-3. Load Line 1 Conceptual Site Model

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Table 2-3. COIs in Soil, Surface Water, and Sediment at Load Line 1

COI	Load Line 1		
	Soil	Surface Water	Sediment
Metals			
Antimony	X	X	X
Arsenic	X	X	X
Lead	X	X	X
Manganese		X	X
Explosives			
2,4,6-TNT	X	X	X
2,4-DNT	X	X	X
2,6-DNT	X	X	X
RDX	X	X	X
PCBs			
PCB-1254	X	X	X
Pesticides			
Dieldrin	X	X	X
PAHs			
Benz(a)anthracene	X	X	X
Benzo(a)pyrene	X	X	X
Benzo(b)fluoranthene	X	X	X
Dibenz(a,h)anthracene	X	X	X
Indeno(1,2,3-cd)pyrene	X	X	X

COI = Chemical of Interest.
DNT = Dinitrotoluene.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
2,4,6-TNT = Trinitrotoluene.
X = COI Present in Medium.

2.1.6.2 Fate and Transport

The details of the fate and transport analysis conducted to assess the potential for COIs to leach from surface soil and subsurface soil (defined as soil leaching COIs) at Load Line 1 and impact groundwater beneath the source and at a nearest downgradient receptor location are presented in Appendix G. The fate and transport analysis also evaluates the potential for SRCs to leach from sediment sources at Load Line 1 and impact groundwater beneath the source and at the nearest downgradient receptor location. A summary of the analyses is presented in this section.

Primarily organic COIs were identified in surface soil and subsurface soil at the AOC in this FS Addendum. These soil leaching COIs were further evaluated to determine if residual concentrations in surface and subsurface soil may potentially impact groundwater quality and warrant evaluation in an FS. In addition, all sediment SRCs were evaluated to determine if residual concentrations in sediment may potentially impact groundwater quality and warrant evaluation in an FS. All of the soil leaching COIs and the SRCs identified in the sediment at the AOC were evaluated through the stepwise fate and transport evaluation that included leachate modeling in the unsaturated zone using the SESOIL model and lateral transport modeling in the saturated zone using the Analytical Transient 1-, 2-, 3-Dimensional (AT123D) model.

If the predicted maximum leachate concentration of a COI was lower than the screening criteria, the chemical was eliminated from further evaluation using AT123D modeling. For the remaining COIs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCLs, and RSLs. Only the CMCOPCs with predicted maximum concentrations higher than their facility-wide background concentrations, and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), were retained as chemical migration chemicals of concern (CMCOCs). These CMCOCs were evaluated with respect to WOE for retaining or eliminating CMCOCs from further consideration as a basis for potential soil or sediment remedial actions.
The evaluation of modeling results with respect to current groundwater data for the AOC and model limitations identified the following CMCOCs at Load Line 1:

- Among the soil leaching COIs, only RDX was predicted to exceed the screening criteria in groundwater beneath the source area; however, it was not predicted to be above criteria at the downgradient receptor location.
- Among the sediment CMCOPCs, none were predicted by analytical solutions to exceed screening criteria in groundwater beneath the source.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if RDX in surface and subsurface soil at the AOC may impact the groundwater beneath the source or at the downstream receptor location. The maximum subsurface soil concentration for RDX (1,500 mg/kg at LL1sb-638M-0013-SO) at a depth interval of 1 to 5 ft bgs was above its Residential RGO, and RDX is considered a soil COC in the HHRA. The modeling estimated that RDX concentrations in groundwater beneath the source could potentially exceed its RSL by orders of magnitude at about 150 years or less with peak concentrations occurring at approximately 600 years or less. RDX also was detected in the AOC groundwater samples exceeding its RSL collected between 2011–2015 (see Appendix G, Table G-15). However, the maximum predicted RDX groundwater concentration at the downgradient receptor location is expected to be below its RSL.

Conclusion–Based on the fate and transport evaluation, it may be concluded that although current concentrations of RDX in soil are not expected to migrate off site from this AOC, it will continue to impact groundwater beneath the source for a long period of time. Therefore, a remedial action is required for the surface and subsurface soil at Load Line 1 for protection of groundwater beneath this AOC.

2.1.6.3 Human Health Risk Assessment Results

The HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to residual contamination in soil, sediment, and surface water at Load Line 1. The approach to risk-based decision making is as follows:

RGOs were compiled for the COIs identified in Section 2.1.6.1. RGOs for Unrestricted (Residential) Land Use are the USEPA Residential RSLs for soil (used for soil and sediment) and tap water (used for surface water) published in May 2016. RSLs for the cancer endpoint were adjusted to correspond to a TR of 1E-05, RSLs for the non-cancer endpoint were used at a target HQ of 1. RGOs for Commercial/Industrial Land Use are the USEPA Industrial RSLs for soil adjusted for a TR of 1E-05 and target HQ of 1. Industrial RSLs are not available to evaluate surface water or sediment because Industrial/Commercial activities are not applicable to surface water (i.e., exposure of industrial and commercial workers is not anticipated for these media). The potential impact of the lack of screening values is addressed in the uncertainty assessment using Industrial RSLs calculated with the on-line USEPA RSL calculator assuming an Industrial Receptor might wade into shallow water bodies. At Load Line 1, media were previously remediated for COCs that exceeded cleanup goals established for the National Guard Trainee; therefore, this FS Addendum only evaluates the Resident Receptor (Adult and Child) and the Industrial Receptor.

The methodology of comparing COI exposure concentrations to RGOs and determining COCs generally follows guidance presented in the Position Paper for Human Health Cleanup Goals (USACE 2012b) and Technical Memorandum (ARNG 2014) and includes calculating an SOR for all non-carcinogenic and carcinogenic COIs. The reported concentration in each discrete or ISM sample was compared to RGOs (i.e., the exposure point concentration [EPC] is the concentration in each individual sample). COIs are identified as COCs for a given receptor if:

- The EPC exceeds the most stringent RGO for either the 1E-05 target cancer risk or the target HQ of 1; or
- The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than 1; chemicals contributing at least 5% to an SOR greater than 1 are also considered COCs.

Metals present at concentrations consistent with naturally occurring background concentrations are not identified as COCs.

The results of the COC screening are combined with the results of the uncertainty assessment to identify COCs to be carried forward for remediation. Details of the screening process and identification of COCs recommended for remediation are provided in Appendix H.2. Detailed figures depicting contaminant distribution and results of screening assessments are provided in Figures H.2-1 through H.2-7 in Appendix H. The soil COCs to be carried forward for potential remediation are summarized below for Unrestricted (Residential) and Industrial Land Use:

- Unrestricted (Residential) Land Use – Antimony; lead; 2,4,6-TNT; RDX; PCB-1254; and four PAHs (benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, and dibenz[a,h]anthracene) were identified as COCs to be carried forward for potential remediation. The COCs recommended for remediation are summarized by area below:
    - Building CB-4 – 2,4,6-TNT and PCB-1254.
    - Building CA-6 – 2,4,6-TNT and PAHs (benz[a]anthracene, benzo[a]pyrene, and benzo[b]fluoranthene).
    - Outlet B Channel – 2,4,6-TNT.
    - Building CB-4A – 2,4,6-TNT; RDX; PCB-1254; and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).

  - Building CA-6A– 2,4,6-TNT.
  - Building CB-3 – Antimony, lead, PCB-1254, and PAHs (benz[a]anthracene, benzo[a]pyrene, and benzo[b]fluoranthene).
  - Isolated Discrete Soil Location – Antimony and lead.
- Industrial Land Use – Antimony; lead; 2,4,6-TNT; RDX; and PCB-1254 were identified as COCs to be carried forward for potential remediation. The COCs are summarized by area below:
  - Building CB-4 – PCB-1254.
  - Building CB-4A – 2,4,6-TNT and RDX.
  - Building CB-3 – Antimony and lead.
  - Isolated Discrete Soil Location – Antimony and lead.

No COCs were identified in sediment or surface water. COCs identified for potential remediation at Load Line 1 are summarized in Tables 2-4 and 2-5.

2.1.6.4 Ecological Risk Assessment Results

The ERA for wet sediment and surface water at Load Line 1 is presented in Appendix I of this FS Addendum and follows a unified approach of methods integrating Army, Ohio EPA, and USEPA guidance. This ERA approach is consistent with the general approach by these agencies and primarily follows the Level I Scoping ERA, Level II Screening ERA, and Level III Baseline ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008), with specific application of components from the *Facility-wide Ecological Risk Work Plan* (USACE 2003b) (herein referred to as the FWERWP), *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c), and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997). The ERA process implemented in this FS Addendum report combines these guidance documents to meet requirements of Ohio EPA and the Army, while following previously accepted methods established for RVAAP. This unified approach resulted from coordination between USACE and Ohio EPA during the summer of 2011.

A historical ERA (a screening-level ecological risk assessment [SERA] and baseline ecological risk assessment [BERA]) was performed as part of the Phase II RI (USACE 2003a) for Load Line 1. The ERA for wet sediment and surface water in Appendix I was conducted because the historical evaluation was not based on the current Ohio EPA guidance (Ohio EPA 2008) and did not include the recently collected FS Addendum data. Soil was evaluated for ecological receptors for Load Line 1 in the Phase II RI (USACE 2003). As concluded in the IROD at Load Lines 1 through 4 (USACE 2007): *the majority of COECs in soil are co-located with human health COCs and remedial activities implemented to address human health COCs will serve to reduce the concentrations and number of COECs in soil to which ecological receptors are exposed, resulting in lowered ecological risk*. As a result, ecological cleanup goals were not required. Based on the removal action subsequent to the IROD, no further action is necessary for ecological exposures to soil.

Table 2-4. Summary of Human Health COC Concentrations and Conclusions for Unrestricted (Residential) Land Use at Load Line 1

				COC											Conclusion for Unrestricted Land Use
				Metal		Explosive		PAH					Pesticide	PCB	
		Residential RGO		31	400	36	61	1.6	0.16	1.6	0.16	1.6	0.34	1.2	
Station	Sample Type	Date	Depth (ft)	Antimony	Lead	TNT	RDX	B(a)A	B(a)P	B(b)F	DA	IP	Dieldrin	PCB-1254	
Building CB-4															
LL1-005	D	09/13/00	0.0 - 1.0	--	1,110	--	--	--	--	--	--	--	--	--	NFA
LL1-341	D	10/02/00	0.0 - 1.0	--	--	83	--	--	--	--	--	--	--	--	Remediate
LL1-342	D	09/29/00	0.0 - 1.0	--	--	39	--	--	--	--	--	--	--	--	NFA
LL1-343	D	09/29/00	0.0 - 1.0	--	--	150	--	--	--	--	--	--	--	--	Remediate
LL1ss-609	ISM	12/01/09	0.0 - 0.5	--	--	--	--	--	0.24[b]	0.38[a,b]	--	--	--	4.9	Remediate
LL1sb-641M	ISM	07/06/11	1.0 - 3.0	--	--	--	--	0.23[a]	0.19	0.22[a]	0.03[a]	--	--	--	NFA
LL1sb-642M	ISM	07/06/11	1.0 - 3.0	--	--	--	--	0.21[a]	0.19	0.25[a]	--	0.12[a]	--	--	NFA
LL1ss-017-cs	ISM	10/29/07	2.0 - 3.0	--	--	--	--	--	--	--	--	--	--	10.9	Remediate
Building CA-6															
LL1-136	D	09/15/00	0.0 - 1.0	--	--	180	--	--	--	--	--	--	--	--	Remediate
LL1SB-635M03	D	08/31/10	1.0 - 5.0	--	--	--	--	3.2	2	2.7	--	--	--	--	Remediate
LL1SB-635M04	D	08/31/10	1.0 - 5.0	--	--	--	--	5.5	3.5	5.5	--	--	--	--	Remediate
LL1SB-635M	ISM	08/31/10	1.0 - 3.0	--	--	--	--	1.8	1	1.5[a]	--	--	--	--	Remediate
LL1SB-635M	ISM	08/31/10	5.0 - 7.0	--	--	--	--	1.8	1.2	1.8	--	--	--	--	Remediate
Outlet B Channel															
LL1ss-024-cs	ISM	09/12/07	2.5 - 3.5	--	--	290	--	--	--	--	--	--	--	--	Remediate
Building CB-4A															
LL1-156	D	09/13/00	0.0 - 1.0	--	--	--	67	--	--	--	--	--	--	--	Remediate
LL1-159	D	09/14/00	0.0 - 1.0	--	--	64	--	--	--	--	--	--	--	--	Remediate
LL1-160	D	09/14/00	0.0 - 1.0	--	454[b]	250	--	--	--	--	--	--	--	--	Remediate
LL1-161	D	09/14/00	0.0 - 1.0	--	411[b]	200	--	--	--	--	--	--	--	--	Remediate
LL1-162	D	09/14/00	0.0 - 1.0	--	1,430[b]	--	--	--	--	--	--	--	--	--	NFA[c]
LL1-168	D	09/13/00	0.0 - 1.0	--	--	--	--	1.2[a]	0.93	1.2[a]	0.096[a]	--	--	--	Remediate
LL1-356	D	09/30/00	0.0 - 1.0	--	636	--	--	--	--	--	--	--	--	--	NFA
LL1-407	D	10/01/00	0.0 - 1.0	--	--	180	--	--	--	--	--	--	--	--	Remediate
LL1SB-638M13	D	09/01/10	1.0 - 5.0	--	--	--	1,500	--	--	--	--	--	--	--	Remediate
LL1SB-638M14	D	09/01/10	1.0 - 5.0	--	--	100	--	--	--	--	--	--	--	--	Remediate
LL1ss-523M	ISM	10/26/09	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	1.22	NFA
LL1ss-524M	ISM	10/26/09	0.0 - 1.0	--	--	158	60.3[a]	--	--	--	--	--	--	0.915[a]	Remediate
LL1ss-525M	ISM	10/26/09	0.0 - 1.0	--	--	--	--	1.87	1.4	1.15[a]	--	--	--	--	Remediate
LL1ss-619	ISM	12/01/09	0.0 - 0.5	--	--	--	--	--	0.087[a]	0.15[a]	--	--	0.09[ab]	2.2	Remediate
LL1SB-638M	ISM	09/01/10	1.0 - 3.0	--	--	150	490	--	--	--	--	--	--	--	Remediate
LL1SB-638M	ISM	09/01/10	3.0 - 5.0	--	--	2,700	--	--	--	--	--	--	--	--	Remediate

Table 2-4. Summary of Human Health COC Concentrations and Conclusions for Unrestricted (Residential) Land Use at Load Line 1 (continued)

				COC											
				Metals		Explosives		PAHs					Pesticide	PCB	Conclusion for Unrestricted Land Use
		Residential RGO		31	400	36	61	1.6	0.16	1.6	0.16	1.6	0.34	1.2	
Station	Sample Type	Date	Depth (ft)	Antimony	Lead	TNT	RDX	B(a)A	B(a)P	B(b)F	DA	IP	Dieldrin	PCB-1254	
LL1sb-644M	ISM	07/05/11	3.0 - 5.0	--	--	--	--	--	0.1[a]	--	--	--	--	14	Remediate
LL1sb-644M	ISM	07/05/11	5.0 - 7.0	--	--	--	--	--	--	--	--	--	--	1.8	Remediate
Building CA-6A															
LL1-333	D	09/16/00	0.0 - 1.0	--	674	--	--	--	--	--	--	--	--	--	NFA
LL1SB-633M	ISM	08/25/10	3.0 - 5.0	--	--	47	--	--	--	--	--	--	--	--	Remediate
LL1ss-033-cs	ISM	09/11/07	2.3 - 3.3	--	--	160	--	--	--	--	--	--	--	--	Remediate
Building CB-3															
LL1-184	D	09/18/00	0.0 - 1.0	648	1,620	--	--	--	--	--	--	--	--	--	Remediate
LL1-185	D	09/18/00	0.0 - 1.0	429	736	--	--	0.22[a,b]	0.21[b]	0.41[a,b]	--	--	--	1.7	Remediate
LL1-386	D	09/28/00	0.0 - 1.0	--	550	--	--	--	--	--	--	--	--	--	Remediate
LL1-387	D	09/29/00	0.0 - 1.0	--	639	--	--	--	--	--	--	--	--	--	Remediate
LL1-410	D	09/29/00	0.0 - 1.0	--	510	--	--	--	--	--	--	--	--	--	Remediate
FWCss-001	ISM	12/01/09	0.0 - 0.5	--	--	--	--	0.9[a]	0.84	1.5[a]	--	--	--	--	Remediate
LL1ss-040-cs	ISM	09/12/07	2.0 - 3.0	--	--	--	--	--	0.49	--	--	--	--	--	NFA
Isolated Discrete Soil Locations															
CB12-02	D	11/04/99	0.0 - 1.0	--	532	--	--	--	--	--	--	--	--	--	NFA
CB23-01	D	11/04/99	0.0 - 1.0	--	426	--	--	--	--	--	--	--	--	--	NFA
LL1-049	D	09/16/00	0.0 - 0.5	1,180	1,210	--	--	--	--	--	--	--	--	--	Remediate
LL1-087	D	09/25/00	0.0 - 1.0	--	602	--	--	--	--	--	--	--	--	--	NFA
LL1-091	D	09/25/00	0.0 - 1.0	--	--	--	--	--	0.84	1.1[a]	0.18	--	--	4.7	NFA
LL1-103	D	09/19/00	0.0 - 1.0	--	--	--	--	0.64[a]	0.53	0.75[a]	0.086[a]	--	--	0.74[a]	NFA
LL1-130	D	09/27/00	0.0 - 1.0	--	--	--	--	0.41[a]	0.37	0.47[a]	--	--	--	2.4	NFA
LL1-252	D	09/17/00	0.0 - 0.5	--	1,140	--	--	--	--	--	--	--	--	--	Remediate
LL1-369	D	09/28/00	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	1.7	NFA
LL1-087	D	09/28/00	1.0 - 2.5	--	558	--	--	--	--	--	--	--	--	--	NFA

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.

[b]Sample location (or overlying ISM sample location for LL1-162) is recommended for remediation for other chemicals of interest; however, this chemical is not recommended as a COC for remediation.

[c]Although NFA is recommended for this sample location for lead, the sample location is within an ISM sample area (LL1ss-619) recommended for remediation to address PCB-1254. Confirmation sampling will include an evaluation of lead in this area.

All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
D = Discrete soil sample.
-- = Chemical is not a human health COC in this sample.
DA = Dibenz(a,h)anthracene.
ft = Feet.
IP = Indeno(1,2,3-cd)pyrene.
ISM = Incremental Sampling Methodology.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-Trinitro-1,3,5-Triazine.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.

Table 2-5. Summary of Human Health COC Concentrations and Conclusions for Commercial/Industrial Land Use at Load Line 1

				COC								
				Metal		Explosive		PAH			PCB	Conclusion for Commercial/ Industrial Land Use
		Industrial RGO		470	800	510	280	29	2.9	29	9.7	
Station	Sample Type	Date	Depth (ft)	Antimony	Lead	TNT	RDX	B(a)A	B(a)P	B(b)F	PCB-1254	
Building CB-4												
LL1-005	D	09/13/00	0.0 - 1.0	--	1,110	--	--	--	--	--	--	NFA
LL1ss-017-cs	ISM	10/29/07	2.0 - 3.0	--	--	--	--	--	--	--	10.9	Remediate
Building CB-4A												
LL1-162	D	09/14/00	0.0 - 1.0	--	1,430	--	--	--	--	--	--	NFA
LL1SB-638M13	D	09/01/10	1.0 - 5.0	--	--	--	1,500	--	--	--	--	Remediate
LL1SB-638M	ISM	09/01/10	1.0 - 3.0	--	--	150[a]	490	--	--	--	--	Remediate
LL1SB-638M	ISM	09/01/10	3.0 - 5.0	--	--	2,700	--	--	--	--	--	Remediate
LL1sb-644M	ISM	07/05/11	3.0 - 5.0	--	--	--	--	--	0.1[a]	--	14	NFA
Building CA-6												
LL1SB-635M04	D	08/31/10	1.0 - 5.0	--	--	--	--	5.5[a]	3.5	5.5[a]	--	NFA
Building CB-3												
LL1-184	D	09/18/00	0.0 - 1.0	648	1,620	--	--	--	--	--	--	Remediate
Isolated Discrete Soil Location												
LL1-049	D	09/16/00	0.0 - 0.5	1,180	1,210	--	--	--	--	--	--	Remediate
LL1-252	D	09/17/00	0.0 - 0.5	--	1,140	--	--	--	--	--	--	Remediate

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
D = Discrete soil sample.
ft = Feet.
ISM = Incremental Sampling Methodology.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-Trinitro-1,3,5-Triazine.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.
-- = Chemical is not a human health COC in this sample.

A Level I ERA was conducted for Load Line 1 to determine the presence/absence of important ecological places and resources and the presence of contamination. Perennial surface water in streams and ponds and wetlands are important ecological resources at Load Line 1, and chemical contamination is present based on the historical ERAs. Because there is contamination and important/significant ecological resources at each of the load lines, the ERA in Appendix F continued to a Level II Screening ERA.

The Level II ERA identified procedures to determine AOC-related COIs. Data from the Phase II RI and the FS Addendum were integrated for each load line and were evaluated separately for sediment and surface water. These ERAs used updated sediment reference values (SRVs) and ecological screening values (ESVs) that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008). The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003b). The maximum detected concentration (MDC) of each chemical is compared to its respective facility-wide background concentration. Wet sediment concentrations are also compared to the SRV. Chemicals are not considered site-related if the MDC is below the background concentration (or SRV for sediment). For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV. In addition to the ESV comparison, it was determined if the chemical is a persistent, bioaccumulative, and toxic (PBT) compound. Chemicals are retained as integrated COIs if they exceed background concentrations (and SRVs for sediment) and the ESV, if the chemical exceeds background concentrations (and SRVs for sediment) and had no toxicity information, or if the chemical is considered a PBT compound. MDC to ESV ratios are used to determine the integrated COIs that result from the combined current and historical data sets. A ratio greater than 1 suggests a possible environmental consequence. Any chemicals with ratios greater than 1 are identified as integrated COIs.

Wet sediment at Load Line 1 was analyzed at three exposure units (EUs): North Area Channel, Outlets A&B Channels, and Outlet C Channel and Charlie's Pond. There is one integrated COI (mercury) at the North Area Channel, four integrated COIs at the Outlets A&B Channels, and four integrated COIs at the Outlet C Channel and Charlie's Pond.

Surface water at Load Line 1 was analyzed at two EUs: Outlet C Channel and Charlie's Pond and Outlets D/E/F Channels and Criggy's Pond. There is one integrated COI (iron) at the Outlet C Channel and Charlie's Pond and there are no integrated COIs at the Outlets D/E/F Channels and Criggy's Pond.

Technical and refinement factors were then used to refine the integrated COIs from the Level II Screening ERA. The factors included use of mean exposure concentrations, discussion of approved ESVs, and other topics. This type of assessment is Step 3A in the ERA process (USEPA 1997). Step 3A refines the list of integrated COIs to determine if: (1) there are COECs requiring further evaluation in a Level III Baseline ERA or remediation to protect ecological receptors, or (2) integrated COIs can be eliminated from further consideration. This evaluation is an important part of the Level II Screening ERA and is adapted from USEPA Step 3A, outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk*

Assessments (USEPA 1997) and *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c).

For Load Line 1, the evaluation in Step 3A showed no further evaluation is necessary for integrated COIs, and no ecological concern requires remediation. Consequently, the Level II Screening ERA for Load Line 1 concludes that no further action is necessary to be protective of important ecological resources.

2.2 LOAD LINE 2

Load Line 2 was located in the southeastern portion of the facility and was used to melt and load TNT and Composition B into large-caliber shells and bombs. The line operated from 1941 through 1945, from 1951 to 1957 for munitions-demilitarization activities, and again from 1969 to 1971. Demilitarization projects also occurred at Load Line 2 from 1947 through 1949 when a washout plant was installed at Load Line 2. From 1950 to 1952, Load Line 2 reclaimed cartridge bases using an annealing process for reuse. During the entirety of its operational history, Load Line 2 produced about 10 million munitions, and approximately 1.8 million kg (4 million lb) of TNT was salvaged during demilitarization activities.

During its operational history, bulk TNT and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane (HMX) were offloaded at Buildings DA-6 and DA-6A for screening and preparation before being transported to the melt pour buildings (DA-4 and DA-4A) for processing and loading into shells. Upon completion of primary charge loading, the shells were transported to Building DB-10 for drilling operations for booster charges or other preparation processes. Bulk explosive carrier washout activities were conducted in Building DB-25. When the facility was at full capacity, Load Line 2 generated approximately 842,700 gallons of pinkwater per month from wash-down and steam decontamination of equipment. During melt pour operations, the floors and walls were washed down with water and the pinkwater was collected in settling tanks located throughout each load line building. The solids settled in the tank, and the wash water was pumped through sawdust filtration units and ultimately discharged to Kelly’s Pond, a 2-acre unlined, settling pond south of the AOC. Water from the settling pond was discharged to a surface stream (Sand Creek) that exited the installation. Chromic acid waste also was discharged from Building DB-802 into a ditch that emptied into the West Branch of the Mahoning River (USACE 1996). In 1951, the load line was rehabilitated, including the removal of explosive accumulations. All buildings and structures at Load Line 2 have been demolished.

Each production building formerly located at Load Line 2 is presented below with a summary of its historical use and potential contamination source description. Former production buildings are included in Table 2-6, and the non-production buildings are listed in Table 2-7. Figure 2-4 presents the Load Line 2 AOC features.

Table 2-6. Former Production Buildings at Load Line 2

Building ID	Purpose	Description of Potential Sources
DA-6	Explosive Preparation Building	Used to screen bulk granular TNT or bulk RDX and HMX prior to transport to the melt pour building.
DA-6A	Explosive Preparation Building	Used to screen bulk granular TNT or bulk RDX and HMX prior to transport to the melt pour building.
DB-10	Drilling and Assembly Building	Location where booster charges were installed after primary charge loaded at DB-4/4A.
DB-10-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.
DB-10-VP2	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.
DB-13	Packing and Shipping Building	Packing and shipping operations for completed munitions.
DB-13A	Shell Storage Building/Assembling and Shipping Building	Packing and shipping operations for completed munitions.
DB-13B	Shipping Warehouse Annex	Packing and shipping operations for completed munitions.
DB-25	Shell Carrier Washout Building	Bulk explosives were washed out in this building. Effluent was directed to an above-grade concrete settling tank to the south of the building, which then discharged to an unlined drainage ditch.
DB-26	Radiographic Building	Radiographic equipment in this building was utilized to quality assurance check primary charges within munitions.
DB-27	Cyclic Heat Building No. 2	Built in the 1950s. Loaded shells were placed in the cyclic buildings to alternate heating and cooling cycles to recrystallize the primary explosive charge.
DB-27A	Cyclic Heat Building No. 1	Built in the 1950s. Loaded shells were placed in the cyclic buildings to alternate heating and cooling cycles to recrystallize the primary explosive charge.
DB-27B	Boiler Plant	Built in the 1950s. Provided HVAC for DB-27 and DB-27A.
DB-27C	Shipping Building	Built in the 1950s for packing and shipping operations for completed munitions.
DB-3	Shell Receiving and Painting Building	Shells were cleaned and painted in this building.
DB-4	Melt Load Building and SPCC	Located in the production area, this building was a primary melt pour building for explosives. Contamination was noted to be prevalent around doorways, drains, and vacuum pumps.
DB-4A	Melt Loading Building	Located in the production area, this building was a primary melt pour building for explosives.
DB-4-A-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.
DB-4A-WN	Washout Annex	Settling tanks adjacent to Building 4 containerized explosives washout water (pinkwater).
DB-4A-WS	Washout Annex	Settling tanks adjacent to Building 4 containerized explosives washout water (pinkwater).
DB-4-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.

Table 2-6. Former Production Buildings at Load Line 2 (continued)

Building ID	Purpose	Description of Potential Sources
DB-4-WN	Washout Annex	Settling tanks adjacent to Building 4 containerized explosives washout water (pinkwater).
DB-4-WS	Washout Annex	Settling tanks adjacent to Building 4 containerized explosives washout water (pinkwater).
DB-802	Inert Storage Building	Utilized for receiving, inert storage, and shell preparation at the load line.
DB-9	Booster Service Building	Physical plant service building.
DB-9A	Booster Service Building	Physical plant service building.
DA-28	Elevator Machine House	Takes screened explosives from Building DA-6/DA6A and transports to Building DB-4/DB-4A for melt pour operations.
DA-28A	Elevator Machine House	Takes screened explosives from Building DA-6/DA6A and transports to Building DB-4/DB-4A for melt pour operations.

HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
HVAC = Heating, Ventilation, and Air Conditioning.
ID = Identification.
TNT = Trinitrotoluene.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
SPCC = Spill Prevention, Control, and Countermeasures.

Table 2-7. Former Non-production Buildings Inventory at Load Line 2

Building ID	Purpose
DC-1	Power House No. 2 (steam plant and power house for the load line)
LL-2-CTank1	Concrete Settling Tank
LL-2-CTank2	Concrete Settling Tank
LL2-WST-1	Wooden Settling Tank
LL2-WST-2	Wooden Settling Tank
LL-DB-2	Paint and Oil Storage Building
DA-5	Ammonium Nitrate Service Building (physical plant service building)
DA-7	TNT Service Building (physical plant service building)
DB-11	Fuse Service Building (physical plant service building)
DB-19	Electric Locomotive Service Building (physical plant service building)
DB-20A	Meteorology Laboratory/Line Office (physical plant service building)
DB-8	Change House
DB-8A	Change House
DB-22	Change House
DA-21	TNT Box Building (physical plant service building)
DB-29	Elevator Machine House
2-51	Clock Alley
2-51A	Load Line Office
950-D	Gate House

ID = Identification.
TNT = Trinitrotoluene.

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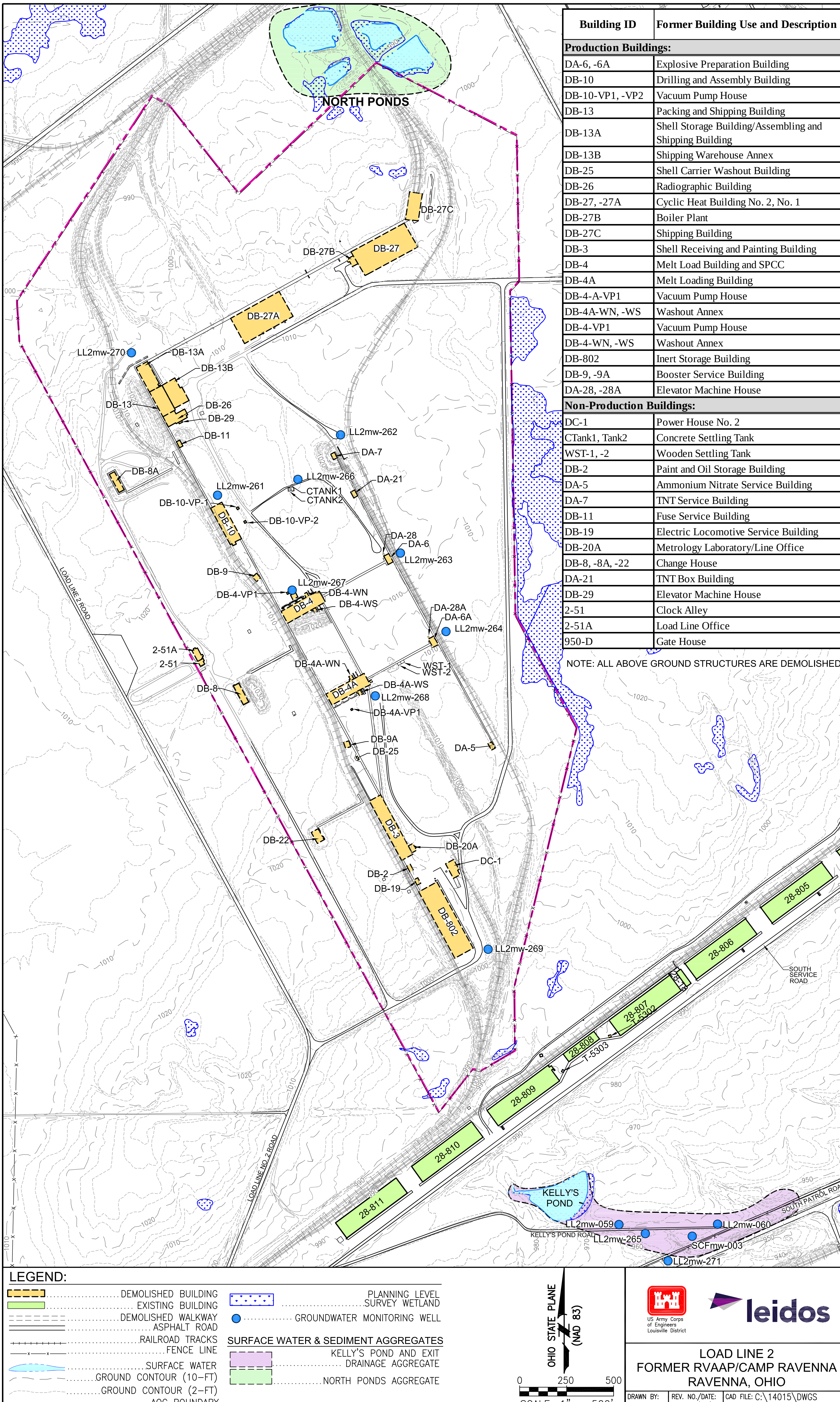

Building ID	Former Building Use and Description
Production Buildings:	
DA-6, -6A	Explosive Preparation Building
DB-10	Drilling and Assembly Building
DB-10-VP1, -VP2	Vacuum Pump House
DB-13	Packing and Shipping Building
DB-13A	Shell Storage Building/Assembling and Shipping Building
DB-13B	Shipping Warehouse Annex
DB-25	Shell Carrier Washout Building
DB-26	Radiographic Building
DB-27, -27A	Cyclic Heat Building No. 2, No. 1
DB-27B	Boiler Plant
DB-27C	Shipping Building
DB-3	Shell Receiving and Painting Building
DB-4	Melt Load Building and SPCC
DB-4A	Melt Loading Building
DB-4-A-VP1	Vacuum Pump House
DB-4A-WN, -WS	Washout Annex
DB-4-VP1	Vacuum Pump House
DB-4-WN, -WS	Washout Annex
DB-802	Inert Storage Building
DB-9, -9A	Booster Service Building
DA-28, -28A	Elevator Machine House
Non-Production Buildings:	
DC-1	Power House No. 2
CTank1, Tank2	Concrete Settling Tank
WST-1, -2	Wooden Settling Tank
DB-2	Paint and Oil Storage Building
DA-5	Ammonium Nitrate Service Building
DA-7	TNT Service Building
DB-11	Fuse Service Building
DB-19	Electric Locomotive Service Building
DB-20A	Metrology Laboratory/Line Office
DB-8, -8A, -22	Change House
DA-21	TNT Box Building
DB-29	Elevator Machine House
2-51	Clock Alley
2-51A	Load Line Office
950-D	Gate House

NOTE: ALL ABOVE GROUND STRUCTURES ARE DEMOLISHED

Figure 2-4. Load Line 2 AOC Features

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2.2.1 Environmental Setting

This section provides a summary of the environmental setting of Load Line 2 as presented in the Phase II RI Report for Load Line 2 (SAIC 2004b) and includes surface features and site topography, geologic setting, and local hydrogeology.

2.2.1.1 Surface Features and Site Topography

Load Line 2 is situated in the southeastern quadrant of the RVAAP facility. The topography within the bounds of the AOC is characterized as moderately subdued on a reworked sandstone bedrock surface. Topography of Load Line 2 was mapped by USACE in 1998 on a 0.6-m (2-ft) contour interval, with an accuracy of 0.006 m (0.02 ft), from aerial photographs taken in 1997. This survey was the basis for the topographic features presented in the figures of the Phase II RI report. Elevations within the bounds of the AOC vary from approximately 301 to 307 m (990 to 1,010 ft) amsl. However, topography drops sharply to the south of the AOC, in the direction of Kelly’s Pond. In general, the land surface slopes from the center of the load line in all directions. There is a high point (1,020 ft) to the north of the AOC, and surface elevation decreases to 930 ft to the south within the bounds of RVAAP. Kelly’s Pond is located just south of the fenced boundary of Load Line 2 and a group of four unnamed ponds is found on the northeastern border of the AOC.

Former production infrastructure features at Load Line 2 consist mainly of asphalt and gravel access roads, man-made ditches, sewer lines, manholes, ballast from old railroad tracks, and buildings/steel building frames associated with the load line. The main process area is heavily vegetated with heavy grass and scrub vegetation between the major structures of the load line. The non-production areas around the main process area are characterized by scrub vegetation and immature hardwoods.

2.2.1.2 Geologic Setting of Load Line 2

Subsurface characterization at Load Line 2 during the Phase I and II RIs was performed by installing six test trenches to depths of 3.048 m (10 ft) around the periphery of the AOC and by continuous sampling during the installation of piezometers and monitoring wells. Borings from soil sampling locations also were used to characterize the shallow subsurface soil interval. Bedrock was encountered in all Phase II RI subsurface borings at depths ranging from 1.22 m (4 ft) to 4.88 m (16 ft).

Soil

At Load Line 2, soil of the Trumbull, Mitiwanga, and Mahoning series is present. The Trumbull series soil is deep, poorly drained, and occurs on nearly level terrain. Permeabilities typically are low (less than 0.15 cm [0.06 inches] per hour), and the soil remains saturated with water for long periods in winter, spring, and summer. Ponding is common after heavy rains. This soil series is found mainly along small drainage features or in low-lying areas adjacent to Mahoning or Resmen series soil in areas less than 4 ha (10 acres) (USDA 1978).

Soil of the Mahoning series is typified by poorly drained soil formed in silty clay loam or clay loam glacial till where bedrock is generally greater than 1.8 m (6 ft). This soil is found on uplands. Runoff is typically medium to rapid, and the soil is seasonally wet. Permeabilites range from 1.52 to 5.08 cm (0.6 to 2.0 inches) per hour.

Mitiwanga series soil consists of moderately deep, somewhat poorly drained soil formed in glacial till overlying sandstone bedrock, and this soil is found primarily on undulating uplands. The soil is characterized most commonly as a silty clay loam varying in color from yellowish-brown to dark yellowish brown. This soil exhibits a moderate available water capacity and has a water table near the surface late in winter and spring. Permeabilities range from 1.52 to 5.08 cm (0.6 to 2.0 inches) per hour.

At Load Line 2, unconsolidated zone characteristics vary widely in character from one area to another due to lateral discontinuity within the glacial till and site disturbances. Based on test pit and boring data, unconsolidated deposits consist primarily of a yellowish-brown (10YR5/4), silty to sandy clay with intermittent gravel, with thicknesses ranging from 0 to 5.49 m (0 to 18 ft). On average, the unconsolidated interval was 1.9 m (6.3 ft) thick at Load Line 2. This interval typically has a stiff consistency, low plasticity, and is dry to moist. In comparatively undisturbed areas where some test pits were excavated, the surface soil interval consisted of a light yellow-brown (10YR5/4) to gray (2.5Y4/4) mottled, clayey silt to silty clay.

As observed from boring logs, some areas within Load Line 2 have been substantially reworked and contain sandy fill, pea gravel, ballast material, and slag; however, silty clays and silty sands dominate in the near surface interval. Concrete, rebar, nails, glass, paint chips, and other debris exist at the ground surface in many areas, especially in the vicinity of buildings.

Bedrock Geology

The Sharon Conglomerate unit of the Sharon Member (Pottsville Formation) was encountered in all subsurface borings at Load Line 2. The Sharon Conglomerate was encountered at depths ranging from 0.7 to 18.6 ft bgs in monitoring wells installed inside the production area of Load Line 2. The unit is characterized by a light yellowish-brown to brownish-gray, fine- to medium-grained sandstone, which commonly contains iron-stained fractures. In the vicinity of Load Line 2, shale lenses of varying thickness were commonly observed in subsurface borings. These shale lenses are composed of light brownish-gray to dark gray shale, typically 0.3 m (1 ft) in thickness or less. However, in the subsurface boring for well LL2mw-269, the observed lithology consisted of silty clays to clayey silts overlying shale, and no sandstone was encountered. These shale lenses also were encountered in borings drilled during the Phase II RI at Load Line 3 at a greater frequency and thickness. The prevalence of shale in the vicinity of Load Lines 2 and 3 was not observed during investigations at Load Line 1 and Ramsdell Quarry to the northeast; the Sharon Conglomerate in these areas consists of a much more homogenous quartz sandstone with little observed shale. Farther to the west at Load Line 12, an extensive dark gray shale was encountered in subsurface borings. The observed facies changes imply a change of depositional environment across the southeastern portion of the facility with energetic conditions in the Load Line 1 and Ramsdell Quarry areas and increasingly quiescent conditions toward the south-central portion of RVAAP (e.g., vicinity of Load Lines 12 and 4).

2.2.1.3 Load Line 2 Hydrogeologic Setting

All wells at Load Line 2 are screened within the Sharon Member conglomerate unit. A potentiometric surface map of Load Line 2 is provided in the Phase II RI Report. Within Load Line 2, a radial groundwater flow pattern exists, centered around a potentiometric high in the center of the load line. Groundwater depths range from approximately 5 to 14.7 ft bgs (EQM 2010). Water table elevations drop steeply on the south side of the AOC, consistent with topography. A 15.2-m (50-ft) decrease in water levels was observed from the center of the load line to monitoring wells located just to the south of Kelly's Pond, a distance of approximately 1,295 m (4,250 ft).

Results of slug tests performed at the 12 monitoring wells in September 2001 show low to moderate hydraulic conductivities. Hydraulic conductivities ranged from 3.67×10^{-6} cm/sec (1.04×10^{-2} ft/day) to 2.62×10^{-3} cm/sec (7.43 ft/day). Slug test results are representative of the entire screened interval for the monitoring wells; therefore, any local heterogeneities within the screened interval that affect hydraulic conductivity, such as shale lenses, are represented in the slug test.

The primary surface water conveyance at Load Line 2 drains to the south and ultimately discharges into Kelly's Pond. Surface water flows through a series of manmade ditches, which ultimately connect on the south end of the AOC and flow through a corrugated metal pipe underneath the railroad tracks en route to Kelly's Pond. The largest of these ditches begins just north of Building DB-4 and is approximately 50 ft wide and 15 ft deep. Surface water also flows north through a smaller network of ditches to a group of four ponds situated on the northeastern corner of Load Line 2, but the majority of surface water runoff is to the south. These ditches mainly served as a surface and wastewater (e.g., pink wastewater) runoff control system. Flow in the ditches is intermittent and driven primarily by storm events.

A below ground storm sewer system also exists within the former production area at Load Line 2 for management of stormwater runoff. Runoff is collected at a series of inlets located adjacent to the primary buildings and along roadways, and is directed via pipes to discharge points at the major drainages ditches noted above. The stormwater system collected pink wastewater and runoff from contaminated surface soil in the immediate vicinity of the melt-pour buildings and other major production buildings.

2.2.2 Co-located or Proximate Sites

The following subsections summarize sites that are co-located or proximate to Load Line 2 but are addressed separately.

2.2.2.1 Facility-wide Sewers

The defunct sanitary and storm sewers within the perimeter of Load Line 2 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Sewer sediment, pipe bedding material, and sewer water were evaluated as currently summarized in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a). The sanitary sewers in the Load Line 2 FA were part of the Sand Creek Sewage Treatment Plant Network. Load Line 2 also contains a discrete storm sewer network. Demolition activities at former Load Line 2 impacted numerous sewer structures, especially those associated with shallow storm sewers adjacent to buildings and walkways.

Sewer water and sediment samples were collected from storm and sanitary sewers during the Phase II RI (USACE 2004b); video surveys also were conducted. Inspections and explosives field screening tests were conducted at the Load Line 2 FA during a 2007 *Summary of CERL Findings, RVAAP Sewer System (*USACE-CERL 2007) and the *Explosive Evaluation of Sewers* (LES 2007a). During both studies, wipe samples of sewer line inverts were collected for analysis of explosive residues, using field test kit methods (e.g., Expray® 24 and DropEx).

Analytical results showed detectable levels of explosives in sanitary and storm sewer sediment and sewer water samples at Load Line 2. The sporadic distribution of explosives and propellant SRCs, as compared to inorganic chemicals and PAHs, reflects the fact that former production operations and primary sources of these compounds, especially the melt pour line at Load Line 2, ceased operations decades ago, and only residual secondary sources (e.g., contaminated soil and sediment) remain as contributors. Precipitation events and groundwater infiltration with associated flushing through the systems, along with degradation processes, appear to be reducing explosives concentrations over time.

Lead was identified as an SRC in sewer media. Notable longitudinal trends were observed in sediment along storm sewer segments in the southwestern portions of the Load Line 2 FA. Lead sources potentially included lead-based paint flaking from deteriorating buildings over time, which would wash into storm sewer drop inlets. Additionally, historical plumbing systems common to World War II era buildings, such as those at RVAAP, used lead to seal joints in cast-iron plumbing systems and may have contributed to lead observed in sewer media. Lead was identified as a potential concern based on the potential to partition and migrate to surface water. Elevated lead concentrations were observed in sewer sediment and outfall sediment upstream of impacted surface water locations. Therefore, this location was classified as a localized source to be removed. An Engineering Evaluation/Cost Analysis (EE/CA) is underway to address this lead contamination and includes proposed removal of 147 cubic yards of lead-contaminated sediment from the Load Line 2 FA.

2.2.2.2 Facility-wide Groundwater

As part of the IRP, the Army implements the FWGWMP in accordance with previous agreements made with Ohio EPA. The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP.

In 2015, for the FWGWMP, groundwater samples were collected from 4 of 13 monitoring wells associated with Load Line 2. Chemicals were detected at concentrations greater than site-specific screening levels at LL2mw-059, LL2mw-060, LL2mw-267, and LL2mw-271; organic constituent concentrations were below site-specific screening levels at LL2mw-271.

Increasing concentration trends were observed in the following two groundwater monitoring wells:

- **LL2mw-059.** 2,4-DNT shows a slightly increasing trend over the past 19 years; however, concentrations typically have been less than 0.5 µg/L. The maximum detection of 0.86 µg/L occurred in 2007. This well is located south of Load Line 2, and upgradient of several other wells without exceedances.
- **LL2mw-267.** 2-amino-4,6-DNT, 4-amino-2,6-DNT, and RDX show increasing concentration trends over the past 15 years; however, concentrations for each of these constituents are relatively low, with maximum detections ranging from 1.7 to 2.1 µg/L occurring in 2007.

One pesticide constituent along with several explosives and propellants were detected above screening criteria in the area of Load Line 1, Load Line 2, and Load Line 3. Based on the similarity of constituents, it is probable that the area within the isoconcentration contours constitutes one contiguous groundwater plume. All of the impacts to groundwater were detected in the Sharon Sandstone aquifer. Monitoring well samples from the unconsolidated aquifer did not have any exceedances for organic constituents. The Sharon Sandstone groundwater flow direction in this area of Camp Ravenna is toward the south-southeast (EQM 2016).

Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at Load Line 2 will be addressed as part of that facility-wide AOC.

2.2.2.3 Munitions Response Sites

There is no MRS within or adjacent to the AOC boundary identified as part of the Military Munitions Response Program (MMRP).

2.2.2.4 Compliance Restoration Sites

USTs RV-20 and RV-21 at Building DB-27 Boiler House and USTs RV-57 and RV-58 at Building DC-1 are covered under site CC-RVAAP-72 Facility-wide USTs. No further action is warranted based on the recommendation in the *Site Inspection for CC-RVAAP-72 facility-wide USTs* (USACE 2015c).

The facility-wide coal storage site, Power House No. 2, was assessed under site CC-RVAAP-73 as part of the Coal Sites AOC in the HRR (USACE 2011a). As indicated in the HRR, evaluation of the historical data in soil at this site will be addressed in a future CERCLA action and therefore is included in this FS Addendum.

2.2.3 Previous Investigations, Decisions, and Actions

Since 1978, Load Line 2 has been the subject of multiple investigations and/or assessments leading to CERCLA decisions and/or remedial actions at the AOC. The Preliminary Assessment conducted in 1996 concluded that Load Line 2 was a high-priority AOC for future environmental investigations due to primary contaminant release mechanisms from process effluent discharges to surface water and surface soil. Subsequently, a Phase I RI was conducted and recommended additional investigation in a Phase II RI due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC. During the Phase II RI, a total of 172 environmental samples (including 17 sub-slab samples) were collected to determine the nature and extent of surface soil contamination at Load Line 2. Based on the results of the human health and ERAs, Load Line 2 was recommended for further evaluation in an FS.

Kelly's Pond, which receives exit drainage from Load Line 2, was assessed during a 2003 Facility-wide Biological and Water Quality Study. One ISM sediment sample and two surface water samples were collected from Kelly's Pond. Explosives, PAHs, and metals were detected in sediment and/or surface water from the pond. As part of the biological assessment, Kelly's Pond was rated as very poor quality based on the Lake/Lacustrine Qualitative Habitat Evaluation Index (L-QHEI) and received the lowest score of the ponds evaluated at RVAAP (USACE 2005a). Fish communities and macroinvertebrate communities were not similar (i.e., lower in quality and quantity of species) when compared to reference ponds (USACE 2005c), but a direct correlation between poor biological condition and chemical exposure could not be determined because of the poor habitat.

An FFS recommended excavation with off-site disposal as an interim remedy to address surface soil, subsurface soil, and dry sediment contamination at Load Line 2. Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007 (USACE 2008a). A total of 320 tons of hazardous PCB-contaminated soil and 2,617 tons of non-hazardous soil were removed from a total of 24 discrete areas within Load Line 2. After the excavation was completed, ISM samples were collected and analyzed for Load Line 2 COCs: PCB-1254, TNT, RDX, aluminum, antimony, arsenic, hexavalent chromium, lead, and manganese. Previous sample locations and previous remediation areas are presented in Plates 2-3 and 2-4 (located at the end of this section).

To determine if any additional areas required excavation to remove contaminated soil beneath former building slabs (removed between March and June 2008), the following sampling activities were completed at Load Line 2: stockpile sampling, post-slab removal field screening, and final confirmatory sampling. Analytical and field screening results from these building slabs at Load Line 2 indicated there were no concentrations of explosives beneath former building slabs that exceeded cleanup goals (USACE 2009b). Additional field investigation activities completed at Load Line 2 included collection of field screening samples from visually impacted zones. Additional characterization and remediation were warranted at the following Load Line 2 locations:

- North elevator sump at Building DB-4 to a maximum depth of 4 ft bgs,
- The north sump area (DB-4-WN) to a maximum depth of 4 ft bgs, and
- An area adjacent to DB-10 and DB-10-VP-2 where bulk TNT was removed to a maximum depth of 2 ft bgs.

ISM sampling was also completed in 2008 within building footprints following the removal of building slabs and any contaminated soil identified as part of the *Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11* (USACE 2009c) to determine if any additional excavation was required at building locations beyond those determined by field screening. This investigation concluded that there were no additional areas outside of those areas identified during the screening effort requiring remediation at Load Line 2 (USACE 2009c).

As part of the remedial actions completed for sub-slab soil at Load Line 2, two distinct areas were excavated in June 2010. A total of 791 cubic yards of soil were excavated from the sumps at DB-4/DB-4-WN and 94 cubic yards were excavated from the bulk TNT area at DB-10/DB-10-VP-2 (USACE 2010d).

In 2009, USACE collected 23 surface soil and 37 subsurface soil ISM samples at Load Line 2 to characterize deeper subsurface soil beneath the former building slabs that was not previously investigated via subsurface soil ISM techniques. The additional surface soil ISM samples in the former coal storage area at Load Line 2 were collected and analyzed to provide preliminary data for future RIs of these AOCs.

Additional characterization sampling was completed at Load Line 2 to guide future soil remedial and administrative measures. The samples collected as part of this investigation helped eliminate soil data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010a). Five surface soil ISM samples and 12 subsurface soil horizontal ISM samples were collected at Load Line 2 to further refine ISM sample areas that had levels of PAH contamination above RVAAP FWCUGs identified in the *Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 through 4 and 12* (USACE 2013). Samples were collected at former Building DB-4, Building DB-4A, and discrete station LL2ss-165. Two PAHs (benzo[a]pyrene and dibenz[a,h]anthracene) were detected at concentrations exceeding FWCUGs utilized in the Characterization Sampling Report in surface and subsurface ISM samples. Conclusions of this investigation indicated that three of the six previous areas exceeding FWCUGs identified in the Characterization Sampling Report were bound and delineated. The remaining three areas were not fully delineated for PAHs and RVAAP full-suite chemicals (USACE 2013).

CERCLA activities completed at Load Line 2 are presented in the timeline illustrated in Figure 2-5 and additional details related to the previous investigations are provided in Appendix A.

2.2.4 June 2016 Surface Water and Sediment Sampling

Following the data gap analysis conducted during the PBA13 SAP Addendum, additional samples for soil were determined to be unnecessary given the spectrum and density of existing ISM and discrete data available for soil. Surface water and sediment sampling outlined in the PBA13 SAP Addendum were based on the data gap analysis and defined by available historical surface water and sediment locations that exceeded human health and/or ecological screening criteria.

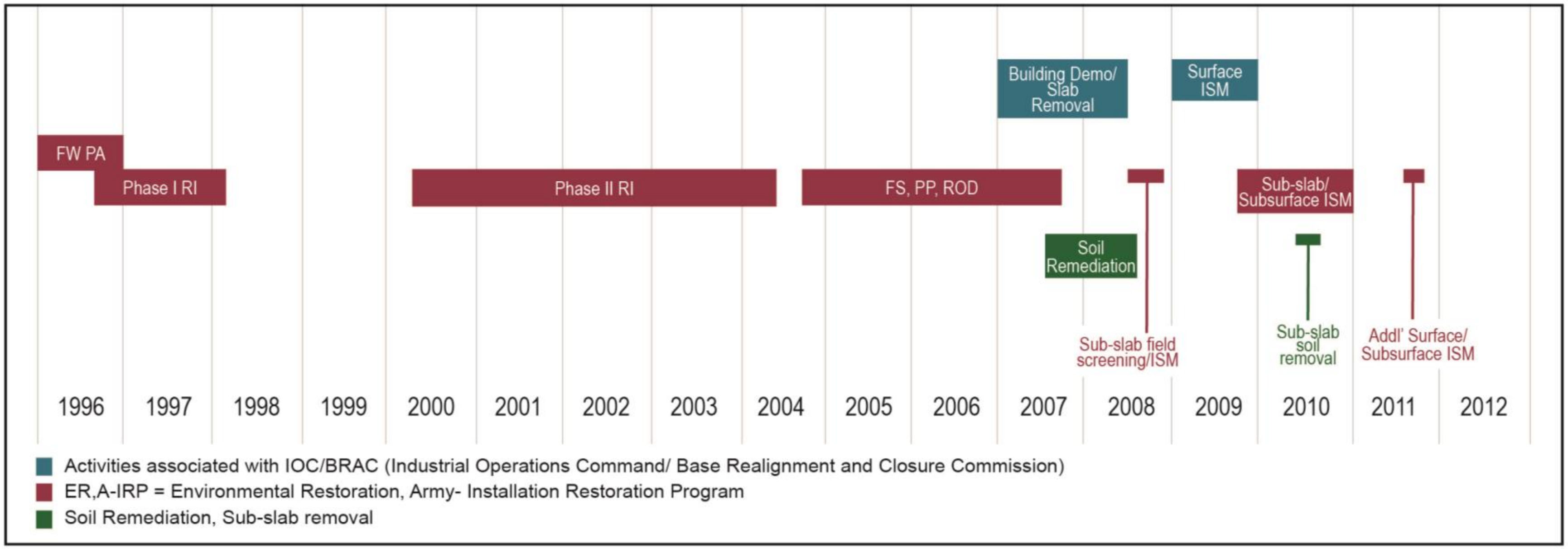

Figure 2-5. Timeline of Remedial Activities at Load Line 2

The Phase II RI (USACE 2004b) established surface water and sediment data aggregates at Load Line 2 by evaluating historical; and current surface water flow directions and conveyances. This data gap evaluation conducted in the SAP Addendum used the same data aggregates that were presented and approved in the Phase II RI as follows:

- North Ponds, and
- Kelly's Pond and Exit Drainage.

Surface water and sediment aggregates are shown in Figure 2-4. The Phase II RI established a complete evaluation of surface water and sediment based on historical receptors. These same data aggregates were re-evaluated in the SAP Addendum to identify data gaps and any required action needed to meet the current receptors as identified in the Technical Memorandum (ARNG 2014).

Historically, surface water has only been collected at the Kelly's Pond and Exit Drainage aggregate. Surface water in the North Ponds is presented intermittently throughout the year and dependent upon precipitation and seasonal variation. Therefore, surface water data for this evaluation are only available for this aggregate. Sediment sample data are available for both aggregates.

Based on the human health and ecological screening evaluations conducted in the SAP, additional sampling within Load Line 2 was conducted for the Kelly's Pond and Exit Drainage aggregate to satisfy data gaps. Sampling within this aggregate was designed to target the pond and exit drainage separately because the physical features are separate and the contamination appears to be different in the two physical features. Two discrete sediment samples were collected in Kelly's Pond (LL2sd-631-0001-SD from the center of the pond and LL2sd-633-0001-SD from the inlet to the pond) from 0 to 1 ft bgs and analyzed for lead and PAHs. Lead and PAHs were detected in both sediment samples. Two discrete sediment samples were collected from the Exit Drainage aggregate (LL2sd-630-0001-SD and LL2sd-632-0001-SD) from 0 to 1 ft bgs and analyzed for lead; silver; PAHs; 2,4,6-TNT; 2,4-DNT; 4-amino-2,6-DNT; endrin ketone; and beta-BHC. Lead and PAHs were detected in the sediment samples from both aggregates. Silver, the explosives constituents, and pesticides constituents were not detected in the sediment from the Exit Drainage.

The general approach for investigation activities was presented in the SAP Addendum FSP. Appendix B provides further details on the June 2016 sampling event. Figure B-2 in Appendix B illustrates the sediment sample locations. The sampling results are provided in Appendix E.

2.2.5 Data Assembly and Use Assessment – Load Line 2

All data collected at Load Line 2 were extracted from the REIMS database. This includes data from investigations summarized in the following reports:

- Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 through 4 and 12 (USACE 2013);
- Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 through 4 (USACE 2011c);

- Phase II RI Report for the Load Line 2 (USACE 2004b);
- Remedial Action Completion Report for the Remediation of Soils and Dry Sediments at RVAAP 08-11 (Load Lines 1 through 4) (USACE 2008a);
- Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11 (USACE 2009c);
- Remediation Completion Report for Sub-Slab Soils at Load Lines 2 through 4 (USACE 2010d);
- Facility-wide Biological and Water Quality Study (USACE 2005a); and
- Sampling of Potential Disposal Areas at Load Line 1 and Load Line 2 (USACE 2000).

The data from investigations summarized in the following reports were not used in this FS Addendum:

- *Phase I Remedial Investigation Report for the Phase I Remedial Investigation of High Priority Areas of Concern* (USACE 1998) – These data are more than 16 years old and are no longer considered representative of the site (e.g., buildings and slabs have been removed and/or remediated).
- November 2004 Sampling Completion Report (USACE 2005b).
- Preliminary Evaluation of Pre (Floor Slab Removal) Contamination for the Sampling of Soils Beneath Floor Slabs and Load Lines 2 through 4 and Excavation and Transportation of Contaminated Soils to Load Line 4 (USACE 2008b).
- Sampling and Screening Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11 (USACE 2009b).
- RI/FS Report for RVAAP-67 Facility-wide Sewers (USACE 2012a) – The sewers are currently being evaluated under a separate RI. Data from the Facility-wide Sewers Investigation was evaluated qualitatively in consideration of the CSM.

Once the data were assembled and evaluated for use, COIs were identified specific to Load Line 2 media.

2.2.6 Load Line 2 Conceptual Site Model

The CSM is a site specific, systematic planning tool. It provides a concise summary of residual contamination distribution, exposure pathways, migration routes, and assessment of the affects to human health and ecological receptors that supports development of RAOs and the FS. A graphical depiction of the CSM is presented in Figure 2-6. The following sections summarize the COIs identified in soil, surface water, and sediment, and provide results of the fate and transport analysis, HHRA, and ERA.

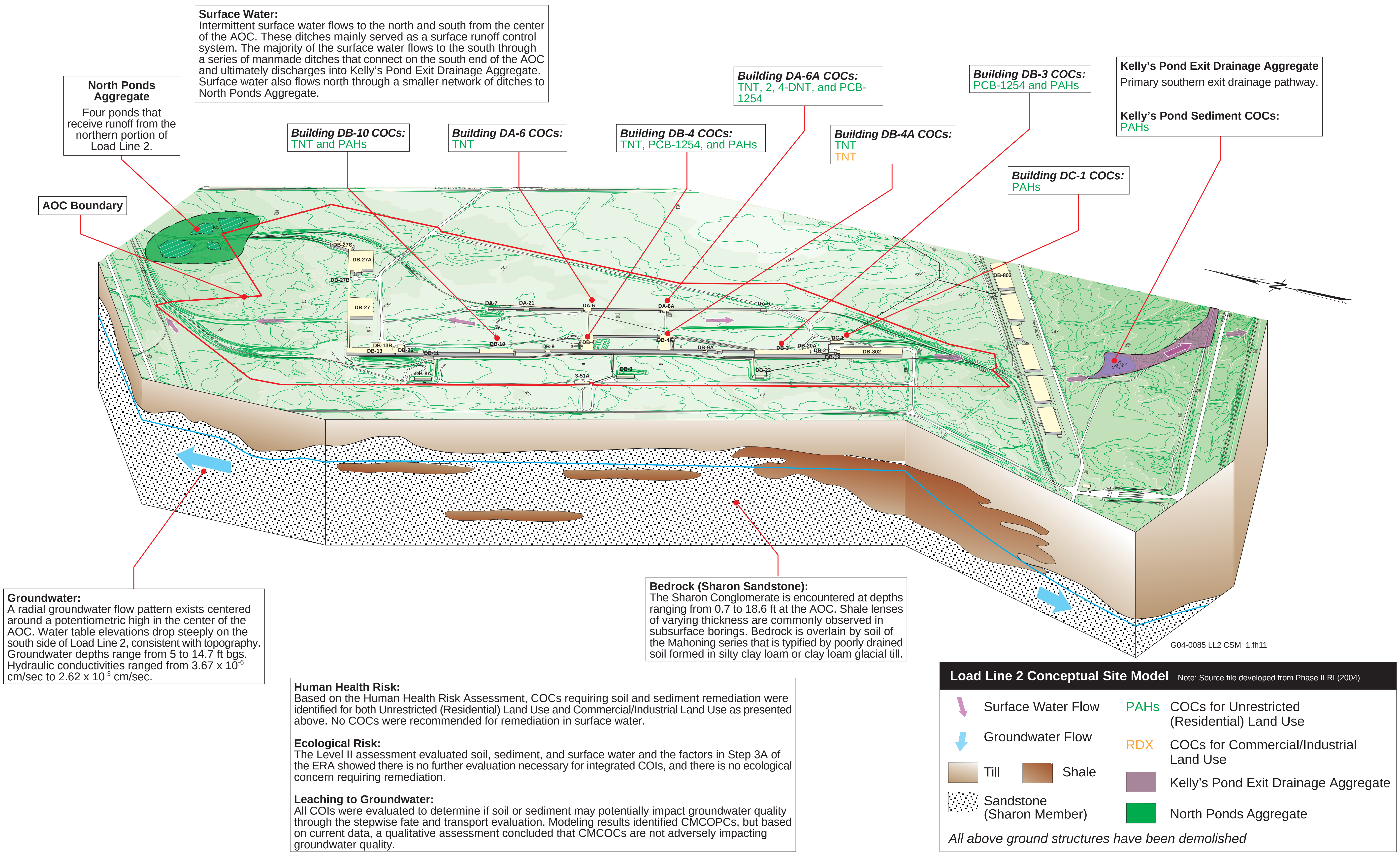

Figure 2-6. Load Line 2 Conceptual Site Model

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2.2.6.1 Load Line 2 COIs

Load Line 2 COIs were developed from the chemicals identified as exceeding residential risk targets in the Phase II RI (USACE 2004b). Load Line 2 COIs for exposure of Resident Receptor (Adult and Child) to soil, sediment, and surface water are shown in Table 2-8. The list of COIs shown in Table 2-8 is longer than the list of COCs included in the IROD (USACE 2007) because the IROD focused on only the National Guard Trainee Receptor and soil.

Table 2-8. COIs in Soil, Surface Water, and Sediment at Load Line 2

COI	Load Line 2		
	Soil	Surface Water	Sediment
Metals			
Aluminum	X	X	X
Antimony	X	X	X
Arsenic	X	X	X
Cadmium	X	X	X
Copper	X	X	X
Chromium, hexavalent	X	X	X
Lead	X	X	X
Manganese	X	X	X
Thallium	X	X	X
Explosives			
2,4,6-TNT	X	X	X
2,4-DNT	X	X	X
RDX	X	X	X
PCBs			
PCB-1254	X	X	X
PCB-1260	X	X	X
Pesticides			
Dieldrin	X	X	X
PAHs			
Benz(a)anthracene	X	X	X
Benzo(a)pyrene	X	X	X
Benzo(b)fluoranthene	X	X	X
Dibenz(a,h)anthracene	X	X	X
Indeno(1,2,3-cd)pyrene	X	X	X

COI = Chemical of Interest.
DNT = Dinitrotoluene.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
TNT = Trinitrotoluene.

2.2.6.2 Fate and Transport

The details of the fate and transport analysis conducted to assess the potential for COIs to leach from surface soil and subsurface soil (defined as soil leaching COIs) at Load Line 2 and impact groundwater beneath the source and at a nearest downgradient receptor location are presented in Appendix G. The fate and transport analysis also evaluates the potential for SRCs to leach from sediment sources at Load Line 2 and impact groundwater beneath the source and at the nearest downgradient receptor location. A summary of the analyses is presented in this section.

Mainly organic COIs (2,4-DNT and RDX) were identified in surface soil and subsurface soil at the AOC in this FS Addendum. These soil leaching COIs were further evaluated to determine if residual concentrations in surface and subsurface soil may potentially impact groundwater quality and warrant evaluation in an FS. Also, all sediment SRCs were evaluated to determine if residual concentrations in sediment may potentially impact groundwater quality and warrant evaluation in an FS. All of the soil leaching COIs and the SRCs identified in the sediment at the AOC were evaluated through the stepwise fate and transport evaluation that included leachate modeling in the unsaturated zone using SESOIL model and lateral transport modeling in the saturated zone using the AT123D model.

If the predicted maximum leachate concentration of a COI was lower than the screening criteria, the chemical was eliminated for further evaluation using AT123D modeling. For these remaining COIs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCLs, and RSLs. Only the CMCOPCs with predicted maximum concentration higher than its facility-wide background concentration, and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), was retained as a CMCOC. These CMCOCs were evaluated with respect to WOE for retaining or eliminating CMCOCs from further consideration as a basis for potential soil or sediment remedial actions.

The evaluation of modeling results with respect to current groundwater data for the AOC and model limitations identified the following CMCOCs at Load Line 2:

- The soil leaching COIs, 2,4-DNT and RDX, were predicted to exceed the screening criteria in groundwater beneath the source; however, only RDX was predicted to be above criteria at the downgradient receptor location.
- Among the sediment CMCOPCs, only antimony was predicted by analytical solutions to exceed screening criteria in groundwater beneath the source; however, it was not predicted to be above criteria at the downgradient receptor location.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if 2,4-DNT and RDX (i.e., the CMCOPCs in soil) and antimony (i.e., CMCOPC in sediment) at the AOC may impact the groundwater beneath the source or at the downstream receptor location.

2,4-DNT – The maximum surface soil concentration for 2,4-DNT (3.3 mg/kg at LL2ss-087) was below its residential soil RGO. 2,4-DNT modeling results using this maximum concentration indicate groundwater concentrations beneath the source area could potentially exceed its RSL in less than 150 years with peak concentration occurring at approximately 250 years; 2-4-DNT was not detected above its RSL in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). Also, the maximum predicted groundwater concentration of 2,4-DNT at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative and 2,4-DNT would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

RDX – The maximum surface soil concentration for RDX (25 mg/kg at LL2ss-162-0944) was below its residential soil RGO, and RDX was not identified a soil COC in the HHRA. The modeling estimates that RDX concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 20 years or less with peak concentrations occurring at approximately 40 years or less; the maximum predicted groundwater concentration of RDX at the downgradient receptor location is also expected to be above its RSL (Appendix G, Table G-15). However, RDX was not detected in the AOC groundwater samples exceeding its RSL collected from 2011–2015 (Appendix G, Table G-15). Based on the AOC period of operations, RDX should have already been detected in groundwater exceeding its RSL. Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and RDX would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

Antimony – The maximum sediment concentration for antimony (9.5 mg/kg at FSW-SD-034-0000) was below its residential soil RGO. The modeling assumes that the sediment is in direct contact with groundwater and no attenuation due to sorption is occurring; therefore, antimony is predicted to be already in groundwater beneath the source area exceeding its MCL, although antimony was not detected above its MCL in the AOC groundwater samples collected from 2012–2015 (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and antimony would be expected to be below its MCL based on attenuation while accounting for the vertical leaching distance.

Conclusion – This qualitative assessment concludes that the soil and sediment contaminants identified as CMCOCs for evaluation are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts for the AOC groundwater beneath the source and at the downgradient receptor location. Based on the fate and transport evaluation, CMCOCs were not identified for Load Line 2, and no further action is required for soil and sediment to be protective of groundwater for the AOC.

2.2.6.3 Human Health Risk Assessment Results

The HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to residual contamination in soil, sediment, and surface water at Load Line 2. The approach to risk-based decision making is as follows:

RGOs were compiled for the COIs identified in Section 2.2.6.1. RGOs for Unrestricted (Residential) Land Use are the USEPA Residential RSLs for soil (used for soil and sediment) and tap water (used for surface water) published May 2016. This is a very conservative approach, since residential exposure to sediment and surface water will be much less than that assumed for soil and tap water. Soil RSLs assume Resident Receptors are exposed daily to soil in a residential yard. Exposure to sediment in small water bodies will be less frequent and for a shorter duration. Use of Tap Water RSLs based on potable water use to evaluate the small surface water bodies at Load Line 2 is also very conservative compared to the potential incidental exposure that may occur at these conveyances.

RSLs for the cancer endpoint were adjusted to correspond to a TR of 1E-05, RSLs for the non-cancer endpoint were used at a target HQ of 1. RGOs for Commercial/Industrial Land Use are the USEPA Industrial RSLs for soil adjusted for a TR of 1E-05 and target HQ of 1. Industrial RSLs are not available to evaluate surface water or sediment because Industrial/Commercial activities are not applicable to surface water (i.e., exposure of industrial and commercial workers is not anticipated for these media). The potential impact of the lack of screening values is addressed in the uncertainty assessment using Industrial RSLs calculated with the on-line USEPA RSL calculator assuming an Industrial Receptor might wade into shallow water bodies. At Load Line 2, media were previously remediated for COCs that exceeded cleanup goals established for the National Guard Trainee; therefore, this FS Addendum only evaluates the Resident Receptor (Adult and Child) and the Industrial Receptor.

The methodology of comparing COI exposure concentrations to RGOs and determining COCs generally follows guidance presented in the Position Paper for Human Health Cleanup Goals (USACE 2012b) and Technical Memorandum (ARNG 2014) and includes calculating an SOR for all non-carcinogenic and carcinogenic COIs. The reported concentration in each discrete or ISM sample was compared to RGOs (i.e., the EPC is the concentration in each individual sample). COIs are identified as COC for a given receptor if:

- The EPC exceeds the most stringent RGO for either the 1E-05 target cancer risk or the 1 target HQ; or
- The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than 1; chemicals contributing at least 5% to an SOR greater than 1 are also considered COCs.

Metals present at concentrations consistent with naturally occurring background concentrations are not identified as COCs.

The results of the COC screening are combined with the results of the uncertainty assessment to identify COCs to be carried forward for remediation. Details of the screening process and identification of COCs recommended for remediation are provided in Appendix H.3. Detailed figures depicting contaminant distribution and results of screening assessments are provided in Figures H.3-1 through H.3-9 in Appendix H. The COCs to be carried forward for potential remediation are summarized below for Unrestricted (Residential) and Industrial Land Use:

- Unrestricted (Residential) Land Use – Antimony; lead; 2,4,6-TNT; 2,4-DNT; PCB-1254; PCB-1260; and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene) were identified as COCs to be carried forward for potential remediation in soil. PAHs were identified as COCs to be carried forward for potential remediation in sediment. No COCs were recommended for remediation in surface water. The COCs recommended for remediation are summarized by area below:
    - Building DB-10 – 2,4,6-TNT; PCB-1254; PCB-1260; and PAHs (benzo[a]pyrene, benz[a]anthracene, and benzo[b]fluoranthene).
    - Building DB-4 – 2,4,6-TNT; PCB-1254; and PAHs (benzo[a]pyrene; benz[a]anthracene; benzo[b]fluoranthene; and indeno[1,2,3-cd]pyrene).
    - Building DA-6 – 2,4,6-TNT.

- Building DB-4A – 2,4,6-TNT.
- Building DA-6A – 2,4,6-TNT; 2,4-DNT; and PCB-1254.
- Building DB-3 – PCB-1254 and PAHs (benz[a]anthracene, benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).
- Building DC-1 – PAHs (benzo[a]pyrene; benz[a]anthracene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).
- Isolated Discrete Soil Samples – Lead and antimony.
- Kelly's Pond – PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene) in sediment.

Industrial/Commercial Land Use – 2,4,6-TNT was identified as a COC to be carried forward for potential remediation in soil at Building DB-4A. No COCs were recommended for remediation in sediment or surface water. The COCs recommended for remediation are summarized by area below:

- Building DB-4A – 2,4,6-TNT.

COCs identified for potential remediation at Load Line 2 are summarized in Tables 2-9 and 2-10.

2.2.6.4 Ecological Risk Assessment Results

The ERA for wet sediment and surface water at Load Line 2 is presented in Appendix I of this FS Addendum and follows a unified approach of methods integrating Army, Ohio EPA, and USEPA guidance. This ERA approach is consistent with the general approach by these agencies and primarily follows the Level I Scoping ERA, Level II Screening ERA, and Level III Baseline ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008), with specific application of components from the FWERWP (USACE 2003b) (*Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c), and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997). The ERA process implemented in this FS Addendum report combines these guidance documents to meet requirements of the Ohio EPA and the Army, while following previously accepted methods established for RVAAP. This unified approach resulted from coordination between USACE and Ohio EPA during the summer of 2011.

A historical ERA (a SERA and BERA) was performed as part of the Phase II RI (USACE 2004b) for Load Line 2. The ERA for wet sediment and surface water in Appendix I was conducted because the historical evaluation was not based on the current Ohio EPA guidance (Ohio EPA 2008) and did not include the recently collected FS Addendum data. Soil was evaluated for ecological receptors for Load Line 2 in the Phase II RI (USACE 2004). As concluded in the IROD at Load Lines 1 through 4 (USACE 2007): *the majority of COECs in soil are co-located with human health COCs and remedial activities implemented to address human health COCs will serve to reduce the concentrations and number of COECs in soil to which ecological receptors are exposed, resulting in lowered ecological risk.* As a result, ecological cleanup goals were not required. Based on the removal action subsequent to the IROD, no further action is necessary for ecological exposures to soil.

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Table 2-9. Summary of Human Health COC Concentrations in Soil and Sediment and Conclusions for Unrestricted (Residential) Land Use

				Metal			Explosive		PAH					PCB		
	Sample	Residential RGO[b]		31	400	0.78	36	17	1.6	0.16	1.6	0.16	1.6	1.2	2.4	
Station	**Type**	**Date**	**Depth (ft)**	**Antimony**	**Lead**	**Thallium**	**TNT**	**2,4-DNT**	**B(a)A**	**B(a)P**	**B(b)F**	**DA**	**IP**	**PCB-1254**	**PCB-1260**	**Conclusion for Unrestricted Land Use**
Building DB-10																
LL2ss-315M	ISM	06/22/10	1.3 - 2.3	--	--	--	46.4	--	1.01[a]	1.13	0.957[a]	--	--	--	--	Remediate
LL2ss-298M	ISM	06/24/08	0.0 - 1.0	--	--	--	--	--	0.445[a]	0.406	0.339[a]	--	--	2.24	0.785[a]	Remediate
LL2-120	D	07/25/01	0.0 - 1.0	--	820	--	--	--	--	--	--	--	--	--	--	NFA
Building DB-4																
LL2ss-285M	ISM	06/20/08	0.0 - 1.0	--	--	--	125	--	0.427[a]	0.379	0.301[a]	--	--	0.437[a]	--	Remediate
LL2ss-407	ISM	12/02/09	0.0 - 0.5	--	--	--	--	--	3.9	3.8	5.1	--	2	1.3	--	Remediate
LL2-130	D	07/27/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	2.5	--	All of these discrete samples are within LL2ss-407, which is recommended for remediation; therefore, alone, these results might not drive remediation, but they will be taken care of as part of the 407 excavation
LL2-130	D	07/28/01	1.0 - 3.0	--	747	--	46	--	--	--	--	--	--	--	--	
LL2-133	D	07/28/01	0.0 - 1.0	--	--	--	--	--	0.39[a]	0.5	0.66[a]	--	--	0.77[a]	--	
LL2-133	D	07/29/01	1.0 - 3.0	--	--	--	53	--	--	--	--	--	--	--	--	
LL2-131	D	07/26/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	5	--	
LL2-134	D	07/28/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	4.4	--	
LL2ss-519M	ISM	07/02/11	0.0 - 1.0	--	--	--	--	--	0.52[a]	0.59	0.63[a]	0.097[a]	0.4[a]	--	--	NFA
LL2-127	D	07/26/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	1.2[a]	--	NFA
LL2sb-513M	ISM	07/01/11	1.0 - 3.0	--	--	--	--	--	1[a]	0.88	1.1[a]	0.16[a]	--	--	--	NFA
Building DA-6																
LL2-082	D	07/25/01	0.0 - 1.0	--	--	--	1100	--	--	--	--	--	--	--	--	NFA
LL2SB-508M	ISM	08/25/10	1.0 - 3.0	--	--	--	230	--	--	--	--	--	--	--	--	Remediate
LL2ss-055-cs	ISM	10/08/07	2.0 - 3.0	--	--	--	77.6	--	--	--	--	--	--	--	--	Remediate
Building DB-4A																
LL2-158	D	07/27/01	0.0 - 1.0	--	--	--	610	--	--	--	--	--	--	--	--	Remediate
LL2ss-288M	ISM	06/18/08	0.0 - 1.0	--	--	--	66.6	--	--	--	--	--	--	--	--	NFA
LL2ss-287M	ISM	06/24/08	0.0 - 1.0	--	--	--	--	--	--	0.167	--	--	--	--	--	NFA
LL2-146	D	07/27/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	2.8	NFA
LL2-148	D	07/27/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	1.8	--	NFA
Building DA-6A																
LL2-087	D	07/26/01	0.0 - 1.0	--	--	--	240	3.3[a]	--	--	--	--	--	2.6	--	Remediate
LL2-087	D	07/30/01	3.0 - 5.0	--	--	--	240	--	--	--	--	--	--	--	--	Remediate
LL2SB-506M	ISM	08/24/10	3.0 - 5.0	--	--	--	130	--	--	--	--	--	--	--	--	Remediate
LL2ss-406	ISM	12/01/09	0.0 - 0.5	--	--	--	38	--	--	--	--	--	--	--	--	Remediate
LL2-093	D	07/26/01	0.0 - 1.0	--	--	--	--	--	0.17[a]	0.21	0.22[a]	--	--	--	--	NFA
Building DB-3																
LL2-165	D	07/28/01	0.0 - 1.0	--	--	--	--	--	--	1.9	2.4	0.22	--	9.4	--	Remediate
LL2ss-516M	ISM	07/03/11	0.0 - 1.0	--	--	--	--	--	1.5[a]	1.6	1.9	0.24	--	--	--	Remediate
LL2ss-280M	ISM	06/18/08	0.0 - 1.0	--	--	--	--	--	0.392[a]	0.402	0.285[a]	--	--	--	--	NFA
LL2ss-279M	ISM	06/18/08	0.0 - 1.0	--	--	--	--	--	0.371[a]	0.316	0.24[a]	--	--	--	--	NFA
Building DC-1																
LL2-170	D	07/24/01	0.0 - 1.0	--	--	--	--	--	1.1[a]	1.5	1.3[a]	--	--	--	--	NFA
LL2-171	D	07/24/01	0.0 - 1.0	--	--	--	--	--	0.44[a]	0.56	0.61[a]	0.11[a]	--	--	--	NFA
LL2-169	D	07/24/01	0.0 - 1.0	--	--	--	--	--	1.7	1.8	2	0.28	--	--	--	Remediate
FWCss-002	ISM	12/03/09	0.0 - 0.5	--	--	--	--	--	1.5[a]	1.4	2.5	--	--	--	--	Remediate
LL2-172	D	07/24/01	0.0 - 1.0	--	--	--	--	--	0.22[a]	0.3	0.35[a]	--	0.19[a]	--	--	NFA
Building DB-13																
LL2-100	D	07/26/01	0.0 - 1.0	59.5	1220	0.99	--	--	--	--	--	--	--	3	--	NFA
LL2-100	D	07/29/01	1.0 - 3.0	--	1530	--	--	--	--	--	--	--	--	--	--	NFA
LL2-108	D	07/27/01	0.0 - 1.0	--	--	--	--	--	0.16[a]	0.19	0.28[a]	--	0.13[a]	--	--	NFA
Isolated Discrete Samples																
LL2-252	D	07/30/01	0.0 - 0.5	69.2	656	--	--	--	--	--	--	--	--	--	--	Remediate

Table 2-9. Summary of Human Health COC Concentrations in Soil and Sediment and Conclusions for Unrestricted (Residential) Land Use (continued)

				Metals			Explosives		PAHs					PCBs		
	Sample	Residential RGO		31	400	0.78	36	17	1.6	0.16	1.6	0.16	1.6	1.2	2.4	
Station	Type	Date	Depth (ft)	Antimony	Lead	Thallium	TNT	2,4-DNT	BaA	BaP	BbF	DA	IP	PCB-1254	PCB-1260	Conclusion for Unrestricted Land Use
Kelly's Pond and Exit Drainage																
LL2sd-053	D	07/30/01	0 - 0.5	--	--	--	--	--	0.15[a]	0.18	0.25[a]	--	0.11[a]	--	--	Remediate
LL2sd-182	D	07/31/01	0 - 0.5	--	--	--	--	--	0.6[a]	0.55	0.71[a]	0.082[a]	--	--	--	NFA
Kelly's Pond	ISM	06/23/03	0 - 0.3	--	--	--	--	--	1.25[a]	1.4	2.3	0.135[a]	1.045[a]	--	--	Remediate
LL2SD-630	D	05/16/16	0 - 1	--	--	--	--	--	0.228[a]	0.216	0.311[a]	0.0296[a]	--	--	--	NFA
LL2SD-632	D	05/16/16	0 - 1	--	--	--	--	--	0.471[a]	0.463	0.675[a]	0.0797[a]	--	--	--	Remediate
LL2SD-633	D	05/16/16	0 - 1	--	--	--	--	--	0.806[a]	0.941	1.39[a]	0.154[a]	0.646[a]	--	--	Remediate
LL2SD-631	D	05/17/16	0 - 1	--	--	--	--	--	16.4	23.6	41.2	4.55	19.1	--	--	Remediate

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.

[b]Residential RGOs are the same for soil and sediment. This results in a very conservative assessment of sediment.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
D = Discrete soil sample.
DA = Dibenz(a,h)anthracene.
DNT = Dinitrotoluene.
ft = Feet.
IP = Indeno(1,2,3-cd)pyrene.
ISM = Incremental Sampling Methodology.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.
-- = Chemical is not a COC in this sample.

Table 2-10. Summary of Human Health COC Concentrations in Soil and Conclusions for Industrial/Commercial Land Use

	Sample	Residential RGO		Metal		Explosive	PAH			Pesticide	PCB	Conclusion for
				470	800	510	29	2.9	29	1.4	9.7	Commercial/Industrial
Station	**Type**	**Date**	**Depth (ft)**	**Antimony**	**Lead**	**TNT**	**B(a)A**	**B(a)P**	**B(b)F**	**Dieldrin**	**PCB-1254**	**Land Use**
Building DB-10												
LL2-120	D	07/25/01	0.0 - 1.0	--	820	--	--	--	--	--	--	NFA
Building DB-4												
LL2ss-407	ISM	12/02/09	0.0 - 0.5	--	--	--	3.9[a]	3.8	5.1[a]	--	1.3[a]	NFA
Building DA-6												
LL2-082	D	07/25/01	0.0 - 1.0	--	--	1100	--	--	--	--	--	NFA
Building DB-4A												
LL2-158	D	07/27/01	0.0 - 1.0	--	--	610	--	--	--	--	--	Remediate
Building DB-3												
LL2-165	D	07/28/01	0.0 - 1.0	--	--	--	--	1.9[a]	--	0.29[a]	9.4[a]	NFA
Building DB-13												
LL2-100	D	07/26/01	0.0 - 1.0	--	1220	--	--	--	--	--	--	NFA
LL2-100	D	07/29/01	1.0 - 3.0	--	1530	--	--	--	--	--	--	NFA

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
D = Discrete soil sample.
ft = Feet.
ISM = Incremental Sampling Methodology.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.
-- = Chemical is not a human health COC in this sample.

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A Level I ERA was conducted for Load Line 2 to determine presence/absence of important ecological places and resources and the presence of contamination. Perennial surface water in streams, a pond, and wetlands are important ecological resources at Load Line 2, and chemical contamination is present based on the historical ERAs. Because there is contamination and important/significant ecological resources at each of the load lines, the ERA in Appendix F continued to a Level II Screening ERA.

The Level II ERA identified procedures to determine AOC-related COIs. Data from the Phase II RI, Biological and Water Quality Study (USACE 2005a) and the FS Addendum were integrated for each load line and were evaluated separately for sediment and surface water. These ERAs used updated SRVs and ESVs that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008). The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003b). The MDC of each chemical is compared to its respective facility-wide background concentration. Wet sediment concentrations are also compared to the SRV. Chemicals are not considered site-related if the MDC is below the background concentration (or SRV for sediment). For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV. In addition to the ESV comparison, it was determined if the chemical is a PBT compound. Chemicals are retained as integrated COIs if they exceed background concentrations (and SRVs for sediment) and the ESV, if the chemical exceeds background concentrations (and SRVs for sediment) and had no toxicity information, or if the chemical is considered a PBT compound. MDC to ESV ratios are used to determine the integrated COIs that result from the combined current and historical data sets. A ratio greater than 1 suggests a possible environmental consequence. Any chemicals with ratios greater than 1 are identified as integrated COIs.

Wet sediment at Load Line 2 was analyzed at two EUs: North Ponds and Kelly’s Pond. There is one integrated COI (nitrocellulose) at the North Ponds and 22 integrated COIs at Kelly’s Pond. Surface water at Load Line 2 was analyzed at one EU: Kelly’s Pond. There are no integrated surface water COIs at Kelly’s Pond.

Technical and refinement factors were then used to refine the integrated COIs from the Level II Screening ERA. The factors included use of mean exposure concentrations, discussion of approved ESVs, and other topics. This type of assessment is Step 3A in the ERA process (USEPA 1997). Step 3A refines the list of integrated COIs to determine if: (1) there are COECs requiring further evaluation in a Level III Baseline ERA or remediation to protect ecological receptors, or (2) integrated COIs can be eliminated from further consideration. This evaluation is an important part of the Level II Screening ERA and is adapted from USEPA Step 3A, outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997) and *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c).

For Load Line 2 the evaluation in Step 3A showed no further evaluation is necessary for integrated COIs, and no ecological concern requires remediation. Consequently, the Level II Screening ERA for Load Line 2 concludes that no further action is necessary to be protective of important ecological resources.

2.3 LOAD LINE 3

Load Line 3 is located in the southeastern portion of the facility and was in operation from 1941–1945, from 1951–1957, and again from 1969–1971. Load Line 3 was primarily used to melt bulk explosives and load Composition B into large-caliber shells and bombs. During its operational history from 1941–1945, Load Line 3 produced approximately 6.5 million munitions. Demilitarization activities were conducted between 1951 and 1957, during which time approximately 228,000 munitions were processed at the load line. During the operation of Load Line 3, bulk TNT and HMX were offloaded at Buildings EA-6 and EA-6A for screening and preparation before being transported to melt pour Buildings EA-4 and EA-4A for processing and loading into shells. Bulk explosive carrier washout activities were conducted at Building EB-25. Building wash-down water and wastewater from the load line operations were collected in concrete sumps, pumped through sawdust filtration units, and ultimately discharged to a drainage ditch leading to a settling pond (Upper Cobbs Pond and, ultimately, Lower Cobbs Pond). During the operation of Load Line 3, approximately 304,800 L of pinkwater were generated each month (Jacobs Engineering 1989). All buildings and structures at Load Line 3 have been demolished.

Each building formerly located at Load Line 3 is presented below with a summary of it historical use and potential contamination source description. Former production buildings are included in Table 2-11, and the non-production buildings are listed in Table 2-12. Figure 2-7 presents the Load Line 3 AOC features.

Beginning in the early 1950s, the Defense Logistics Agency (DLA) conducted a strategic materials storage mission at Load Line 3. One hundred above-grade storage tanks (Tanks 1401 through 1500), having a capacity of 500 barrels (21,000 gallons), were constructed to store strategic materials. Tanks 1401 through 1476 were used to store silica carbide. The remainder was used to store various other strategic solid materials. The DLA Tank Storage Area is covered under site CC-RVAAP-79 and is currently undergoing separate investigation; therefore, it is not included in this FS Addendum.

Demolition Activities – By the late 1970s, all but 20 tanks had been removed; those remaining were used to store antimony, asbestos, and magnesium silicate (talc). All DLA storage tanks have been removed; the remaining materials were removed in approximately the year 2000.

2.3.1 Environmental Setting

This section provides a summary of the environmental setting of Load Line 3 as presented in the Phase II RI Report for Load Line 3 (USACE 2004c) and includes surface features and site topography, geologic setting, and local hydrogeology.

Table 2-11. Former Production Buildings at Load Line 3

Building ID	Purpose	Description of Potential Sources
EA-6	Explosive Preparation Building	Utilized to screen bulk granular TNT or bulk RDX and HMX prior to transport to the melt pour building.
EA-6A	Explosive Preparation Building	Utilized to screen bulk granular TNT or bulk RDX and HMX prior to transport to the melt pour building.
EA-28	Elevator Machine House	Took screened explosives from Building EA-6/EA6A and transported to Building EB-4/EB-4A for melt pour operations.
EA-28A	Elevator Machine House	Took screened explosives from Building EA-6/EA6A and transported to Building EB-4/EB-4A for melt pour operations.
EB-4	Melt Load Building	Located in the production area, this building was a primary melt pour building for explosives.
EB-4A	Melt Load Building	Located in the production area, this building was a primary melt pour building for explosives.
EB-4A-WN	Washout Annex	Settling tanks adjacent to Building 4 to containerize explosives washout water (pinkwater).
EB-4A-WS	Washout Annex	Settling tanks adjacent to Building 4 to containerize explosives washout water (pinkwater).
EB-4-WN	Washout Annex	Settling tanks adjacent to Building 4 to containerize explosives washout water (pinkwater).
EB-4-WS	Washout Annex	Settling tanks adjacent to Building 4 to containerize explosives washout water (pinkwater).
EB-4A-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.
EB-4-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.
EB-10-VP1	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.
EB-10-VP2	Vacuum Pump House	The vacuum pump was associated with handling process wastes (explosives dust) pulled from the drilling and assembly building.
EB-10	Drilling and Assembly Building	Location where booster charges were installed after primary charge loaded at EB-4/4A.
EB-10A	Radiographic Building	Following loading of booster charges at EB-10, quality assurance of the primary charges was completed using the radiographic equipment in EB-10A.
EB-13	Packing and Shipping Building	Packing and shipping operations for completed munitions.
EB-13A	Shell Storage Building/Assembling and Shipping Building	Packing and shipping operations for completed munitions.
EB-13B	Shipping Warehouse Annex	Packing and shipping operations for completed munitions.
EB-25	Shell Carrier Washout Building	Bulk explosive carrier washout activities were completed in this building. Effluent was discharged to a concrete settling tank south of the building, which discharged to an unlined drainage ditch.

ID = Identification.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TNT = Trinitrotoluene.

Table 2-12. Former Non-production Buildings Inventory at Load Line 3

Building ID	Purpose
EA-7	TNT Service Building
EB-11	Fuse Service Building
EB-19	Electric Locomotive Service Building
EB-2	Paint and Oil Storage Building
EB-3	Shell Receiving and Painting Building
EB-803	Inert Storage Building – Receiving area for the load line and inert storage prior to completion within the production area
EB-9	Service Building
EB-9A	Service Building
LL3-CST-1	Concrete Settling Tanks
LL3-CST-2	Concrete Settling Tank
EA-21	TNT Box Building
EA-5	AN Service Building
EB-22	Change House
EB-8	Change House
EB-8A	Change House
3-51A	Load Line Office
3-51	Clock Alley
EB-20	Line Office

ID = Identification.
TNT = Trinitrotoluene.

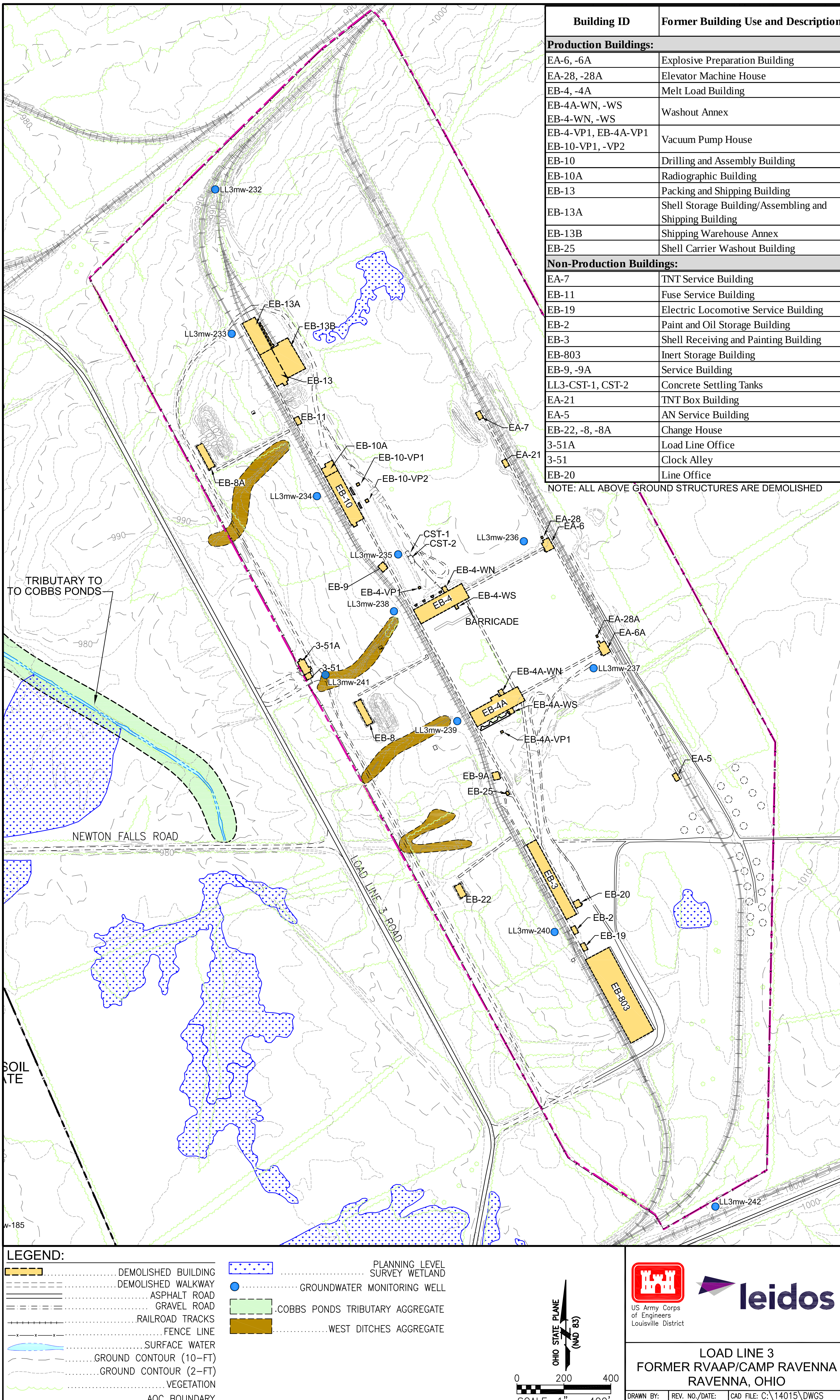
2.3.1.1 Surface Features and Site Topography

Load Line 3 is situated in the southeastern quadrant of the RVAAP facility. The load line is characterized by sloping topography on a reworked sandstone bedrock surface. Elevations within the bounds of the AOC vary from approximately 299 to 311 m (980 to 1,020 ft) amsl. Topographic elevations across most of the AOC generally decrease from east to the west and north towards Cobbs Pond and the stream entering Cobbs Pond. Along the southern most portion of the AOC, land surface elevations gently decrease to the south toward South Service Road.

Former production infrastructure features at Load Line 3 include asphalt and gravel access roads, man-made ditches, sanitary and storm sewer lines, manholes, railroad beds, and buildings. The main process area is heavily vegetated with rough grass and scrub vegetation between the major structures of the load line. Scrub vegetation and immature hardwoods characterize the non-production areas around the main process area. Moderately mature hardwoods exist along the western border of the AOC between Load Line 3 Road and former guardhouse (Building 3-51A) and along the tributary to Cobbs Pond.

2.3.1.2 Geologic Setting of Load Line 3

Subsurface characterization at Load Line 3 during the Phase II RI was performed by installing six test trenches to depths of 3.6 m (12 ft) around the periphery of the AOC and by continuous sampling during installation of monitoring wells. Hand auger borings from soil sampling locations were also used to characterize the shallow subsurface soil interval. Core samples were collected from all monitoring wells drilled into the bedrock interval during the Phase II RI.



Building ID	Former Building Use and Description
Production Buildings:	
EA-6, -6A	Explosive Preparation Building
EA-28, -28A	Elevator Machine House
EB-4, -4A	Melt Load Building
EB-4A-WN, -WS EB-4-WN, -WS	Washout Annex
EB-4-VP1, EB-4A-VP1 EB-10-VP1, -VP2	Vacuum Pump House
EB-10	Drilling and Assembly Building
EB-10A	Radiographic Building
EB-13	Packing and Shipping Building
EB-13A	Shell Storage Building/Assembling and Shipping Building
EB-13B	Shipping Warehouse Annex
EB-25	Shell Carrier Washout Building
Non-Production Buildings:	
EA-7	TNT Service Building
EB-11	Fuse Service Building
EB-19	Electric Locomotive Service Building
EB-2	Paint and Oil Storage Building
EB-3	Shell Receiving and Painting Building
EB-803	Inert Storage Building
EB-9, -9A	Service Building
LL3-CST-1, CST-2	Concrete Settling Tanks
EA-21	TNT Box Building
EA-5	AN Service Building
EB-22, -8, -8A	Change House
3-51A	Load Line Office
3-51	Clock Alley
EB-20	Line Office

NOTE: ALL ABOVE GROUND STRUCTURES ARE DEMOLISHED

Figure 2-7. Load Line 3 AOC Features

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Soil

At Load Line 3, soil of the Mitiwanga and Mahoning series is present. The Mahoning series soil is poorly drained, silty clay loam or clay loam formed over glacial till where bedrock is generally greater than 1.8 m (6 ft). Runoff is typically medium to rapid, and the soil is seasonally wet. Permeabilites range from 1.52 to 5.08 cm (0.6 to 2.0 inches) per hour.

The Mitiwanga series consist of moderately deep, somewhat poorly drained soil formed in glacial till overlying sandstone bedrock. This soil is found primarily on undulating uplands where the water table is near the ground surface in winter and spring. The soil type is characterized most commonly as a silty clay loam varying in color from yellowish-brown to dark yellowish-brown with a moderate available water capacity. Permeabilities range from 1.52 to 5.08 cm (0.6 to 2.0 inches) per hour.

Test pits, piezometer borings, and monitoring wells provide the general geologic characteristics noted below for the unconsolidated and bedrock interval underlying Load Line 3.

Surface soil varies widely in character from one area to another due to lateral discontinuity within the glacial till and site disturbances; however, silty clays and silty sands dominate in the near surface interval. As noted in the Phase II RI Report, boring logs for hand-augered soil sampling stations, some areas of the load line have been substantially reworked and contain sandy fill, gravel, ballast material, and slag. Concrete, rebar, nails, glass, paint chips, roofing materials, etc. exist at the ground surface in many areas, especially in the vicinity of buildings. In comparatively undisturbed areas where some test pits were excavated, the surface soil interval consisted of a brown (10YR5/3) silt.

Range of depth to bedrock, which was encountered in all borings, varied from 1.1 m (3.5 ft) to 4.6 m (15 ft); the average thickness of the unconsolidated interval was only 2.1 m (7 ft) within the load line. The composition of unconsolidated materials is fairly uniform and consists primarily of a yellowish-brown (10YR5/4) silt to clayey silt with intermittent gravel. The unconsolidated materials typically have a stiff consistency and low plasticity and range from dry to moist.

Bedrock Geology

The Sharon Conglomerate unit of the Sharon Member (Pottsville Formation) was encountered in all subsurface borings at Load Line 3. The Sharon Conglomerate was encountered at depths ranging from 1.5 to 22 ft bgs in monitoring wells installed throughout Load Line 3. The underlying shale unit of the Sharon Member was not encountered in any boring at Load Line 3. The unit is characterized by a light yellowish-brown to brownish-gray, fine- to medium-grained sandstone, which commonly contains iron-stained fractures. In the vicinity of Load Line 3, shale lenses of varying thickness were commonly observed in subsurface borings. These shale lenses are comprised of light brownish-gray to dark gray shale, typically 0.3 m (1 ft) in thickness or less. In the boring drilled for monitoring well LL3mw-233, a substantial interval of shale and siltstone was encountered. These shale lenses were also encountered in borings drilled during the Phase II RI at Load Line 2; however, their frequency and thickness were much greater at Load Line 3. The prevalence of shale in the vicinity of Load Lines 2 and 3 was not observed during investigations at Load Line 1 and the Ramsdell Quarry to the northeast; the Sharon Conglomerate in these areas consists of a much more homogenous quartz sandstone with little observed shale. Farther to the west at Load Line 12, an extensive dark gray shale was encountered in subsurface borings. The observed facies changes implies a change of depositional environment across the southeastern portion of the facility with energetic conditions in the Load Line 1 and Ramsdell Quarry area, and increasingly quiescent conditions toward the south-central portion of RVAAP (e.g., vicinity of Load Lines 12 and 4).

2.3.1.3 Load Line 3 Hydrologic/Hydrogeologic Setting

All wells at Load Line 3 were screened within the Sharon Member conglomerate. In general, the potentiometric surface is a subdued replica of the regional topography. Groundwater depths range from approximately 8 to 27 ft bgs (EQM 2010). Shallow groundwater flow associated with Load Line 3 generally flows west-northwest towards the tributary entering Cobbs Pond and the Cobbs Pond complex itself. In the southern portion of the AOC, a southerly component of groundwater flow occurs off of the AOC.

Results of slug tests performed at 11 of the 12 Phase II monitoring wells show low to moderate hydraulic conductivities in the unconsolidated sediments. Slug tests for all wells except LL3mw-233, -235, and -242 were obtained in September 2001. Due to very low water table levels in the late summer and fall of 2001, slug tests were delayed in these wells. Slug tests were obtained from LL3mw-235 and -242 in February 2002 under wet season conditions. Water levels in well LL3mw-233 were not sufficient to conduct a representative slug test even under wet season conditions. Slug test results show hydraulic conductivity ranged from 5.72×10^{-7} cm/sec (1.86×10^{-3} ft/day) to 2.95×10^{-2} cm/sec (8.36×101 ft/day). Slug test results are representative of the entire screened interval for the monitoring wells so any local heterogeneities that affect hydraulic conductivity within the screened interval, such as shale lenses, are represented in the slug test.

Ditches comprise the primary surface water conveyance at Load Line 3, which, ultimately, drain into Cobbs Pond. Most of the surface water runoff is to the west, similar to groundwater flow. These ditches mainly served as a surface and wastewater (e.g., pink wastewater) runoff control system. A below-ground sewer system also exists at Load Line 3 for management of stormwater runoff. Flow in the ditches is intermittent and driven primarily by storm events.

2.3.2 Co-located or Proximate Sites

The following subsections summarize sites that are co-located or proximate to Load Line 3 but are addressed separately.

2.3.2.1 Facility-wide Sewers

The defunct sanitary and storm sewers within the perimeter of Load Line 3 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Sewer sediment, pipe bedding material, and sewer water were evaluated as currently summarized in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a). The sanitary sewers in the Load Line 3 FA were part of the Sand Creek Sewage Treatment Plant Network. The Load Line 3 also contains a discrete storm sewer network. Demolition activities at former Load Line 3 impacted numerous sewer structures, especially those associated with shallow storm sewers adjacent to buildings and walkways.

Sewer water and sediment samples were collected from storm and sanitary sewers during the Phase II RI (USACE 2004c,); video surveys also were conducted. Inspections and explosives field screening tests were conducted at the Load Line 3 FA during a 2007 *Summary of CERL Findings, RVAAP Sewer System (*USACE-CERL 2007) and the *Explosive Evaluation of Sewers* (LES 2007a). The 2007 Explosive Evaluation of Sewers included a video survey of the sewer lines at Load Line 3. Both studies collected wipe samples of sewer line inverts for analysis of explosive residues, using field test kit methods (e.g., Expray® 24 and DropEx). Additionally, wipe samples from video cameras used during the 2007 Explosive Evaluation of Sewers were collected.

All SRCs found in sewer media samples and evaluated through the stepwise fate and transport screening evaluation were eliminated as posing future impacts to groundwater. The HHRA did not identify a complete exposure pathway for any receptor and no further action was recommended from an ecological perspective. In summary, the Facility-wide Sewers RI recommended no further action for the Load Line 3 sewers.

2.3.2.2 Facility-wide Groundwater

As part of the IRP, the Army implements the FWGWMP in accordance with previous agreements made with Ohio EPA. The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP.

In 2015, for the FWGWMP, groundwater samples were collected from 4 of 15 monitoring wells associated with Load Line 3. Chemicals were detected at concentrations greater than site-specific screening levels at all four monitoring wells (LL3mw-238, LL3mw-241, LL3mw-244, and LL3mw-246).

An increasing concentration trend was observed at LL3mw-246. 2-A-4,6-DNT and 4-A-2,6-DNT show increasing concentration trends; however, detected concentrations have been very low and the trends are based only on data collected since January 2014. These trends may change in the future. The range of detections is from 0.23 to 0.48 µg/L.

One pesticide constituent along with several explosives and propellants were detected above screening criteria in the area of Load Lines 1 through 3. Based on the similarity of constituents, it is probable that the area within the isoconcentration contours constitutes one contiguous groundwater plume. All of the impacts to groundwater were detected in the Sharon Sandstone aquifer. Monitoring well samples from the unconsolidated aquifer did not have any exceedances for organic constituents. The Sharon Sandstone groundwater flow direction in this area of Camp Ravenna is toward the south-southeast (EQM 2016).

Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at Load Line 3 will be addressed as part of that facility-wide AOC.

2.3.2.3 Munitions Response Sites

No MRS is within or adjacent to the AOC boundary identified as part of the MMRP.

2.3.2.4 Compliance Restoration Sites

The DLA Tank Storage Area is covered under site CC-RVAAP-79 Facility-wide USTs and is currently undergoing separate investigation.

2.3.3 Previous Investigations, Decisions, and Actions

Since 1978, Load Line 3 has been the subject of multiple investigations and/or assessments leading to CERCLA decisions and/or remedial actions at the AOC. The Preliminary Assessment conducted in 1996 concluded that Load Line 3 was a high-priority AOC for future environmental investigations due to primary contaminant release mechanism from process effluent discharges to surface water and surface soil. Subsequently, a Phase I RI was conducted and recommended additional investigation in a Phase II RI due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC. During the Phase II RI, a total of 217 environmental samples were collected to determine the nature and extent of surface soil contamination at Load Line 3. Based on the results of the human health and ERAs, Load Line 3 was recommended for further evaluation in an FS.

An FFS recommended excavation with off-site disposal as an interim remedy to address surface soil, subsurface soil, and dry sediment contamination at Load Line 3. Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007 (USACE 2008a). A total of 893 tons of hazardous (PCB-contaminated) soil and 2,538 tons of non-hazardous soil were removed from Load Line 3. After the excavation was completed, ISM samples were collected and analyzed for Load Line 3 COCs: PCB-1254, benzo(a)pyrene, TNT, aluminum, antimony, arsenic, hexavalent chromium, lead, and manganese. Previous sample locations and previous remediation areas are presented in Plates 2-5 and 2-6 (located at the end of this section).

To determine if any additional areas required excavation to remove contaminated soil beneath former building slabs (removed between March and June 2008), the following sampling activities were completed at Load Line 3: stockpile sampling, post-slab removal field screening, and final confirmatory sampling. Analytical and field screening results from these building slabs at Load Line 3 indicated there were no concentrations of explosives beneath former building slabs that exceeded cleanup goals (USACE 2009b). Additional field investigation activities completed at Load Line 3 outside of investigation of soil beneath floor slabs included collecting field screening samples from soil at Building EB-4A.

ISM sampling was also completed in 2008 within building footprints following the removal of building slabs and any contaminated soil identified as part of the *Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11* (USACE 2009c) to determine if any additional excavation was required at building locations beyond those determined by field screening. This investigation found that explosives, propellants, semi-volatile organic compounds (SVOCs) (primarily PAHs), PCBs, and metals were detected in the ISM samples collected at Load Line 3.

Based on the characterization and results provided as part of the Sampling and Screening Analysis Report (USACE 2009b) and *Multi-Increment Sampling and Analysis of Soils Below Floor Sabs at RVAAP-09, 10, and 11* Report (USACE 2009c), a total of 1,602 cubic yards of soil were excavated from five areas at Load Line 3:

- Northeastern corner of Building EB-4 and north sump area of Building EB-4-WN (40 ft by 80 ft by 4 ft),
- Northeastern corner of Building EB-4A and sump area of Building EB-4A-WN (40 ft by 60 ft by 4 ft),
- Building EA-6 (20 ft by 20 ft by 5 ft),
- Building EA-6A (40 ft by 40 ft by 5 ft), and
- Building EB-25 (20 ft by 25 ft by 1 ft).

In 2009, USACE collected 19 surface soil and 66 subsurface soil ISM samples at Load Line 3 to characterize deeper subsurface soil beneath the former building slabs that were not previously investigated via subsurface soil ISM techniques. Additional surface soil ISM samples in ore storage areas at Load Line 3 also were collected and analyzed to provide preliminary data for future RIs of these AOCs.

Additional characterization sampling was completed at Load Line 3 to guide future soil remedial and administrative measures. The samples collected as part of this investigation helped eliminate soil data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010a). Eight surface soil ISM samples and 13 subsurface soil horizontal ISM samples were collected at Load Line 3 to further refine ISM sample areas that had concentrations of contaminants above the FWCUGs identified in the Characterization Sampling Report (USACE 2013). The investigation concluded that 5 of the 11 previous areas exceeding the FWCUGs utilized in the Characterization Sampling Report were bound and delineated. The remaining six areas were not fully delineated (USACE 2013).

CERCLA activities completed at Load Line 3 are presented in the timeline illustrated in Figure 2-8, and additional details related to the previous investigations are provided in Appendix A.

2.3.4 June 2016 Surface Water and Sediment Sampling

Following the data gap analysis conducted during the PBA13 SAP Addendum, additional samples for soil were determined to be unnecessary given the spectrum and density of existing ISM and discrete data available for soil. Surface water and sediment sampling outlined in the PBA13 SAP Addendum were based on the data gap analysis and defined by available historical surface water and sediment locations that exceeded human health and/or ecological screening criteria.

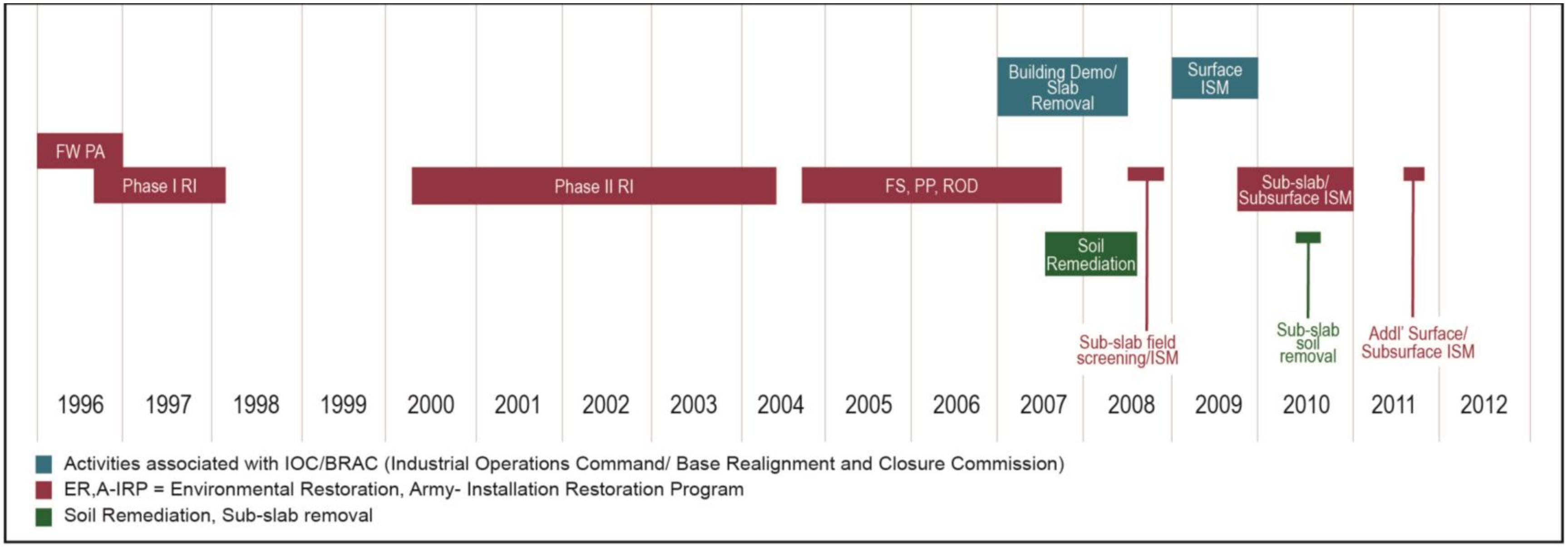

Figure 2-8. Timeline of Remedial Activities at Load Line 3

The Phase II RI (USACE 2004c) established the surface water and sediment data aggregate at Load Line 3 by evaluating historical and current surface water flow directions and conveyances. This data gap evaluation uses the Cobbs' Pond Tributary aggregate, which was the only data aggregate presented and approved in the Phase II RI. The Phase II RI established a complete evaluation of surface water and sediment based on historical receptors. This same data aggregate was re-evaluated in the SAP Addendum to identify data gaps and any required action needed to meet the current receptors identified in the Technical Memorandum (ARNG 2014). The surface water and sediment aggregate is shown in Figure 2-7.

Based on the human health and ecological screening evaluations conducted in the SAP, additional co-located surface water and sediment sampling within Load Line 3 was conducted following the general approach as presented in the SAP Addendum. To satisfy data gaps, two surface water samples (LL3sd/sw-553-0002-SW and LL3sd/sw-554-0002-SW) were collected for analyzed for manganese. Manganese was detected in each surface water sample. Two sediment samples (LL3sd/sw-553-0001-SD and LL3sd/sw-554-0001-SD) were also collected and analyzed for several chemicals (antimony; copper; iron; silver; zinc; 2,4,6-TNT; and 4-amino-2,6-DNT) required for further evaluation based on the ecological screening results. Antimony, copper, iron, silver, and zinc were detected in each sediment sample; however, the explosives constituents were not detected in the sediment samples.

The general approach for investigation activities was presented in the SAP Addendum. Appendix B provides further details on the June 2016 sampling event. Figure B-3 in Appendix B illustrates the sediment sample locations. The sampling results are provided in Appendix E.

2.3.5 Data Assembly and Use Assessment – Load Line 3

All data collected at Load Line 3 were extracted from the REIMS database. This includes data from investigations summarized in the following reports:

- Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 through 4 and 12 (USACE 2013);
- Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 through 4 (USACE 2011c);
- Phase II RI Report for the Load Line 3 (USACE 2004c);
- Remedial Action Completion Report for the Remediation of Soils and Dry Sediments at RVAAP 08-11 (Load Lines 1 through 4) (USACE 2008a);
- Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11 (USACE 2009c); and
- Remediation Completion Report for Sub-Slab Soils at Load Lines 2, 3, and 4 (USACE 2010d).

The data from investigations summarized in the following reports were not used in this FS Addendum:

- *Phase I Remedial Investigation Report for the Phase I Remedial Investigation of High Priority Areas of Concern* (USACE 1998) – These data are more than 16 years old and are no longer considered representative of the site (e.g., buildings and slabs have been removed and/or remediated).
- November 2004 Sampling Completion Report (USACE 2005b).
- Preliminary Evaluation of Pre (Floor Slab Removal) Contamination for the Sampling of Soils Beneath Floor Slabs and Load Lines 2, 3, and 4 and Excavation and Transportation of Contaminated Soils to Load Line 4 (USACE 2008b).
- Sampling and Screening Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11 (USACE 2009b).
- RI/FS Report for RVAAP-67 Facility-wide Sewers (USACE 2012a) –The sewers are currently being evaluated under a separate RI. Data from the Facility-wide Sewers Investigation was evaluated qualitatively in consideration of the CSM.

Once the data were assembled and evaluated for use, COIs were identified specific to Load Line 3 media.

2.3.6 Load Line 3 Conceptual Site Model

The CSM is a site specific, systematic planning tool. It provides a concise summary of residual contamination distribution, exposure pathways, migration routes, and assessment of the affects to human health and ecological receptors that supports development of RAOs and the FS. A graphical depiction of the CSM is presented in Figure 2-9. The following sections summarize the COIs identified in soil, surface water, and sediment, and provide results of the fate and transport analysis, HHRA, and ERA.

2.3.6.1 Load Line 3 COIs

Load Line 3 COIs were developed from the chemicals identified as exceeding residential risk in the Phase II RI (USACE 2004c). Load Line 3 COIs for exposure of Resident Receptors (Adult and Child) to soil, sediment, and surface water are shown in Table 2-13. The list of COIs shown in Table 2-13 is longer than the list of COCs included in the IROD (USACE 2007) because the IROD focused on only the National Guard Trainee Receptor and soil.

Although PAHs are identified in soil, they were not carried through into the surface water and sediment evaluations because only one Phase I sample (collected in 1996) had a concentration (0.14 mg/kg) greater than the RGO (0.059) at a TR level of 1E-06. PAHs were not analyzed for in subsequent sediment samples, and the Phase I benzo(a)pyrene concentration is less than the RGO (0.59 mg/kg), FWCUG (0.22 mg/kg), or current soil RSL (0.15 mg/kg) at a TR of 1E-05. Other PAHs identified in the Phase II RI as COCs in sediment samples are now contributing to the soil risk. These samples were reclassified as surface soil during the data evaluation processes for the RI/FS Addendum data set when it was established that these sample locations are in areas with only intermittent surface water and runoff.

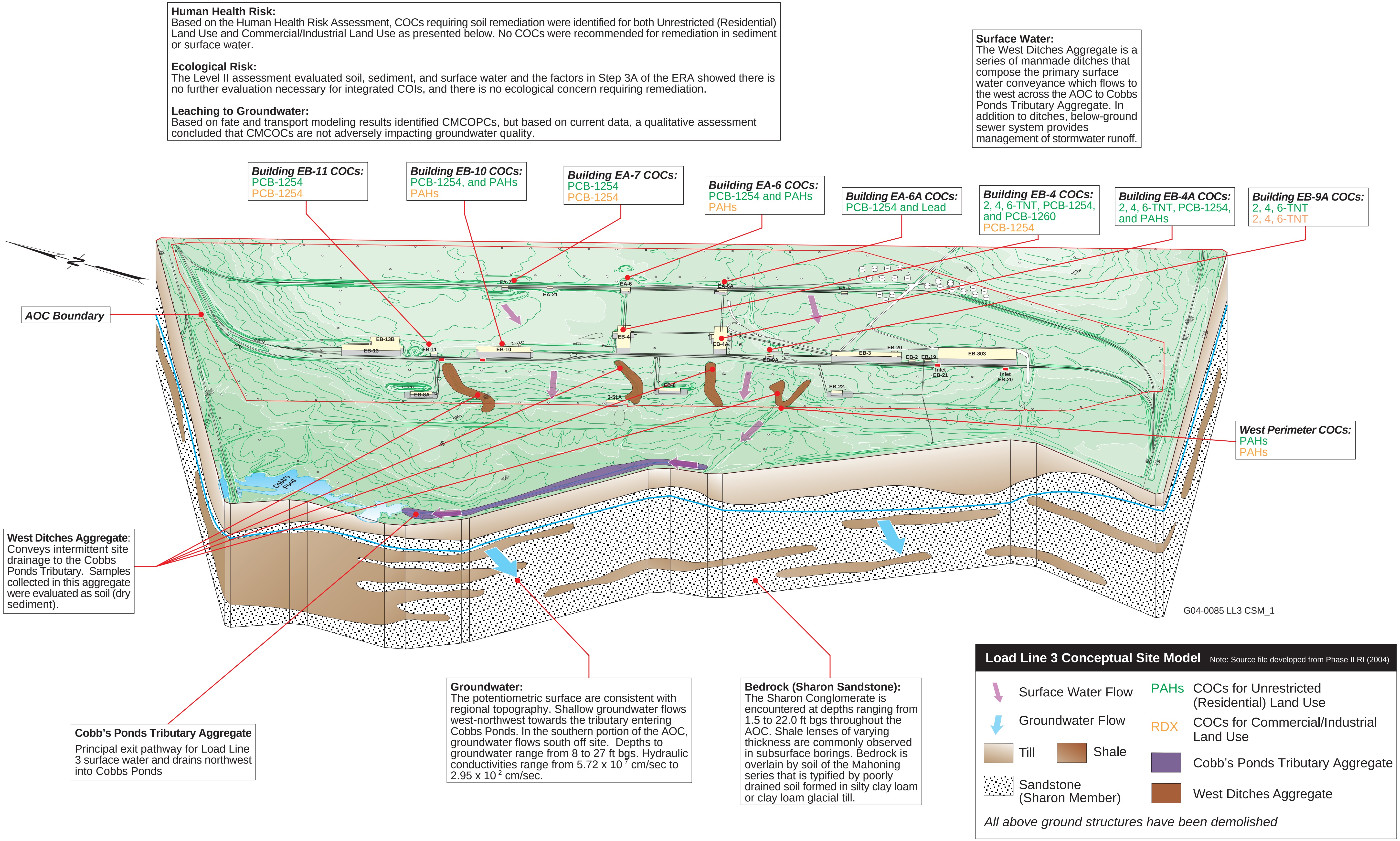

Figure 2-9. Load Line 3 Conceptual Site Model

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Table 2-13. COIs in Soil, Surface Water, and Sediment at Load Line 3

COI	Load Line 3		
	Soil	**Surface Water**	**Sediment**
Metals			
Aluminum	X	X	X
Antimony	X	X	X
Arsenic	X	X	X
Barium	X	X	X
Cadmium	X	X	X
Lead	X	X	X
Manganese	X	X	X
Thallium	X	X	X
Explosives			
1,3-Dinitrobenzene	X	X	X
2,4,6-TNT	X	X	X
2,4-DNT	X	X	X
RDX	X	X	X
PCBs			
PCB-1254	X	X	X
PCB-1260	X	X	X
Pesticides			
4,4'-DDE	X	X	X
4,4'-DDT		X	
Dieldrin	X	X	X
Heptachlor	X	X	X
PAHs			
Benz(a)anthracene	X	--	--
Benzo(a)pyrene	X	--	--
Benzo(b)fluoranthene	X	--	--
Dibenz(a,h)anthracene	X	--	--
Indeno(1,2,3-cd)pyrene	X	--	--

-- = Chemical is not a chemical of interest for specified media.

COI = Chemical of Interest.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
DNT = Dinitrotoluene.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TNT = Trinitrotoluene.
X = COI Present in Medium.

2.3.6.2 Fate and Transport

The details of the fate and transport analysis conducted to assess the potential for COIs to leach from surface soil and subsurface soil (defined as soil leaching COIs) at Load Line 3 and impact groundwater beneath the source and at a nearest downgradient receptor location are presented in Appendix G. The fate and transport analysis also evaluates the potential for SRCs to leach from sediment sources at Load Line 3 and impact groundwater beneath the source and at the nearest downgradient receptor location. A summary of the analyses is presented in this section.

Mainly organic COIs (TNT; 2,6-DNT; and RDX) were identified in surface and subsurface soil at the AOC in this FS Addendum. These soil leaching COIs were further evaluated to determine if residual concentrations in surface and subsurface soil may potentially impact groundwater quality and warrant evaluation in an FS. In addition, all sediment SRCs were evaluated to determine if residual concentrations in sediment may potentially impact groundwater quality and warrant evaluation in an FS. All of the soil leaching COIs and the SRCs identified in the sediment at the AOC were evaluated through the stepwise fate and transport evaluation that included leachate modeling in the unsaturated zone using the SESOIL model and lateral transport modeling in the saturated zone using the AT123D model.

If the predicted maximum leachate concentration of a COI was lower than the screening criteria, the chemical was eliminated for further evaluation using AT123D modeling. For these remaining COIs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCLs, and RSLs. Only the CMCOPCs with predicted maximum concentrations higher than their facility-wide background concentrations, and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), were retained as CMCOCs. These CMCOCs were evaluated with respect to WOE for retaining or eliminating CMCOCs from further consideration as a basis for potential soil or sediment remedial actions.

The evaluation of modeling results with respect to current groundwater data for the AOC and model limitations identified the following CMCOCs at Load Line 3:

- Among the soil leaching COIs, 2,6-DNT and RDX were predicted to exceed the screening criteria in groundwater beneath the source; however, none of these COIs was predicted to be above criteria at the downgradient receptor location.
- Among the sediment CMCOPCs, only cobalt was predicted by analytical solutions to exceed screening criteria in groundwater beneath the source; however, it was not predicted to be above criteria in the downgradient receptor location.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if 2,6-DNT and RDX (i.e., the CMCOPCs in soil), and cobalt (i.e., CMCOPC in sediment) at the AOC may impact the groundwater beneath the source or at the downstream receptor location.

2,6-DNT – The maximum surface soil concentration for 2,6-DNT (0.23 mg/kg at LL3ss-067) was below its residential soil RGO, and 2,6-DNT was not identified as a soil COC in the HHRA. 2,6-DNT modeling results using this maximum concentration indicate groundwater concentrations beneath the source area could potentially exceed its FWCUG in less than 450 years with peak concentration occurring at approximately 750 years; 2,6-DNT was not detected above its RSL/FWCUG in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). In addition, the maximum predicted groundwater concentration of 2,6-DNT at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and 2,6-DNT would be expected to be below its RSL/FWCUG based on its estimated site-specific biodegradation rate.

RDX – The maximum surface soil concentration for RDX (34 mg/kg at LL3ss-117-0851) was below its residential soil RGO. The modeling estimates that RDX concentrations in groundwater beneath the source area could potentially exceed its RSL at about 150 years or less with peak concentrations occurring at approximately 250 years or less; however, the maximum predicted RDX groundwater concentration at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). RDX was not detected in the AOC groundwater samples exceeding its RSL collected from 2011–2015 (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative and RDX would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

Cobalt – The maximum sediment concentration for cobalt (15.3 mg/kg at LL3sd-051-1079-SD) was below its residential soil and sediment RGO,, and cobalt was not identified as sediment COC in the HHRA for this area. The modeling assumes that the sediment is in direct contact with groundwater and no attenuation due to sorption is occurring; therefore, cobalt is predicted to be already in groundwater beneath the source area exceeding its RSL, although cobalt was not detected above its RSL in the AOC groundwater samples collected from 2012–2015 (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative and cobalt would be expected to be below its RSL based on attenuation while accounting for the vertical leaching distance.

Conclusion – This qualitative assessment concludes that the soil and sediment contaminants identified as CMCOCs for WOE evaluation are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts for the AOC groundwater beneath the source and at the downgradient receptor location. Potential additional investigation under the Facility-wide Groundwater AOC may be warranted for the AOC, but based on the fate and transport evaluation, CMCOCs were not identified for Load Line 3, and no further action is required for soil and sediment to be protective of groundwater for the AOC.

2.3.6.3 Human Health Risk Assessment Results

The HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to residual contamination in soil, sediment, and surface water at Load Line 3. The approach to risk-based decision making is as follows:

RGOs were compiled for the COIs identified in Section 2.3.6.1. RGOs for Unrestricted (Residential) Land Use are the USEPA Residential RSLs for soil (used for soil and sediment) and tap water (used for surface water) published in May 2016. RSLs for the cancer endpoint were adjusted to correspond to a TR of 1E-05, RSLs for the non-cancer endpoint were used at a target HQ of 1. RGOs for Commercial/Industrial Land Use are the USEPA Industrial RSLs for soil adjusted for a TR of 1E-05 and target HQ of 1. Industrial RSLs are not available to evaluate surface water or sediment because Industrial/Commercial activities are not applicable to surface water (i.e., exposure of industrial and commercial workers is not anticipated for these media). The potential impact of the lack of screening values is addressed in the uncertainty assessment using Industrial RSLs calculated with the on-line USEPA RSL calculator assuming an Industrial Receptor might wade into shallow water bodies. At

Load Line 3, media were previously remediated for COCs that exceeded cleanup goals established for the National Guard Trainee; therefore, this FS Addendum only evaluates the Resident Receptor (Adult and Child) and the Industrial Receptor.

The methodology of comparing COI exposure concentrations to RGOs and determining COCs generally follows guidance presented in the Position Paper for Human Health Cleanup Goals (USACE 2012b) and Technical Memorandum (ARNG 2014) and includes calculating an SOR for all non-carcinogenic and carcinogenic COIs. The reported concentration in each discrete or ISM sample was compared to RGOs (i.e., the EPC is the concentration in each individual sample). COIs are identified as COCs for a given receptor if:

- The EPC exceeds the most stringent RGO for either the 1E-05 target cancer risk or the 1 target HQ; or
- The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than 1; chemicals contributing at least 5% to an SOR greater than 1 are also considered COCs.

Metals present at concentrations consistent with naturally occurring background concentrations are not identified as COCs.

The results of the COC screening are combined with the results of the uncertainty assessment to identify COCs to be carried forward for remediation. Details of the screening process and identification of COCs recommended for remediation are provided in Appendix H.4. Detailed figures depicting contaminant distribution and results of screening assessments are provided in Figures H.4-1 through H.4-7 in Appendix H. The COCs to be carried forward for potential remediation are summarized below for Unrestricted (Residential) and Industrial Land Use:

- Unrestricted (Residential) Land Use – Lead; 2,4,6-TNT; PCB-1254; 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) were identified as COCs to be carried forward for potential remediation at Load Line 3. The COCs recommended for remediation are summarized by area below:
    - Building EB-10 – Lead, PCB-1254, and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene).
    - Building EB-11 – PCB-1254.
    - Building EA-7 – PCB-1254.
    - Building EB-4 – PCB-1254; 2,4,6-TNT; and PCB-1260.
    - Building EA-6 – PCB-1254 and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene).
    - West Perimeter Area – PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene).
    - Building EB-4A – 2,4,6-TNT; PCB-1254; and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).
    - Building EB-9A – 2,4,6-TNT.
    - Building EA-6A – Lead and PCB-1254.

- Isolated Discrete Soil Location – PCB-1254 and 2,4,6-TNT.

- Industrial Land Use – 2,4,6-TNT; PCB-1254; and four PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene) were identified as COCs to be carried forward for potential remediation at Load Line 3. The COCs recommended for remediation are summarized by area below:
  - Building EB-10 – Lead, PCB-1254, and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).
  - Building EB-11 – PCB-1254.
  - Building EA-7 – PCB-1254.
  - Building EB-4 – PCB-1254 and PCB-1260.
  - Building EA-6 – PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).
  - West Perimeter Area – PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).
  - Building EB-9A – 2,4,6-TNT.
  - Isolated Discrete Soil Location – PCB-1254.

No COCs were identified in sediment or surface water. COCs identified for potential remediation at Load Line 1 are summarized in Tables 2-14 and 2-15.

2.3.6.4 Ecological Risk Assessment Results

The ERA for wet sediment and surface water at Load Line 3 is presented in Appendix I of this FS Addendum and follows a unified approach of methods integrating Army, Ohio EPA, and USEPA guidance. This ERA approach is consistent with the general approach by these agencies and primarily follows the Level I Scoping ERA, Level II Screening ERA, and Level III Baseline ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008), with specific application of components from the FWERWP (USACE 2003b) (herein referred to as the FWERWP), *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c), and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997). The ERA process implemented in this FS Addendum report combines these guidance documents to meet requirements of Ohio EPA and the Army, while following previously accepted methods established for RVAAP. This unified approach resulted from coordination between USACE and Ohio EPA during the summer of 2011.

A historical ERA (a SERA and BERA) was performed as part of the Phase II RI (USACE 2004) for Load Line 3. The ERA for wet sediment and surface water in Appendix I was conducted because the historical evaluation was not based on the current Ohio EPA guidance (Ohio EPA 2008) and did not include the recently collected FS Addendum data. Soil was evaluated for ecological receptors for Load Line 3 in the Phase II RI (USACE 2003). As concluded in the IROD at Load Lines 1 through 4 (USACE 2007): *the majority of COECs in soil are co-located with human health COCs and remedial activities implemented to address human health COCs will serve to reduce the concentrations and number of COECs in soil to which ecological receptors are exposed, resulting in lowered ecological risk.* As a result, ecological cleanup goals were not required. Based on the removal action subsequent to the IROD, no further action is necessary for ecological exposures to soil.

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Table 2-14. Summary of Human Health COC Concentrations and Conclusions for Unrestricted (Residential) Land Use at Load Line 3

				COC													Conclusion for Unrestricted Land Use
				Metal		Explosive		PAH					Pesticide		PCB		
		Residential RGO		6.8	400	36	61	1.6	0.16	1.6	0.16	1.6	0.34	1.3	1.2	2.4	
Station	Sample Type	Date	Depth (ft)	Arsenic	Lead	TNT	RDX	B(a)A	B(a)P	B(b)F	DA	IP	Dieldrin	Heptachlor	PCB-1254	PCB-1260	
Building EB-10																	
LL3-083	D	08/06/01	0.0 - 1.0	--	--	--	--	0.26[a]	0.26	0.33[a]	--	--	--	--	--	--	Remediate
LL3-085	D	08/06/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	3.9	--	Remediate
LL3-088	D	08/06/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	1.8	--	Remediate
LL3-092	D	08/07/01	0.0 - 1.0	--	599	--	--	--	--	--	--	--	--	--	20	--	Remediate
LL3SB-409M	ISM	08/30/10	1.0 - 3.0	--	--	--	--	--	0.17	--	--	--	--	--	--	--	NFA
LL3SB-409M02	D	08/30/10	1.0 - 7.0	--	--	--	--	0.43[a]	0.41	0.5[a]	0.059[a]	--	--	--	--	--	Remediate
LL3SB-409M06	D	08/30/10	1.0 - 7.0	--	--	--	--	0.25[a]	0.27	0.3	0.039[a]	--	--	--	--	--	Remediate
LL3SB-409M08	D	08/30/10	1.0 - 7.0	--	--	--	--	0.17[a]	0.17	0.24[a]	--	--	--	--	--	--	Remediate
LL3SB-409M09	D	08/30/10	1.0 - 7.0	--	--	--	--	0.4[a]	0.38	0.47[a]	0.045[a]	--	--	--	--	--	Remediate
LL3SB-409M11	D	08/30/10	1.0 - 7.0	--	--	--	--	0.2[a]	0.21	0.28[a]	--	--	--	--	--	--	Remediate
LL3sb-414M	ISM	06/29/11	1.0 - 3.0	--	--	--	--	0.71[a]	0.58	0.76[a]	0.12[a]	--	--	--	--	--	Remediate
LL3sb-414M	ISM	06/29/11	3.0 - 5.0	--	--	--	--	63	47	54	7.2	21	--	--	--	--	Remediate
LL3sb-415M	ISM	06/29/11	3.0 - 5.0	--	--	--	--	0.36[a]	0.4	0.48[a]	0.065[a]	--	--	--	--	--	Remediate
LL3ss-266M	ISM	06/25/08	0.0 - 1.0	--	--	--	--	0.286[a]	0.268	0.223[a]	--	--	--	--	--	--	Remediate
Building EB-11																	
LL3ss-073-cs	ISM	10/22/07	2.5 - 3.5	--	--	--	--	--	--	--	--	--	--	--	13.8	--	Remediate
LL3-074	D	08/09/01	0.0 - 1.0	--	--	--	--	0.17[a]	0.21	0.32[a]	--	--	--	--	--	--	NFA
Building EA-7																	
LL3-054	D	08/10/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	17	--	Remediate
Building EA-21																	
No COCs were identified in Building EA-21.																	
Building EB-4																	
LL3-104	D	08/08/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	2.3	--	Remediate
LL3-227	D	08/24/01	0.0 - 1.0	--	--	37	--	--	--	--	--	--	--	--	--	--	Remediate
LL3sb-413M	ISM	06/30/11	1.0 - 3.0	--	--	--	--	--	--	--	--	--	--	--	100	5[a]	Remediate
LL3ss-077-cs	ISM	11/20/07	2.5 - 3.5	--	--	--	--	--	--	--	--	--	--	--	6.09	--	Remediate
LL3ss-085-cs	ISM	10/31/07	2.5 - 3.5	--	--	--	--	--	--	--	--	--	--	--	3.38	--	Remediate
LL3ss-253M	ISM	06/15/10	3.3 - 4.3	--	--	37.5	--	--	0.147[a,b]	--	0.0862[a,b]	--	--	--	1.28	--	Remediate
LL3ss-297M	ISM	06/16/10	3.9 - 4.9	--	--	29.3[a]	--	--	0.093[a,b]	--	0.0852[a,b]	--	--	--	2.9	--	Remediate
LL3ss-355	ISM	12/03/09	0.0 - 0.5	--	--	--	--	0.21[a]	0.11[a]	0.21[a]	--	--	--	0.27[a]	0.86[a]	--	NFA
Building EA-6																	
LL3-057	D	07/31/01	0.0 - 1.0	--	--	52[b]	--	4.8	5.8	7	0.74	2.4	--	--	--	--	Remediate
LL3-060	D	07/31/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	4	--	Remediate
LL3-063	D	07/31/01	0.0 - 1.0	--	--	650[b]	--	5.7	5.4	5.5	0.93	3	--	--	14[b]	--	Remediate
LL3-063	D	08/07/01	1.0 - 3.0	--	--	240	--	--	--	--	--	--	--	--	--	--	NFA
LL3ss-293M	ISM	06/04/10	4.7 - 5.7	--	--	--	--	7.57	5.88	4.6	0.847	--	--	--	--	--	Remediate
West Perimeter Area																	
LL3-050(p2)	D	08/08/01	0.0 - 0.5	--	--	--	--	2.8	3	4.2	0.41	1.3	--	--	--	--	Remediate
LL3sd-416M	ISM	07/02/11	0.0 - 0.5	--	--	--	--	8.6	6.8	9.1	1.2	4.1	--	--	--	--	Remediate
Building EB-4A																	
LL3-117	D	08/06/01	0.0 - 1.0	--	432	--	34[a]	--	--	--	--	--	1.2	--	15	--	NFA
LL3ss-098-cs	ISM	09/21/07	2.0 - 3.0	--	--	83	--	--	--	--	--	--	--	--	--	--	Remediate
LL3ss-256M	ISM	06/26/08	0.0 - 1.0	--	--	51	--	0.772[a]	0.622	0.478[a]	--	--	--	--	1.38	--	Remediate
LL3ss-258M	ISM	06/27/08	0.0 - 1.0	--	--	40.9	--	--	--	--	--	--	--	--	--	--	Remediate
LL3ss-419M	ISM	07/02/11	0.0 - 1.0	--	--	--	--	0.48[a]	0.4	0.44[a]	0.056[a]	--	--	--	--	--	Remediate

Table 2-14. Summary of Human Health COC Concentrations and Conclusions for Unrestricted (Residential) Land Use at Load Line 3 (continued)

				COC													
				Metals		Explosives		PAHs					Pesticide		PCB		
		Residential RGO		6.8	400	36	61	1.6	0.16	1.6	0.16	1.6	0.34	1.3	PCB		
Station	**Sample Type**	**Date**	**Depth (ft)**	**Arsenic**	**Lead**	**TNT**	**RDX**	**B(a)A**	**B(a)P**	**B(a)F**	**DA**	**IP**	**Dieldrin**	**Heptachlor**	**PCB-1254**	**PCB-1260**	**Conclusion for Unrestricted Land Use**
Building EB-9A																	
LL3ss-265M	ISM	06/24/08	0.0 - 1.0	--	--	700	--	--	--	--	--	--	--	--	--	--	Remediate
LL3ss-421M	ISM	07/02/11	0.0 - 1.0	--	--	--	--	0.25[a]	0.26	0.4[a]	0.06[a]	0.2[a]	--	--	--	--	NFA
Building EB-25																	
No COCs were identified in Building EB-25.																	
Building EA-6A																	
LL3-064	D	07/31/01	0.0 - 1.0	--	--	--	--	0.79[a]	0.6	0.67[a]	0.12[a]	--	--	--	--	--	NFA
LL3-065	D	08/07/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	1.3	--	NFA
LL3-066	D	08/08/01	0.0 - 1.0	--	--	--	--	0.19[a]	0.14[a]	0.21[a]	--	--	--	--	--	1.4[a]	NFA
LL3-067	D	07/31/01	0.0 - 1.0	--	758	--	--	--	--	--	--	--	--	--	5.6	--	Remediate
LL3-152	D	08/13/01	0.0 - 1.0	--	--	--	--	0.69[a]	0.7	0.98[a]	0.097[a]		--	--	--	--	NFA
LL3ss-261M	ISM	06/07/10	5.3 - 6.3	--	--	28.1[a]	--	0.323[a]	0.249	0.2[a]	--	--	--	--	--	--	NFA
Isolated Discrete Soil Samples																	
LL3-047(p2)	D	08/08/01	0.0 - 0.5	22.3[b]	--	--	--	--	0.099[a,b]	--	--	--	--	--	9	--	Remediate
LL3-056	D	08/10/01	0.0 - 1.0	--	--	--	--	--	--	--	--	--	--	--	1.5	--	NFA
LL3-056	D	08/12/01	1.0 - 3.0	--	--	500	--	--	--	--	--	--	--	--	--	--	Remediate
LL3-136	D	08/10/01	0.0 - 1.0	--	--	--	31[a]	0.54[a]	0.53	0.76[a]	0.069[a]		--	--	--	--	NFA
LL3-138	D	08/10/01	0.0 - 1.0	--	--	--	--	--	0.12[a]	0.16[a]	--	--	--	--	2.5	--	NFA
LL3-142	D	08/09/01	0.0 - 1.0	--	--	--	--	0.45[a]	0.61	0.96[a]	0.083[a]	--	--	--	--	--	NFA
LL3-144	D	08/09/01	0.0 - 1.0	--	634[b]	--	--	--	--	--	--	--	--	--	14	--	Remediate
LL3-145	D	08/09/01	0.0 - 1.0	--	572	--	--	--	--	--	--	--	--	--	--	--	NFA
LL3sd/sw-048(d)	D	08/08/01	0.0 - 0.5	--	--	110	--	0.28[a,b]	0.26[b]	0.37[a,b]	--	--	--	--	--	--	Remediate

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
[b]Sample location is recommended for remediation for other chemicals of interest; however, this chemical is not recommended as a COC for remediation.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
D = Discrete soil sample.
DA = Dibenz(a,h)anthracene.
ft = Feet.
IP = Indeno(1,2,3-cd)pyrene.
ISM = Incremental Sampling Methodology.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-Trinitro-1,3,5-Triazine.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.
-- = Chemical is not a human health COC in this sample.

Table 2-15. Summary of Human Health COC Concentrations and Conclusions for Commercial/Industrial Land Use at Load Line 3

				COC								
				Explosive		PAH				PCB		Conclusion for Commercial/ Industrial Land Use
		Industrial RGO		510	280	29	2.9	29	2.9	9.7	9.9	
Station	Sample Type	Date	Depth (ft)	TNT	RDX	B(a)A	B(a)P	B(b)F	DA	PCB-1254	PCB-1260	
Building EB-10												
LL3-092	D	08/07/01	0.0 - 1.0	--	--	--	--	--	--	20	--	Remediate
LL3sb-414M	ISM	06/29/11	3.0 - 5.0	--	--	63	47	54	7.2	--	--	Remediate
Building EB-11												
LL3ss-073-cs	ISM	10/22/07	2.5 - 3.5	--	--	--	--	--	--	13.8	--	Remediate
Building EA-7												
LL3-054	D	08/10/01	0.0 - 1.0	--	--	--	--	--	--	17	--	Remediate
Building EA-21												
No COCs for the Industrial Receptor were identified in Building EA-21												
Building EB-4												
LL3sb-413M	ISM	06/30/11	1.0 - 3.0	--	--	--	--	--	--	100	5[a]	Remediate
Building EA-6												
LL3-057	D	07/31/01	0.0 - 1.0	--	--	4.8[a]	5.8	7[a]	0.74[a]	--	--	Remediate
LL3-063	D	07/31/01	0.0 - 1.0	650[b]	--	--	5.4	--	0.93[a]	14[b]	--	Remediate
LL3ss-293M	ISM	06/04/10	4.7 - 5.7	--	--	7.57[a]	5.88	4.6[a]	0.847[a]	--	--	Remediate
West Perimeter Area												
LL3-050(p2)	D	08/08/01	0.0 - 0.5	--	--	--	3	--	--	--	--	Remediate
LL3sd-416M	ISM	07/02/11	0.0 - 0.5	--	--	8.6[a]	6.8	9.1[a]	1.2[a]	--	--	Remediate
Building EB-4A												
LL3-117	D	08/06/01	0.0 - 1.0	--	34[a]	--	--	--	--	15	--	NFA
Building EB-9A												
LL3ss-265M	ISM	06/24/08	0.0 - 1.0	700	--	--	--	--	--	--	--	Remediate
Building EB-25												
No COCs for the Industrial Receptor were identified in Building EB-25												
Building EA-6A												
No COCs for the Industrial Receptor were identified in Building EA-6A												

Table 2-15. Summary of Human Health COC Concentrations and Conclusions for Commercial/Industrial Land Use at Load Line 3 (continued)

				COC								Conclusion for Commercial/ Industrial Land Use
				Explosive		PAH				PCB		
		Industrial RGO		510	280	29	2.9	29	2.9	9.7	9.9	
Station	Sample Type	Date	Depth (ft)	TNT	RDX	B(a)A	B(a)P	B(b)F	DA	PCB-1254	PCB-1260	
LL3-056	D	08/12/01	1.0 - 3.0	--	--	--	--	--	--	--	--	NFA
LL3-144	D	08/09/01	0.0 - 1.0	--	--	--	--	--	--	14	--	Remediate

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
[b]Sample location is recommended for remediation for other chemicals of interest; however, this chemical is not recommended as a COC for remediation.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
D = Discrete soil sample.
DA = Dibenz(a,h)anthracene.
ft = Feet.
ISM = Incremental Sampling Methodology.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-Trinitro-1,3,5-Triazine.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.
-- = Chemical is not a human health COC in this sample.

A Level I ERA was conducted for Load Line 1 to determine presence/absence of important ecological places and resources and the presence of contamination. Perennial surface water in channelized ditches/streams and wetlands are important ecological resources at Load Line 3, and chemical contamination is present based on the historical ERAs. Because there is contamination and important/significant ecological resources at each of the load lines, the ERA in Appendix I continued to a Level II Screening ERA.

The Level II ERA identified procedures to determine AOC-related COIs. Data from the Phase II RI and the FS Addendum were integrated for each load line and were evaluated separately for sediment and surface water. These ERAs used updated SRVs and ESVs that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008). The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003b). The MDC of each chemical is compared to its respective facility-wide background concentration. Wet sediment concentrations are also compared to the SRV. Chemicals are not considered site-related if the MDC is below the background concentration (or SRV for sediment). For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV. In addition to the ESV comparison, it was determined if the chemical is a PBT compound. Chemicals are retained as integrated COIs if they exceed background concentrations (and SRVs for sediment) and the ESV, if the chemical exceeds background concentrations (and SRVs for sediment) and had no toxicity information, or if the chemical is considered a PBT compound. MDC to ESV ratios are used to determine the integrated COIs that result from the combined current and historical data sets. A ratio greater than 1 suggests a possible environmental consequence. Any chemicals with ratios greater than 1 are identified as integrated COIs.

Wet sediment and surface water at Load Line 3 were analyzed at Cobbs Pond Tributary. Eleven integrated COIs are present in sediment and two integrated COIs are present in surface water.

Technical and refinement factors were then used to refine the integrated COIs from the Level II Screening ERA. The factors included use of mean exposure concentrations, discussion of approved ESVs, and other topics. This type of assessment is Step 3A in the ERA process (USEPA 1997). Step 3A refines the list of integrated COIs to determine if: (1) there are COECs requiring further evaluation in a Level III Baseline ERA or remediation to protect ecological receptors, or (2) integrated COIs can be eliminated from further consideration. This evaluation is an important part of the Level II Screening ERA and is adapted from USEPA Step 3A, outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997) and *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c).

For Load Line 3, the evaluation in Step 3A showed no further evaluation is necessary for integrated COIs, and no ecological concern requires remediation. Consequently, the ERA for Load Line 3 concludes that no further action is necessary to be protective of important ecological resources.

2.4 LOAD LINE 4

Load Line 4 is located in the south central portion of the facility. The load line operated from 1941–1945 to produce 91,970 projectiles and bombs and again from 1951–1957 to produce 1,269,262 mines. Load Line 4 was used to melt and load TNT into large-caliber shells, bombs, and antitank mines. During its operational history, Load Line 4 produced about 1.2 million munitions. Pinkwater generated during operations was collected in concrete sumps and pumped via an overhead 6-inch-diameter cast iron flume to a settling basin and sawdust filtration unit located southwest of Building G-8. Effluent from the filtration unit was discharged to an unlined drainage ditch that flows into a 2-acre pond in the southwestern portion of the AOC, which discharged to a surface stream that exits the facility at a point south of the load line. When the facility was at full capacity, Load Line 4 generated approximately 895,000 gallons of pinkwater per month from wash-down and steam decontamination of equipment. All buildings and structures at Load Line 4 have been demolished.

Each former building located at Load Line 4 is presented below with a summary of its historical use and potential contamination source description. Former production buildings are included in Table 2-16, and non-production buildings are listed in Table 2-17. Figure 2-10 presents the Load Line 4 AOC features.

Table 2-16. Former Production Buildings at Load Line 4

Building ID	Purpose	Description of Potential Sources
G-11	Magazine/AN Service Building	TNT screening was completed at this building. After being screened, the TNT was transferred to G-10 or G-15.
G-12	Explosive Cooling Building	Following loading at Building G-8, shells were transferred to G-12/G-12A for cooling.
G-12A	Explosive Cooling Building	Following loading at Building G-8, shells were transferred to G-12/G-12A for cooling.
G-13	Funnel Removal and Face Off	Drilling operations for booster charges or other preparation steps depending on munition type were completed at G-13. These activities were completed after cooling at G-12/G-12A.
G-13A	X-Ray	Following loading of booster charges at G-13, a quality assurance check of the primary charges was completed using the radiographic equipment at this building.
G-15	Explosive Prep Building/TNT Screening Building	TNT was prepared and screened at this building.
G-16	TNT Receiving	Bulk TNT was offloaded at this building. Following receipt, it was transported to G-11.
G-18	Paint Storage/Component Service Building	Packing and shipping operations for completed munitions.
G-19	Packing and Shipping Building	Packing and shipping operations for completed munitions.
G-19A	Shipping Building	Packing and shipping operations for completed munitions.
G-8	Melt Pour Building	Following screening and preparation, the bulk TNT arrived at the melt pour building where it was loaded into shells.

ID = Identification.
TNT = 2,4,6-Trinitrotoluene.

Table 2-17. Former Non-production Buildings at Load Line 4

Building ID	Purpose
LL4-CC-1	Construction Camp Fire House
LL4-CC-2	Hunkin Conkey Construction
Ll4-CC-3	Workmen's Sheds
LL4-CC-4	Garage
LL4-CC-5	Stock Rooms
LL4-CC-6	Communications Unit
LL4-G-2	Paint Storage
LL4-G-3	Shell Preparation and Painting Building
LL4-G-4	Power House No. 7
LL4-G-5	Line Office
LL4-G-6	Change House
G-6A	Change House
LL4-G-7	Booster Service Building
SD-5	Sewage Ejector Station
T-5201-LL4	Guard Post
G-20	Gate House
WW-23	Elevated Water Tank
G-9	Explosive Screening Building (used as a magazine and empty transport cart storage area)
G-1	Material Receiving/Inert Storage Warehouse (physical plant service building)
G-1A	Material Receiving/Truck Repair Shop (physical plant service building)
G-14	Booster Service Building (physical plant service building)
G-17	Supplementary Charges Magazine (physical plant service building)

ID = Identification.

2.4.1 Environmental Setting

This section provides a summary of the environmental setting of Load Line 4 as presented in the Phase II RI Report for Load Line 4 (USACE 2004d) and includes surface features and site topography, geologic setting, and local hydrogeology.

2.4.1.1 Surface Features and Site Topography

Load Line 4 is situated in the southeastern quadrant of the RVAAP facility. The topography within the AOC is subdued on a glacial till surface. Elevations within the bounds of the AOC vary from approximately 299 to 305 m (980 to 1,000 ft) amsl. The overall topography slopes very gently from north to south within the AOC with localized steeper slopes cut along the main stream and southwestern edge of the settling pond.

Former production infrastructure features at Load Line 4 include asphalt and gravel access roads, man-made ditches, sanitary and storm sewer lines, manholes, railroad beds, and buildings. The main process area is heavily vegetated with rough grass and scrub vegetation between the major structures of the load line. Scrub vegetation and immature hardwoods characterize the non-production areas around the main process area. Moderately mature hardwoods exist along the northern portion of the load line.

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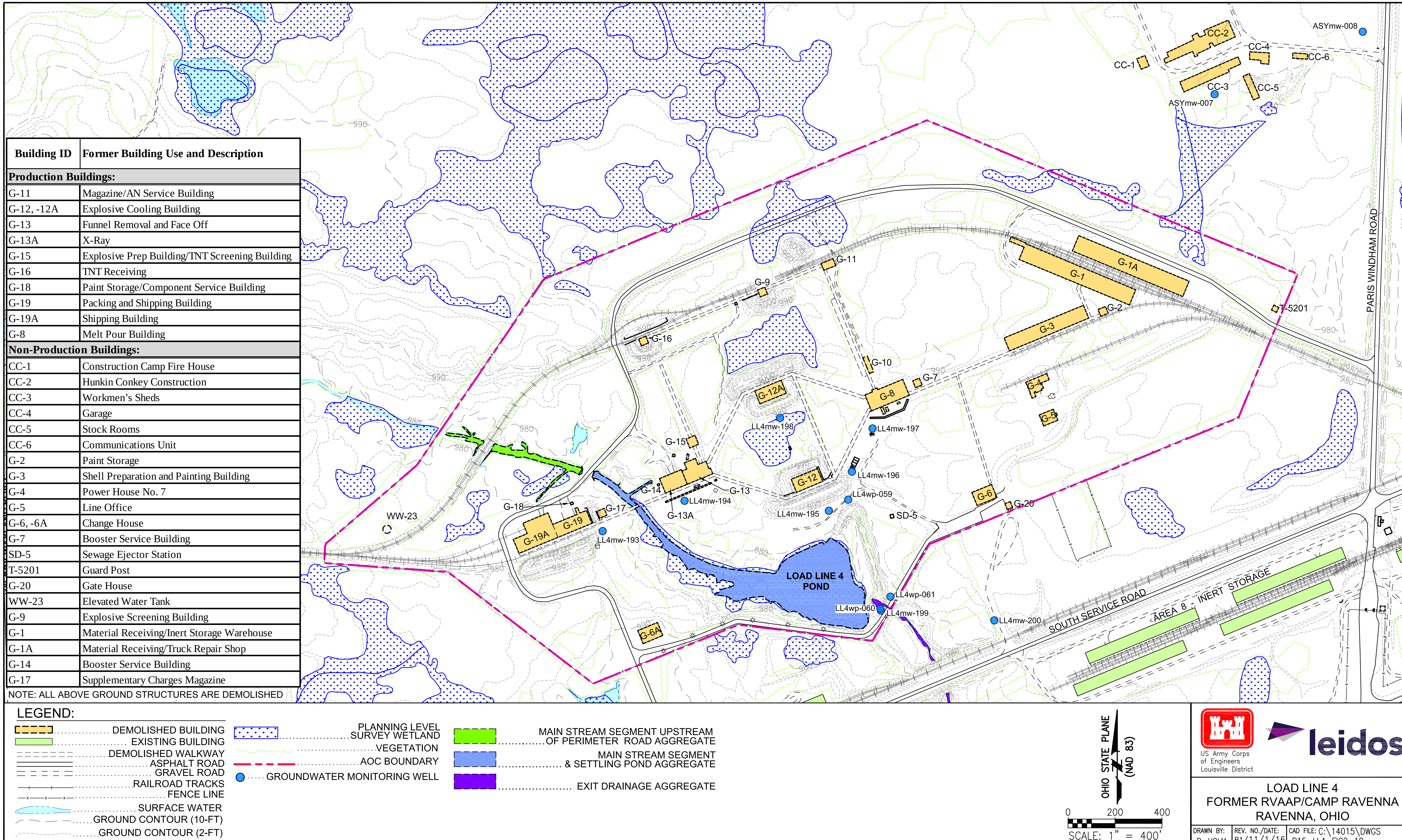

Building ID	Former Building Use and Description
Production Buildings:	
G-11	Magazine/AN Service Building
G-12, -12A	Explosive Cooling Building
G-13	Funnel Removal and Face Off
G-13A	X-Ray
G-15	Explosive Prep Building/TNT Screening Building
G-16	TNT Receiving
G-18	Paint Storage/Component Service Building
G-19	Packing and Shipping Building
G-19A	Shipping Building
G-8	Melt Pour Building
Non-Production Buildings:	
CC-1	Construction Camp Fire House
CC-2	Hunkin Conkey Construction
CC-3	Workmen's Sheds
CC-4	Garage
CC-5	Stock Rooms
CC-6	Communications Unit
G-2	Paint Storage
G-3	Shell Preparation and Painting Building
G-4	Power House No. 7
G-5	Line Office
G-6, -6A	Change House
G-7	Booster Service Building
SD-5	Sewage Ejector Station
T-5201	Guard Post
G-20	Gate House
WW-23	Elevated Water Tank
G-9	Explosive Screening Building
G-1	Material Receiving/Inert Storage Warehouse
G-1A	Material Receiving/Truck Repair Shop
G-14	Booster Service Building
G-17	Supplementary Charges Magazine

NOTE: ALL ABOVE GROUND STRUCTURES ARE DEMOLISHED

Figure 2-10. Load Line 4 AOC Features

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2.4.1.2 Geologic Setting of Load Line 4

Subsurface characterization at Load Line 4 during the Phase II RI was performed by installing six test trenches to depths of 3.65 m (14 ft) around the periphery of the AOC, and by continuous sampling during the drilling of monitoring wells. Hand auger borings from soil sampling locations were also used to characterize the shallow subsurface soil interval.

Soil

At Load Line 4, soil of the Mahoning series is present. The Mahoning series soil is poorly drained, silty clay loam or clay loam formed over glacial till where bedrock is generally greater than 1.8 m (6 ft). Runoff is typically medium to rapid, and the soil is seasonally wet. Permeabilities range from 1.52 to 5.08 cm (0.6 to 2.0 inches) per hour.

Test pits and monitoring well borings provide the general geologic characteristics noted below for the unconsolidated zone underlying Load Line 4. Surface soil at Load Line 4 varies widely in character from one area to another due to lateral discontinuity within the glacial till and site disturbances; however, sandy silts dominate in the near surface interval. As noted in the boring logs for hand-augered soil sampling stations, some areas of the load line have been substantially reworked and contain sandy fill, gravel, ballast material, and slag. Concrete, rebar, nails, glass, paint chips, etc. exist at the ground surface in many areas, especially in the vicinity of buildings. In comparatively undisturbed areas where some test pits were excavated, the surface soil interval consisted of a light yellow brown (10YR6/4) sandy silt.

At depths ranging from 0 to 2.1 m (0 to 7 ft) bgs, unconsolidated deposits consist primarily of a brown (10YR4/3) to yellowish-brown (10YR5/4), silty sand to sandy silt with some gravel. On average, this unconsolidated interval was 1 m (3 ft) thick and had a stiff consistency, low plasticity, and widely variable moisture content (dry to moist) depending on location. At depths ranging from 0.6 to 5.2 m (2 to 17 ft) bgs, a gray to dark yellowish-brown silty clay or clayey silt occurs. In some borings, intermittent gravel was observed. Below the clayey silt layer described above, a gray to yellowish-brown sand and silty sand was encountered at depths ranging from 2.1 to 6.1 m (7 to 20 ft) bgs. In the deepest borings drilled during the Phase II RI, a gray silty clay was encountered at depths of approximately 4.9 to 6.1 m (16 to 20 ft) bgs.

Bedrock Geology

Bedrock was not encountered in any boring drilled during the Phase II RI at Load Line 4; the deepest boring was drilled to approximately 6.7 m (22 ft) bgs. Drilling logs from historical water supply wells in the vicinity of the load line, which were installed to depths of 30.5 m (100 ft) or more, indicate that the unconsolidated zone is underlain by the Sharon Conglomerate. Detailed information on structural or lithological characteristics of the bedrock interval at Load Line 4 is not available from these historical logs.

During investigations at Load Lines 1 through 3 and Load Line 12 to the east of Load Line 4, the Sharon Conglomerate unit of the Sharon Member (Pottsville Formation) was encountered. At these adjacent load lines, the unit is characterized by a light yellowish-brown to brownish-gray, fine- to medium-grained sandstone, which commonly contains iron-stained fractures. At Load Line 1 to the northeast, the Sharon Conglomerate consists of a relatively pure quartz sandstone with little observed shale. In the vicinity of Load Line 2, shale lenses typically 0.3 m (1 ft) in thickness or less, were commonly observed in subsurface borings. Shale lenses were encountered in borings drilled during the Phase II RI at Load Line 3 at a greater frequency and thickness than at Load Line 2. Farther west at Load Line 12, an extensive dark gray shale was encountered in subsurface borings. The observed facies changes imply a change of depositional environment across the southeastern portion of the facility with energetic conditions in the Load Line 1 and Ramsdell Quarry area, and increasingly quiescent conditions toward the south-central portion of RVAAP (e.g., vicinity of Load Lines 12 and 4).

2.4.1.3 Load Line 4 Hydrologic/Hydrogeologic Setting

All wells at Load Line 4 were screened within the unconsolidated zone, with most screens either entirely or partially within the silty sand to sand interval, which was present at depths ranging from 2.1 to 6.1 m (7 to 20 ft) bgs. A potentiometric surface map specific to Load Line 4 is provided in the Phase II RI Report. The map was constructed using static water level data from eight monitoring wells installed during the Phase II RI and reflects flow conditions established as part of the facility-wide potentiometric evaluation. In general, the potentiometric surface is a subdued replica of the topography within the AOC, and shallow groundwater flow is to the south and off of the AOC consistent with surface water drainage patterns. Groundwater depths range from approximately 3.4 to 15.8 ft bgs (EQM 2010).

Results of slug tests performed at the eight monitoring wells in September 2001 indicate low to moderate hydraulic conductivities in the unconsolidated sediments ranging from 2.92×10^{-3} cm/sec (8.23 ft/day) to 4.05×10^{-5} cm/sec (1.15×10^{-1} ft/day). Slug test results are representative of the entire screened interval for the monitoring wells; therefore, any local heterogeneity that affects hydraulic conductivity within the screened interval, such as clay lenses, will be represented in the slug test.

The primary surface water conveyance at Load Line 4 enters the AOC from the west and is sourced from comparatively undisturbed areas. This stream is perennial and contains a substantial amount of flow during the majority of the year. From its entrance point, the stream crosses the AOC from northwest to southeast and flows into the large settling pond. A standpipe controls water levels in the settling pond. Drainage from the pond flows southeast off of the AOC where it exits RVAAP at PF-8. Storm drainage ditches comprise the remaining surface water conveyances; these contain flow only intermittently during rain events or snow melt. Drainage ditches in most of the load line ultimately drain into the main stream or the settling pond. Of particular interest are a pair of drainage ditches that convey intermittent flow from Building G-12 and the former settling basin to the pond; the ditch from the settling basin transported pinkwater effluent when the line was in operation. In the northeastern portion of the load line, in the vicinity of Buildings G-1 through G-5, surface water drainage is to the northeast off of the AOC via several drainage ditches. None of these ditches contain water except during rainfall events. Most of the surface water runoff is to the south, similar to groundwater flow at the load line.

A below ground storm sewer system also exists at Load Line 4 for management of storm water runoff. Runoff is collected at a series of inlets located adjacent to the primary buildings and along roadways. Termination points for the storm sewer system include the drainage ditches and main stream noted above. Flow was observed in the some of the storm sewers during a site walkover in spring 2001, indicating that groundwater influx into portions of the system (at cracks or joints in the pipe) occurs during wet seasons of the year.

2.4.2 Co-located or Proximate Sites

The following subsections summarize sites that are co-located or proximate to Load Line 4 but are addressed separately.

2.4.2.1 Facility-wide Sewers

The defunct sanitary and storm sewers within the perimeter of Load Line 4 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Sewer sediment, pipe bedding material, and sewer water were evaluated as currently summarized in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a). The sanitary sewers at the Load Line 4 FA were part of the Sand Creek Sewage Treatment Plant Network. Load Line 4 also contains a discrete storm sewer network. Demolition activities at former Load Line 4 impacted numerous sewer structures, especially those associated with shallow storm sewers adjacent to buildings and walkways.

Sewer water and sediment samples were collected from storm and sanitary sewers during the Phase II RI (USACE 2004d); video surveys also were conducted. Inspections and explosives field screening tests were conducted at the Load Line 4 FA during a 2007 *Summary of CERL Findings, RVAAP Sewer System (*USACE-CERL 2007) and the *Explosive Evaluation of Sewers* (LES 2007a). The 2007 Explosive Evaluation of Sewers included a video survey of the sewer lines at Load Line 4. Both studies collected wipe samples of sewer line inverts for analysis of explosive residues, using field test kit methods (e.g., Expray® 24 and DropEx). Additionally, wipe samples from video cameras used during the 2007 Explosive Evaluation of Sewers were collected.

All SRCs found in sewer media samples and evaluated through the stepwise fate and transport screening evaluation were eliminated as posing future impacts to groundwater. The HHRA did not identify a complete exposure pathway for any receptor and no further action was recommended from an ecological perspective. In summary, the Facility-wide Sewers RI recommended no further action for the Load Line 4 sewers.

2.4.2.2 Facility-wide Groundwater

As part of the IRP, the Army implements the FWGWMP in accordance with previous agreements made with Ohio EPA. The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP. No groundwater samples were collected from the nine monitoring wells associated with Load Line 4. Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at Load Line 4 will be addressed as part of that facility-wide AOC.

2.4.2.3 Munitions Response Sites

There is no munitions response site within or adjacent to the AOC boundary identified as part of the MMRP.

2.4.2.4 Compliance Restoration Sites

USTs RV-63 and RV-64 at Building G-4 are covered under site CC-RVAAP-72 Facility-wide USTs. No further action is warranted based on the recommendation in the *SI for CC-RVAAP-72 Facility-wide USTs* (USACE 2015c).

The facility-wide coal storage site, the Power House No. 7, was assessed under site CC-RVAAP-73 as part of the Coal Sites AOC in the HRR (USACE 2011a). As indicated in the HRR, evaluation of the historical data in soil at this site will be addressed in a future CERCLA action and therefore is included in this FS Addendum.

2.4.3 Previous Investigations, Decisions, and Actions

Since 1978, Load Line 4 has been the subject of multiple investigations and/or assessments leading to CERCLA decisions and/or remedial actions at the AOC. The Preliminary Assessment conducted in 1996 concluded that Load Line 4 was a high-priority AOC for future environmental investigations due to primary contaminant release mechanism from process effluent discharges to surface water and surface soil. Subsequently, a Phase I RI was conducted and recommended additional investigation in a Phase II RI due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC. During the Phase II RI, a total of 161 environmental samples were collected to determine the nature and extent of surface soil contamination at Load Line 4. Based on the results of the human health and ERAs, Load Line 4 was recommended for further evaluation in an FS.

The Load Line 4 settling pond was assessed during a 2003 Facility-wide Biological and Water Quality Study. One ISM sediment samples and two surface water samples were collected from the Load Line 4 settling pond. While explosives, PAHs, and metals were detected in sediment and/or surface water from the pond, the report determined that surface water and sediment quality in Load Line 4 Pond was sufficient to not adversely impact the biological community. In addition, while the habitat quality was considered fair, the macroinvertebrate fauna did not differ significantly from reference conditions and the fish community results were strongly similar to reference pond conditions.

An FFS recommended excavation with off-site disposal as an interim remedy to address surface soil, subsurface soil, and dry sediment contamination at Load Line 4. Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007 (USACE 2008a). A total of 1,208 tons of non-hazardous soil were removed from Load Line 4 from nine areas. After the excavation was completed, ISM samples were collected and analyzed for Load Line 4 COCs: PCB-1254, aluminum, lead, and manganese. Previous sample locations and previous remediation areas are presented in Plates 2-7 and 2-8 (located at the end of this section).

To determine if any additional areas required excavation to remove contaminated soil beneath former building slabs (removed between March and June 2008), the following sampling activities were completed at Load Line 4: stockpile sampling, post-slab removal field screening, and final confirmatory sampling. Analytical and field screening results from these building slabs at Load Line 4 indicated TNT and RDX concentrations were at low levels (less than 2.6 mg/kg); below cleanup goals utilized in this report. The investigation concluded excavation was not required at Load Line 4 for TNT or RDX beneath building slabs (USACE 2009b).

ISM sampling was also completed in 2008 within building footprints following the removal of building slabs and any contaminated soil identified as part of the *Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11* (USACE 2009c) to determine if any additional excavation was required at building locations beyond those determined by field screening. This investigation found that propellants, SVOCs (primarily PAHs), PCBs, pesticides, and metals were detected in ISM samples collected at Load Line 4. No building footprints at Load Line 4 were identified for remediation in the conclusions of this report.

Based on the characterization and results provided as part of the Sampling and Screening Analysis Report (USACE 2009b) and *Multi-Increment Sampling and Analysis of Soils Below Floor Sabs at RVAAP-09, 10, and 11* Report (USACE 2009c), a total of 501 tons of materials were removed from five stockpiles at Load Line 4 for off-site disposal. The stockpiles included three piles of soil, one pile of concrete at Building G-1, and one pile of soil located at Building G-3.

In 2009, USACE collected 11 surface soil and 40 subsurface soil ISM samples at Load Line 4 to characterize deeper subsurface soil beneath the former building slabs that was not previously investigated via subsurface soil ISM techniques. Additional surface soil ISM samples in the former coal storage area at Load Line 4 were collected and analyzed to provide preliminary data for future RIs.

Additional characterization sampling was completed at Load Line 4 to guide future soil remedial and administrative measures. The samples collected as part of this investigation helped eliminate soil data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010a). Eight surface soil ISM samples and 16 subsurface soil horizontal ISM samples (1 from 1–2, 5 from 1–3, 5 from 3–5, and 5 from 5–7 ft bgs) were collected at Load Line 4 to further refine ISM sample areas that had concentrations of contaminants above FWCUGs utilized in the Characterization Sampling Report (USACE 2013). The investigation concluded that 7 of the 10 previous areas exceeding the FWCUGs utilized in the Characterization Sampling Report were further bound and delineated. The remaining three areas were not fully delineated.

A data gap analysis was conducted during the PBA13 SAP Addendum and determined additional samples for soil, sediment, and surface water were unnecessary given the spectrum and density of existing ISM and discrete data available.

CERCLA activities completed at Load Line 4 are presented in the timeline illustrated in Figure 2-11, and additional details related to the previous investigations are provided in Appendix A.

2.4.4 Data Assembly and Use Assessment – Load Line 4

All data collected at Load Line 4 were extracted from the REIMS database. This includes data from investigations summarized in the following reports:

- Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 through 4 and 12 (USACE 2013);
- Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 through 4 (USACE 2011c);
- Phase II RI Report for the Load Line 4 (USACE 2004d);
- Remedial Action Completion Report for the Remediation of Soils and Dry Sediments at RVAAP 08-11 (Load Lines 1 through 4) (USACE 2008a);
- Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11 (USACE 2009c);
- Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations (USACE 2010b); and
- Facility-wide Biological and Water Quality Study (USACE 2005a).

A data use assessment was conducted by reviewing all data to ensure that the medium sampled is still present and has not been removed during remediation, and ensuring that the data approved for use meet the DQOs. The data from investigations summarized in the following reports were not used in this FS Addendum:

- *Phase I Remedial Investigation Report for the Phase I Remedial Investigation of High Priority Areas of Concern* (USACE 1998) – These data are more than 16 years old and are no longer considered representative of the site (e.g., buildings and slabs have been removed and/or remediated).
- November 2004 Sampling Completion Report (USACE 2005b).
- Sampling and Screening Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11 (USACE 2009b).
- Remediation Completion Report for Sub-Slab Soils at Load Lines 2, 3, and 4 (USACE 2010d).

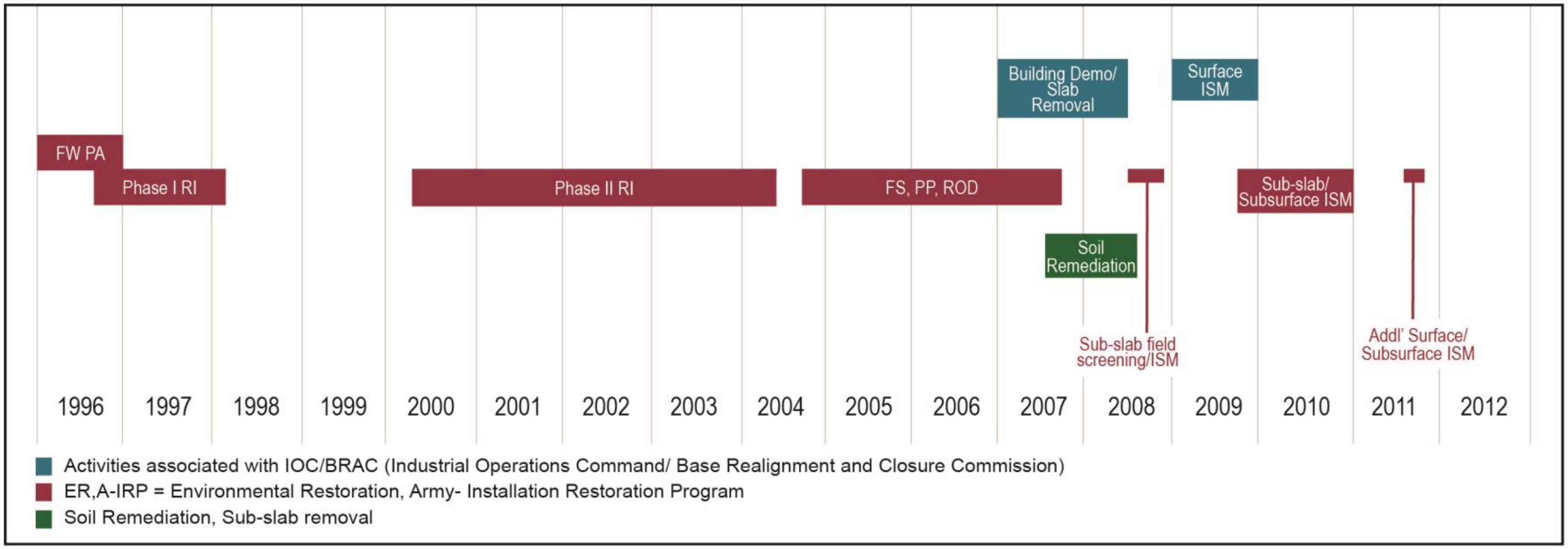

Figure 2-11. Timeline of Remedial Activities at Load Line 4

RI/FS Report for RVAAP-67 Facility-wide Sewers (USACE 2012a) –The sewers are currently being evaluated under a separate RI. Data from the Facility-wide Sewers Investigation was evaluated qualitatively in consideration of the CSM.

Once the data were assembled and evaluated for use, COIs were identified specific to Load Line 4 media.

2.4.5 Load Line 4 Conceptual Site Model

The CSM is a site-specific, systematic planning tool. It provides a concise summary of residual contamination distribution, exposure pathways, migration routes, and assessment of the effects to human health and ecological receptors that supports development of RAOs and the FS. A graphical depiction of the CSM is presented in Figure 2-12. The following sections summarize the COIs identified in soil, surface water, and sediment, and provide results of the fate and transport analysis, HHRA, and ERA.

2.4.5.1 Load Line 4 COIs

Load Line 4 COIs were developed from the chemicals identified as exceeding residential risk targets in the Phase II RI (USACE 2004d). Load Line 4 COIs for exposure of Resident Receptor (Adult and Child) to soil, sediment, and surface water are shown in Table 2-18. The list of COIs shown in Table 2-18 is longer than the list of COCs included in the IROD (USACE 2007) because the IROD focused on only the National Guard Trainee Receptor and soil.

Table 2-18. COIs in Soil, Surface Water, and Sediment at Load Line 4

COI	Load Line 4		
	Soil	Surface Water	Sediment
Metals			
Aluminum	X	X	X
Arsenic	X	X	X
Lead	X	X	X
Manganese	X	X	X
Thallium	X	X	X
PCBs			
PCB-1254	X	X	X
PCB-1260	X	X	X
PAHs			
Benz(a)anthracene	X	X	X
Benzo(a)pyrene	X	X	X
Benzo(b)fluoranthene	X	X	X
Dibenz(a,h)anthracene	X	X	X
Indeno(1,2,3-cd)pyrene	X	X	X

COI = Chemical of Interest.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
X = COI is present in medium.

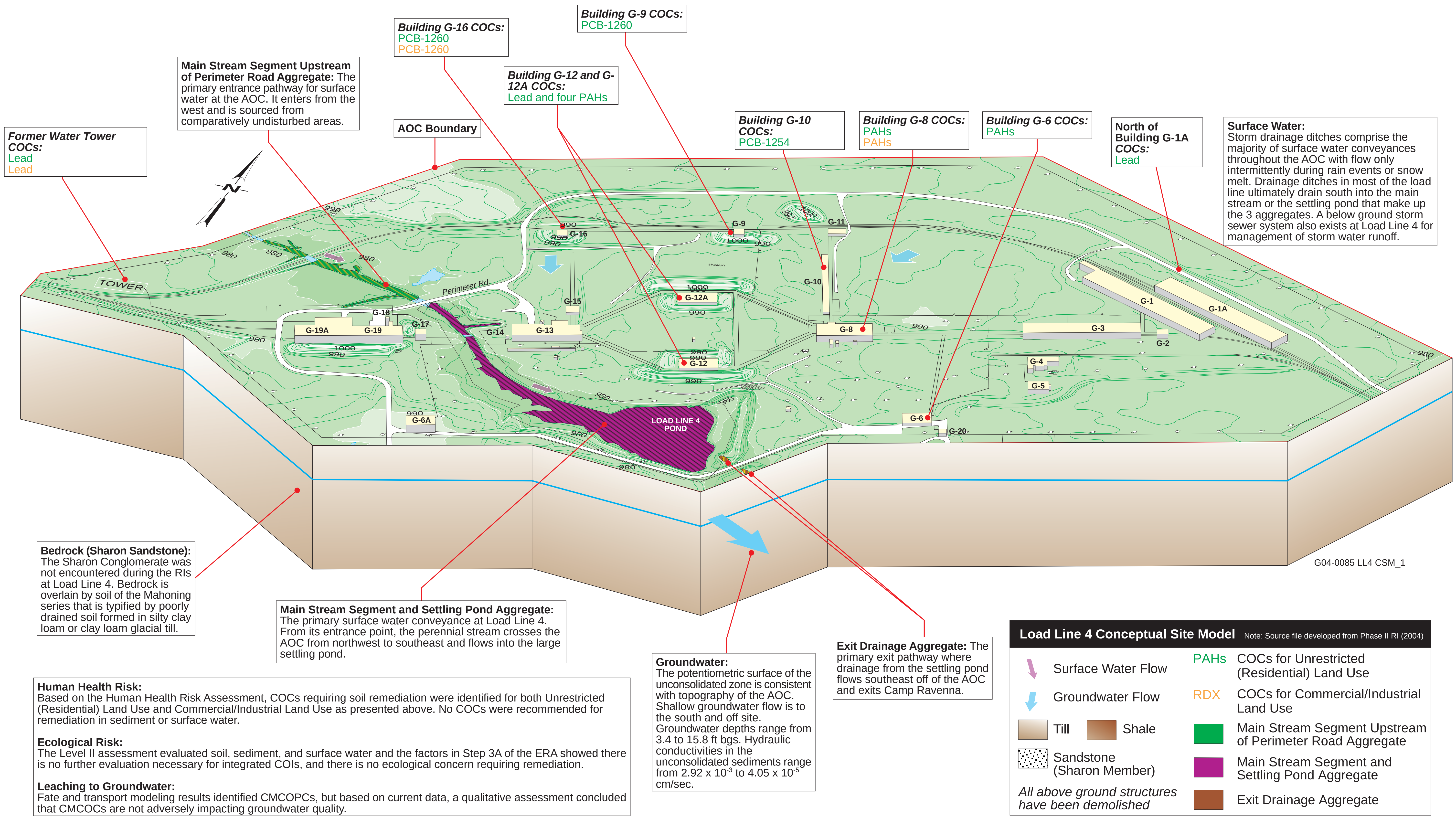

Figure 2-12. Load Line 4 Conceptual Site Model

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2.4.5.2 Fate and Transport

The details of the fate and transport analysis conducted to assess the potential for COIs to leach from surface soil and subsurface soil (defined as soil leaching COIs) at Load Line 4 and impact groundwater beneath the source and at a nearest downgradient receptor location are presented in Appendix G. The fate and transport analysis also evaluates the potential for SRCs to leach from sediment sources at Load Line 4 and impact groundwater beneath the source and at the nearest downgradient receptor location. A summary of the analyses is presented in this section.

One soil leaching COI (RDX) was identified for its potential to leach from soil to groundwater at Load Line 4 in this FS Addendum. This soil leaching COI was further evaluated to determine if residual concentrations in surface and subsurface soil may potentially impact groundwater quality and warrant evaluation in an FS. In addition, all sediment SRCs were evaluated to determine if residual concentrations in sediment may potentially impact groundwater quality and warrant evaluation in an FS. The soil leaching COI and all of the SRCs identified in the sediment at the AOC were evaluated through the stepwise fate and transport evaluation that included leachate modeling in the unsaturated zone using the SESOIL model and lateral transport modeling in the saturated zone using the AT123D model.

If the predicted maximum leachate concentration of a COI was lower than the screening criteria, the chemical was eliminated for further evaluation using AT123D modeling. For these remaining COIs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCLs, and RSLs. Only the COI/CMCOPCs with predicted maximum concentration higher than its facility-wide background concentration, and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), was retained as a CMCOC. These CMCOCs were evaluated with respect to WOE for retaining or eliminating CMCOCs from further consideration as a basis for potential soil or sediment remedial actions.

The evaluation of modeling results with respect to current groundwater data for the AOC and model limitations identified the following CMCOCs at Load Line 4:

- The soil leaching COI, RDX was predicted to exceed the screening criteria in groundwater beneath the source as well as at the downgradient receptor location.
- Among the sediment CMCOPCs, only hexavalent chromium was predicted by analytical solutions to exceed screening criteria in groundwater beneath the source; however, it was not predicted to be above criteria at the downgradient receptor location.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if the soil leaching COI (RDX), and the sediment CMCOPC (hexavalent chromium) at the AOC may impact the groundwater beneath the source or at the downstream receptor location.

RDX – The maximum surface soil concentration for RDX (19 mg/kg at LL4ss-142-0878) was below its residential soil RGO, and RDX was not identified as a soil COC in the HHRA. The modeling estimates that RDX concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 50 years or less with peak concentrations occurring at approximately 100 years or less; the maximum predicted RDX groundwater concentration at the downgradient receptor location is also expected to be above its RSL (Appendix G, Table G-15). However, RDX was not detected in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). Based on the AOC period of operations, RDX should have already been detected in groundwater. Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and RDX would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

Hexavalent Chromium – The maximum sediment concentration for hexavalent chromium (1.4 mg/kg at LL4sd-057-0973-SD) was below its residential soil and sediment RGO, and hexavalent chromium was not identified as sediment COC in the HHRA. The modeling assumes that the sediment is in direct contact with groundwater and no attenuation due to sorption is occurring; therefore, hexavalent chromium is predicted to be already in groundwater beneath the source area exceeding the RSL, although hexavalent chromium was never detected in groundwater. The modeling also predicted that it would take approximately 200 years for hexavalent chromium to be below its RSL; however, the maximum predicted groundwater concentration of hexavalent chromium at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). It should be noted that hexavalent chromium in groundwater is considered to be of concern because the evaluation assumes the minimum dilution attenuation factor (DAF) calculated for chromium using co-located surface water and sediment data for the AOC can be applicable to hexavalent chromium. This assumption was made because hexavalent chromium was not analyzed in surface water, and a DAF for hexavalent chromium could not be calculated. However, if the DAF calculated for chromium is applied to hexavalent chromium, then the estimated concentration of hexavalent chromium would be below its RSL. Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and hexavalent chromium in groundwater beneath the source would be expected to be below its RSL based on its attenuation in the vadose zone before reaching the water table and its estimated site-specific DAF.

Conclusion – Overall, the qualitative assessment for the AOC concludes that the soil and sediment contaminants identified as CMCOCs are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts for the AOC groundwater beneath the source and at the downgradient receptor location. Potential additional investigation under the facility-wide groundwater AOC may be warranted for the AOC, but based on the fate and transport evaluation, CMCOCs were not identified for Load Line 4, and no further action is required for soil and sediment to be protective of groundwater for the AOC.

2.4.5.3 Human Health Risk Assessment Results

The HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to residual contamination in soil, sediment, and surface water at Load Line 4. The approach to risk-based decision making is as follows:

RGOs were compiled for the COIs identified in Section 2.4.5.1. RGOs for Unrestricted (Residential) Land Use are the USEPA Residential RSLs for soil (used for soil and sediment) and tap water (used for surface water) published in May 2016. RSLs for the cancer endpoint were adjusted to correspond to a TR of 1E-05, RSLs for the non-cancer endpoint were used at a target HQ of 1. RGOs for Commercial/Industrial Land Use are the USEPA Industrial RSLs for soil adjusted for a TR of 1E-05 and target HQ of 1. Industrial RSLs are not available to evaluate surface water or sediment because Industrial/Commercial activities are not applicable to surface water (i.e., exposure of industrial and commercial workers is not anticipated for these media). The potential impact of the lack of screening values is addressed in the uncertainty assessment using Industrial RSLs calculated with the on-line USEPA RSL calculator assuming an Industrial Receptor might wade into shallow water bodies. At Load Line 4, media were previously remediated for COCs that exceeded cleanup goals established for the National Guard Trainee; therefore, this FS Addendum only evaluates the Resident Receptor (Adult and Child) and the Industrial Receptor.

The methodology of comparing COI exposure concentrations to RGOs and determining COCs generally follows guidance presented in the Position Paper for Human Health Cleanup Goals (USACE 2012b) and Technical Memorandum (ARNG 2014) and includes calculating an SOR for all non-carcinogenic and carcinogenic COIs. The reported concentration in each discrete or ISM sample was compared to RGOs (i.e., the EPC is the concentration in each individual sample). COIs are identified as COCs for a given receptor if:

- The EPC exceeds the most stringent RGO for either the 1E-05 target cancer risk or the 1 target HQ; or
- The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than 1; chemicals contributing at least 5% to an SOR greater than 1 are also considered COCs.

Metals present at concentrations consistent with naturally occurring background concentrations are not identified as COCs.

The results of the COC screening are combined with the results of the uncertainty assessment to identify COCs to be carried forward for remediation. Details of the screening process and identification of COCs recommended for remediation are provided in Appendix H.5. Detailed figures depicting contaminant distribution and results of screening assessments are provided in Figures H.5-1 through H.5-6 in Appendix H. The COCs to be carried forward for potential remediation are summarized below for Unrestricted (Residential) and Industrial Land Use:

- Unrestricted (Residential) Land Use – Lead; PCB-1254; PCB-1260; and PAHs (benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) were identified as COCs to be carried forward for potential remediation at Load Line 4. The COCs recommended for remediation are summarized by area below:
    - Former Water Tower – Lead.
    - Building G-16 – PCB-1260.
    - Building G-9 – PCB-1260.
    - Buildings G-12 and G-12A – Lead and five PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene).
    - Building G-8 – Five PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene).
    - Building G-10 – PCB-1254.
    - Building G-6 – Four PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).
    - North of Building G-1A – Lead.
- Industrial Land Use – Lead; PCB-1260; and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene) were identified as COCs to be carried forward for potential remediation at Load Line 4. The COCs recommended for remediation are summarized by area below:
    - Former Water Tower – Lead.
    - Building G-16 – PCB-1260.
    - Building G-8 – Four PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).

No COCs were identified for remediation in sediment or surface water. COCs identified for potential remediation at Load Line 4 are summarized in Tables 2-19 and 2-20.

2.4.5.4 Ecological Risk Assessment Results

The ERA for wet sediment and surface water at Load Line 4 is presented in Appendix I of this FS Addendum and follows a unified approach of methods integrating Army, Ohio EPA, and USEPA guidance. This ERA approach is consistent with the general approach by these agencies and primarily follows the Level I Scoping ERA, Level II Screening ERA, and Level III Baseline ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008), with specific application of components from the FWERWP (USACE 2003b), *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c), and *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997). The ERA process implemented in this FS Addendum report combines these guidance documents to meet requirements of Ohio EPA and the Army, while following previously accepted methods established for RVAAP. This unified approach resulted from coordination between USACE and Ohio EPA during the summer of 2011.

Table 2-19. Summary of Human Health COC Concentrations in Soil and Conclusions for Unrestricted (Residential) Land Use at Load Line 4

Station	Date	Depth (ft)	Lead	B(a)A	B(a)P	B(b)F	DA	IP	PCB-1254	PCB-1260	Conclusion for Unrestricted (Residential) Land Use
			COC								
			Metal	PAH					PCB		
	Residential RGO		400	1.6	0.16	1.6	0.16	1.6	1.2	2.4	
Former Water Tower											
LL4-070	08/21/01	0 - 1	1340	--	--	--	--	--	--	--	Remediate
LL4-068	08/21/01	0 - 1	599	--	--	--	--	--	--	--	Remediate
LL4-069	08/21/01	0 - 1	414	--	--	--	--	--	--	--	Remediate
Building G-16											
LL4-071	08/21/01	0 - 1	618[b]	0.15[a,b]	0.21[b]	0.54[a,b]	--	0.15[a,b]	--	28	Remediate
Building G-9											
LL4-075	08/22/01	0 - 1	--	--	0.15[a,b]	0.32[a,b]	--	0.098[a,b]	--	4.5	Remediate
LL4-076	08/22/01	0 - 1	--	--	0.19	0.3[a]	--	0.19[a]	--	0.18[a]	NFA
LL4-078	08/22/01	0 - 1	--	--	--	--	--	--	--	2.6	Remediate
Building G-18											
LL4ss-219M	06/27/08	0 - 1	--	0.382[a]	0.325	0.291[a]	--	--	--	--	NFA
Building G-19											
LL4-095	08/22/01	0 - 1	501	--	--	--	--	--	--	--	NFA
Buildings G-12 and G-12A											
LL4-116	08/14/01	0 - 1	418	--	--	--	--	--	--	--	Remediate
LL4-113	08/21/01	0 - 1	--	--	0.77	1.3[a]	0.38	1.4[a]	--	--	Remediate
LL4-158	08/24/01	0 - 1	--	0.99[a]	--	5.4	--	--	--	--	NFA
LL4ss-420M	06/26/11	0 - 1	--	0.48[a]	0.38	0.51[a]	0.065[a]	--	--	--	Remediate
Building G-8											
LL4SB-402M	08/16/10	1 - 3.0	--	0.13[a]	0.17	0.28[a]	0.033[a]	--	--	--	Remediate
LL4SB-402M	08/16/10	3.0 - 5.0	--	4.1	3.7	4.5	0.48	2.1	--	--	Remediate
LL4SB-402M	08/16/10	5.0 - 7.0	--	2.2	1.9	2.4	0.3	--	--	--	Remediate
LL4SB-402M07	08/16/10	1 - 7.0	--	54	51	61	6.2	29	--	--	Remediate
LL4SB-402M10	08/16/10	1 - 7.0	--	--	0.28	0.65[a]	0.062[a]	0.2[a]	--	--	Remediate
LL4SB-402M11	08/16/10	1 - 7.0	--	0.29[a]	0.38	0.46[a]	0.059[a]	0.3[a]	--	--	Remediate
LL4sb-407M	06/27/11	1 - 3.0	--	3.3	2.9	3.1	0.38	1.6	--	--	Remediate
LL4sb-407M	06/27/11	3.0 - 5.0	--	0.62[a]	0.53	0.63[a]	0.069[a]	--	--	--	Remediate
LL4sb-410M	06/27/11	5.0 - 7.0	--	0.56[a]	0.57	1.1[a]	0.16	--	--	--	Remediate
LL4sb-411M	06/27/11	1 - 3.0	--	0.16[a]	0.16[a]	0.31[a]	0.036[a]	--	--	--	Remediate
LL4ss-206M	07/01/08	0 - 1	--	2.02	2	1.94	0.327	--	--	--	Remediate

Table 2-19. Summary of Human Health COC Concentrations in Soil and Conclusions for Unrestricted (Residential) Land Use at Load Line 4 (continued)

			COC								Conclusion for Unrestricted (Residential) Land Use
			Metal	PAH					PCB		
	Residential RGO		400	1.6	0.16	1.6	0.16	1.6	1.2	2.4	
Station	Date	Depth (ft)	Lead	B(a)A	B(a)P	B(b)F	DA	IP	PCB-1254	PCB-1260	
Building G-10											
LL4-117	08/21/01	0 - 1	--	--	--	--	--	--	2.9	--	Remediate
Building G-6											
LL4-141	08/14/01	0 - 1	--	0.53[a]	0.5	0.67[a]	0.085[a]	--	--	--	Remediate
North of Building G-1A											
LL4-185	08/11/01	0 - 0.5	563	--	--	--	--	--	--	--	Remediate
Building G-4											
LL4-131	08/14/01	0 - 1	987	--	--	--	--	--	--	--	NFA

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
[b]Sample location is recommended for remediation for other chemicals of interest; however, this chemical is not recommended as a COC for remediation.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
D = Discrete soil sample.
DA = Dibenz(a,h)anthracene.
ft = Feet.
IP = Indeno(1,2,3-cd)pyrene.
ISM = Incremental Sampling Methodology.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RGO = Remedial Goal Option.
-- = Chemical is not a human health COC in this sample.

Table 2-20. Summary of Human Health COC Concentrations in Soil and Conclusions for Industrial/Commercial Land Use at Load Line 4

			COC						
			Metals	PAHs				PCBs	
	Industrial RGO		800	29	2.9	29	2.9	9.9	Conclusion for Commercial/Industrial Land Use
Station	Date	Depth (ft)	Lead	B(a)A	B(a)P	B(b)F	DA	PCB-1260	
Former Water Tower									
LL4-070	08/21/01	0 - 1	1340	--	--	--	--	--	Remediate
Building G-16									
LL4-071	08/21/01	0 - 1	--	--	--	--	--	28	Remediate
Building G-8									
LL4SB-402M	08/16/10	3 - 5	--	4.1[a]	3.7	4.5[a]	0.48[a]	--	Remediate
LL4SB-402M07	08/16/10	1 - 7	--	54	51	61	6.2	--	Remediate
Building G-4									
LL4-131	08/14/01	0 - 1	987	--	--	--	--	--	NFA

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
DA = Dibenz(a,h)anthracene.
ft = Feet.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RGO = Remedial Goal Option.
-- = Chemical is not a human health COC in this sample.

A historical ERA (a SERA and BERA) was performed as part of the Phase II RI (USACE 2004d) for Load Line 4. The ERA for wet sediment and surface water in Appendix I was conducted because the historical evaluation was not based on the current Ohio EPA guidance (Ohio EPA 2008) and did not include the recently collected FS Addendum data. Soil was evaluated for ecological receptors for Load Line 4 in the Phase II RI (USACE 2003). As concluded in the IROD at Load Lines 1 through 4 (USACE 2007): *the majority of COEC) in soil are co-located with human health COCs and remedial activities implemented to address human health COCs will serve to reduce the concentrations and number of COECs in soil to which ecological receptors are exposed, resulting in lowered ecological risk.* As a result, ecological cleanup goals were not required. Based on the removal action subsequent to the IROD, no further action is necessary for ecological exposures to soil.

A Level I ERA was conducted for Load Line 4 to determine the presence/absence of important ecological places and resources and the presence of contamination. Perennial surface water in streams, a pond, and wetlands are important ecological resources at Load Line 4 and chemical contamination is present based on the historical ERAs. Because there is contamination and important/significant ecological resources at each of the load lines, the ERA in Appendix I continued to a Level II Screening ERA.

The Level II ERA identified procedures to determine AOC-related COIs. Data from the Phase II RI, Biological and Water Quality Study (USACE 2005a), and the FS Addendum were integrated for each load line and were evaluated separately for sediment and surface water. These ERAs used updated SRVs and ESVs that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008). The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003b). The MDC of each chemical is compared to its respective facility-wide background concentration. Wet sediment concentrations are also compared to the SRV. Chemicals are not considered site-related if the MDC is below the background concentration (or SRV for sediment). For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV. In addition to the ESV comparison, it was determined if the chemical is a PBT compound. Chemicals are retained as integrated COIs if they exceed background concentrations (and SRVs for sediment) and the ESV, if the chemical exceeds background concentrations (and SRVs for sediment) and had no toxicity information, or if the chemical is considered a PBT compound. MDC to ESV ratios are used to determine the integrated COIs that result from the combined current and historical data sets. A ratio greater than 1 suggests a possible environmental consequence. Any chemicals with ratios greater than 1 are identified as integrated COIs.

Wet sediment and surface water at Load Line 4 is divided into three EUs: Main Stream Segment, Settling Pond, and Exit Drainage. There are two integrated COIs (cadmium and nickel) in sediment at the Settling Pond and one integrated COI (PCB-1248) in sediment at the Exit Drainage. There are three integrated COIs (iron, manganese, and mercury) in surface water at the Main Stream Segment, three integrated COIs (manganese, mercury, and DDT) in surface water at the Settling Pond, and one integrated COI (manganese) in surface water at the Exit Drainage.

Technical and refinement factors were then used to refine the integrated COIs from the Level II Screening ERA. The factors included use of mean exposure concentrations, discussion of approved ESVs, and other topics. This type of assessment is Step 3A in the ERA process (USEPA 1997). Step 3A refines the list of integrated COIs to determine if: (1) there are COECs requiring further evaluation in a Level III Baseline ERA or remediation to protect ecological receptors, or (2) integrated COIs can be eliminated from further consideration. This evaluation is an important part of the Level II Screening ERA and is adapted from USEPA Step 3A, outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997) and *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010c).

For Load Line 4, the evaluation in Step 3A showed there is no further evaluation necessary for integrated COIs, and there is no ecological concern requiring remediation. Consequently, the ERA for Load Line 4 concludes that no further action is necessary to be protective of important ecological resources.

2.5 LOAD LINE 12

Load line 12 is a 76-acre former ammonium nitrate manufacturing facility that was operational from 1941–1946. From 1941–1943, explosive-grade ammonium nitrate was manufactured at Load Line 12. Munitions renovation and demilitarization operations were performed at the AOC after ammonium nitrate production was terminated in 1943. Load Line 12 was leased by the Silas Mason Company from 1946–1950 to manufacture fertilizer-grade ammonium nitrate. To improve the quality of TNT recovered from demilitarization operations, washout operations were converted to a steam melt-out process in the late 1950s. Building 900 was used for disassembly and a flashing furnace, and Buildings 904 and 905 were used for melt out operations. A pinkwater treatment plant located near Building 904 was operational from 1981–2000. From 1965–1967, Hercules Alcor, Inc. leased Building FF-19 to produce aluminum chloride. From 1969–1971, Load Line 12 produced M54 primers in support of the Southeast Asian conflict. A former steam plant located in the southern portion of the AOC used fuel oil and coal at various times over the years as fuel. Currently, there are no above-grade structures remaining at Load Line 12. Demolition of buildings occurred between 1973 and 2000. In 1999, approximately 1,500 ft^3 of soil was removed from four pits near Building 904 and taken to a former warehouse at Load Line 4 as part of an explosives composting pilot study. Surface water, wet sediment, and groundwater at Load Line 12 are being addressed under separate CERCLA decisions. This FS Addendum focuses only on soil.

Each production building formerly located at Load Line 12 is presented below with a summary of its historical use and potential contamination source description. Former production buildings are included in Table 2-21, and the non-production buildings are listed in Table 2-22. To date, all buildings and structures at Load Line 12 have been demolished. Figure 2-13 presents the Load Line 12 AOC features.

Table 2-21. Production Buildings Inventory at Load Line 12

Building ID	Purpose	Description of Potential Sources
FE-19	Neutral Liquor Building	Used to prepare granular ammonium nitrate from a neutral liquor during WWII 1941-1943, 1946-1950.
FF-19	Leased by Hercules Alcor, Inc. to produce aluminum chloride from 1965–1967 (formerly FE-19)	Building where aluminum chloride was produced from 1965–1967.
900	Evaporation/Crystallization Unit	Building where evaporation and crystallization of the neutral liquor from FE-19 occurred from 1941–1943. Demilitarization of munitions using hot water washout starting in 1949; converted to steam melt-out in late 1959–1961 and in 1973–1974.
901	Evaporation/Crystallization Unit	Building where evaporation and crystallization of the neutral liquor from FE-19 occurred from 1941–1943.
902	Evaporation/Crystallization Unit	Building where evaporation and crystallization of the neutral liquor from FE-19 occurred from 1941–1943.
903	Evaporation/Crystallization Unit	Building where evaporation and crystallization of the neutral liquor from FE-19 occurred from 1941–1943.
904	Evaporation/Crystallization Unit	Building where evaporation and crystallization of the neutral liquor from FE-19 occurred from 1941–1943; settling and filtration tank effluent was discharged from this building into ditches. Demilitarization of munitions using hot water washout starting in 1949; converted to steam melt-out in late 1959–1961 and in 1973–1974.
905	Evaporation/Crystallization Unit	Building where evaporation and crystallization of the neutral liquor from FE-19 occurred from 1941–1943. Demilitarization of munitions using hot water washout starting in 1949; converted to steam melt-out in late 1959–1961 and in 1973–1974.
906	Evaporation/Crystallization Unit	Building where evaporation and crystallization of the neutral liquor from FE-19 occurred from 1941–1943.
FN-54	Utilized for Neutral Liquor Storage and Bagging and Shipping	Building where neutral liquor from FE-19 was stored and bagged for shipping, and later utilized for cartridge case renovation from 1951–1954.

ID = Identification.
WWII = World War II.

Table 2-22. Non-production Buildings Inventory at Load Line 12

Building ID	Purpose
SD-4	Sewage Ejector Station
T-2501	Boiler House
T-4513	Sump Building
T-5201-LL12	Gate House
WH-29	Well House No. 29
WW-2	Water Works No. 2
WW-22	Elevated Water Tank
WW-2A	Filtered Water Reservoir
4-51	Time Clock Alley
FE-22	Change House
PS-5	Regulator House
FE-53	Office Building/Administration
FJ-55	Rest Room
FJ-56	Storage
FE-17	Power House No. 3
FE-17A	Pump House
FA-20	Compressor Building
FN-54	Bagging and Shipping Building
FE-52	Laboratory

ID = Identification.

2.5.1 Environmental Setting

This section provides a summary of the environmental setting of Load Line 12 as presented in the draft Phase III RI Report for Wet Sediment and Surface Water at Load Line 12 (USACE 2016) and includes surface features and site topography, geologic setting, and local hydrogeology.

2.5.1.1 Surface Features and Site Topography

Load Line 12 is situated in the southeastern quadrant of the RVAAP facility. The AOC is characterized by moderately subdued topography on a reworked sandstone bedrock surface. Elevations across the AOC vary from approximately 296 m to 301 m (970 ft to 987 ft) amsl. In general, land slopes from slightly elevated areas east and southwest of the AOC toward the main process area from either side. Along the axis of the AOC, slope is to the north toward Cobbs Pond. A low, marshy area is present on the western portion of the AOC, adjacent to Buildings 904, 905, and 906.

Former production infrastructure features at Load Line 12 consist mainly of gravel access roads, man-made ditches, sanitary sewer lines, manholes, and remnants of floor slabs. No above-grade structures remain at Load Line 12. Surface soil was highly disturbed during demolition activities that occurred between the Phase I and II RIs. In addition, a former blast berm at Building 903 was removed and placed as fill around portions of Buildings FE-17 and 903. Although rails and rail ties have been removed, the rail beds of three main tracks that traverse the site from north to south and several secondary tracks are still present with their ballast of industrial slag.

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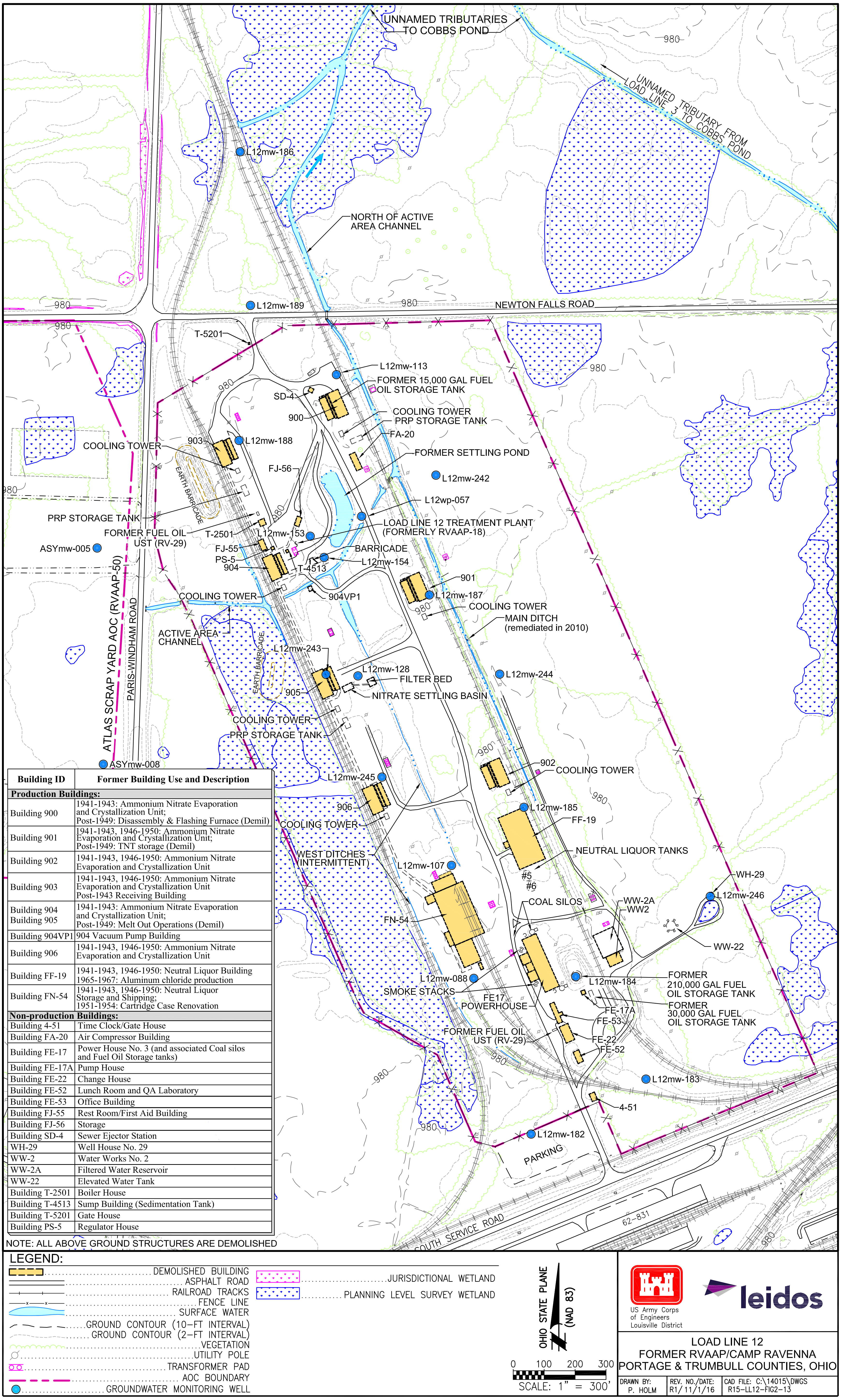

Building ID	Former Building Use and Description
Production Buildings:	
Building 900	1941-1943: Ammonium Nitrate Evaporation and Crystallization Unit; Post-1949: Disassembly & Flashing Furnace (Demil)
Building 901	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit; Post-1949: TNT storage (Demil)
Building 902	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit
Building 903	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit Post-1943 Receiving Building
Building 904 Building 905	1941-1943: Ammonium Nitrate Evaporation and Crystallization Unit; Post-1949: Melt Out Operations (Demil)
Building 904VP1	904 Vacuum Pump Building
Building 906	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit
Building FF-19	1941-1943, 1946-1950: Neutral Liquor Building 1965-1967: Aluminum chloride production
Building FN-54	1941-1943, 1946-1950: Neutral Liquor Storage and Shipping; 1951-1954: Cartridge Case Renovation
Non-production Buildings:	
Building 4-51	Time Clock/Gate House
Building FA-20	Air Compressor Building
Building FE-17	Power House No. 3 (and associated Coal silos and Fuel Oil Storage tanks)
Building FE-17A	Pump House
Building FE-22	Change House
Building FE-52	Lunch Room and QA Laboratory
Building FE-53	Office Building
Building FJ-55	Rest Room/First Aid Building
Building FJ-56	Storage
Building SD-4	Sewer Ejector Station
WH-29	Well House No. 29
WW-2	Water Works No. 2
WW-2A	Filtered Water Reservoir
WW-22	Elevated Water Tank
Building T-2501	Boiler House
Building T-4513	Sump Building (Sedimentation Tank)
Building T-5201	Gate House
Building PS-5	Regulator House

NOTE: ALL ABOVE GROUND STRUCTURES ARE DEMOLISHED

Figure 2-13. Load Line 12 AOC Features

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At the time of Phase II RI field operations, demolition activities had been recently completed and the main process areas were disturbed, seeded, and strawed. Thus, the main process area was poorly vegetated. In 2003, after two growing seasons, vegetative cover has recovered to a large degree. The non-production areas to the east and west of the main process area are characterized by scrub vegetation and immature hardwoods. The area north of the production area is characterized by mature hardwood forest and extensive wetland areas along the principal drainage areas, particularly north of the AOC near Upper Cobbs Pond.

2.5.1.2 Geologic Setting of Load Line 12

Subsurface characterization at Load Line 12 during the Phase I and II RIs was limited to the unconsolidated zone. The most thorough characterization was performed by installing six test trenches to depths of 4.9 m (16 ft) around the periphery of the AOC and by continuous sampling during the drilling of piezometers and monitoring wells. Several soil sampling stations also extended to depths of 1.8 m (6 ft); descriptions of soil types from these hand borings were also used to characterize the shallow subsurface soil interval. Core holes into bedrock were not drilled during the Phase II RI. Five monitoring wells did penetrate the uppermost portion of the bedrock interval, ranging from 0.3 to 0.64 m (1 to 2.1 ft); therefore, a minimal amount of data exists for depth to bedrock and bedrock stratigraphy at the AOC.

Soil

At Load Line 12, soil of the Trumbull series was dominant prior to substantial reworking of the surface during demolition activities. The Trumbull series soil is deep, poorly drained, and occurs on nearly level terrain. Permeabilities typically are low (less than 0.15 cm [0.06 inches] per hour), and the soil remains saturated with water for long periods in winter, spring, and summer. Ponding is common after heavy rains. This soil series is found mainly along small drainage features or in low-lying areas adjacent to Mahoning or Resmen series soil in areas less than 4 ha (10 acres) (USDA 1978). Soil of the Mahoning series also exists north of the AOC in the Upper Cobbs Pond drainage area. This series is typified by poorly drained soil formed in silty clay loam or clay loam glacial till where bedrock is generally greater than 1.8 m (6 ft). Runoff is typically medium to rapid, and the soil is seasonally wet. Permeabilities range from 1.52 to 5.08 cm (0.6 to 2.0 inches) per hour.

Based on current site conditions, surface soil varies widely in character from one area to another due to site disturbance. As noted in the boring logs of the Phase II RI Report, for hand-augered soil sampling stations, areas of fill remaining in the areas that were substantially reworked during construction and demolition of the load line include sandy fill, sand, ballast material, and slag. Small pieces of residual debris (e.g., metal, brick, concrete) exist at the ground surface in many areas, especially in the vicinity of former buildings; however, silty clays and silty sands dominate in the near surface interval. In comparatively undisturbed areas where some test pits were excavated, the surface soil interval consisted of a light olive brown (5YR5/6) to light olive gray (5Y5/2) mottled, clayey silt to silty clay. The permeabilities of soil in the near-surface interval were measured in the laboratory from Shelby tube samples collected from depths ranging from ground surface to 1.52 m (5.0 ft). The permeability values range from 3.3×10^{-7} cm/sec to 7.3×10^{-9} cm/sec (3.02×10^{-3} to 6.67×10^{-5} inches/hour) in the upper portions of the unconsolidated interval at a depth of less than

1.52 m (5 ft). In the deeper portions of the unconsolidated interval, permeabilities ranged from 8.7×10^{-6} cm/sec to 3.0×10^{-8} cm/sec (7.96×10^{-2} to 2.74×10^{-4} inches/hour) at depths from 2.6 to 9.7 m (8.5 to 31.7 ft).

Test pits, piezometer borings, and monitoring well borings provide the general geologic characteristics noted below for the unconsolidated zone (from shallow to deep stratigraphic zones).

At depths beginning at about 0.5 to 1.0 m (1.5 to 3.3 ft), based on test pit and boring data, unconsolidated deposits consist primarily of a yellowish-brown (10YR5/4), mottled, silty clay to clayey silt. This interval typically has a firm to hard consistency, low plasticity, and is dry to moist. Hand penetrometer readings were as high as 4.5 tons/ft. Occasional intervals containing fine to coarse subrounded, flat, siltstone, and shale gravel (up to 5 cm [2 inches]) were observed in some areas. In test pit 2, an interval encountered at a depth of 1.2 m (4 ft) contained sandstone cobbles and boulders up to 0.3 m (1 ft) in diameter. An interval containing coarse material up to cobble-size was also encountered in test pit 3 from a depth of 2.4 to 3.3 m (8 to 11 ft). Seepage of groundwater was observed from this interval.

At depths between 2.7 and 4.0 m (9.0 and 13 ft), a contact with the zone described above and a light olive gray (5Y6/1) to medium dark gray (N5), uniform, moist to wet, soft to very soft, elastic silt to silt clay was observed. This silt was typically medium plastic and exhibited rapid dilatency. Rare coarse material up to cobble size was observed in some areas, and occasional sand lenses and beds were encountered. The contact with the overlying zone was usually sharp, with the exception of test pits 4 and 6, where a more gradual transition was observed that exhibited mottling or lensing of the materials comprising the overlying and underlying zones.

Beneath the uniform, gray silt clay interval, a thin very dark gray (2.5Y3/1) to black (5Y2.5/1) silt clay to sandy clay was encountered. This stratigraphic zone was encountered at depths ranging from 9.3 m (30.5 ft) in the southern portion of the AOC to 4.7 m (15.5 ft) north of the AOC. This silty to sandy clay was observed only in piezometer and monitoring well borings because test pits were not excavated to sufficient depths to encounter it. This material contains shale fragments and directly overlies bedrock.

A thin, medium- to coarse-grained sand with some gravel was observed at fairly consistent depth in several piezometer and monitoring wells borings including:

- 8.8 to 9.3 m (29 to 30.5 ft) in L12mw-182,
- 7.7 to 8.4 m (25.3 to 27.5 ft) in L12mw-107,
- 7.7 to 7.8 m (25.4 to 25.7 ft) in P4;,7.8 to 8.2 m (25.5 to 26.8 ft) in P5,
- 8.1 to 8.4 m (26.7 to 27.6 ft) in P6,
- 7.1 to 7.7 m (23.3 to 25.3 ft) in L12mw-154, and
- 5.6 to 5.7 m (18.0 to 18.8 ft) in P9.

Five of the seven borings in which this sand was encountered are in the central portion of the AOC and coincide with an area of low potentiometric head levels observed in this same. Although a definitive correlation cannot be made, the assumed higher permeabilities of this sand may result in a groundwater flow pathway (sink) directing flow from the central portion of the AOC to the east-northeast.

Bedrock Geology

The bedrock formation underlying the unconsolidated deposits at Load Line 12, as inferred from existing geologic data, is the Pennsylvanian-age Pottsville Formation, Sharon Shale Member. The shale unit of the Sharon member (informally referred to as the Sharon Shale) is a light- to dark-gray fissile shale, which has been eroded in many locations. Bedrock was encountered at depths ranging from 17 ft bgs in the north end of the AOC and greater than 34 ft bgs in the southern portion of the AOC in monitoring wells installed throughout Load Line 12.

Load Line 12 is located within Hiram Till glacial deposits. At Load Line 12, unconsolidated zone characteristics may vary in character due to AOC disturbances, including building construction, demolition, and re-grading. The two soil types found at the AOC are the Trumbull silt loam (0-2%), which is present across the western 70% of Load Line 12, and the Mahoning silt loam in the central eastern portion. The Trumbull silt loam is gently sloping, poorly drained soil formed in silty clay glacial till. The Trumbull silt loam is present as depressional landforms where the water table is close to ground surface and generally where bedrock is greater than 6 ft bgs. Runoff is typically medium to rapid, and the soil is seasonally wet (USDA 2010). Mahoning silt loam is a gently sloping, poorly drained soil formed in silty clay loam or clay loam glacial till, generally where bedrock is greater than 6 ft bgs. The Mahoning silt loam has low permeability, with rapid runoff and seasonal wetness.

Borings associated with L12 mw-183, P9, P10, L12mw-153, L12mw-113, L12mw-189, L12mw-186, and L12mw-188 encountered shale bedrock. Bedrock was observed to be a black (5Y2.5/1), dry, fissile, shale consistent with the lithology of the Sharon Shale.

2.5.1.3 Load Line 12 Hydrologic/Hydrogeologic Setting

Fourteen groundwater monitoring wells were installed at Load Line 12 during the Phase II RI, and five groundwater monitoring wells were installed as part of the Characterization of 14 AOCs. Monitoring wells at the AOC ranged in completion from 18.5 to 36.1 ft bgs. Depth to groundwater at Load Line 12 ranges from 3.25 to 18.21 ft below top of casing. Although some wells are completed in bedrock, all monitoring wells at Load Line 12 were installed to monitor groundwater in the unconsolidated zone. Two additional unconsolidated monitoring wells, L12mw-182ss and L12mw-247, were installed under the FWGWMP in 2012 (EQM 2015).

All monitoring well groundwater elevations were collected under the FWGWMP. The estimated direction of groundwater flow at the AOC indicates a complex flow environment, with multiple localized flow environments. Water level elevations at the AOC range from 966.35 to 976.53 ft amsl, with highest elevations generally occurring in the northern and southwestern portions of the AOC. Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. Overall groundwater flow in the vicinity of Load Line 12 is to the central portion of the AOC, and an east to west groundwater flow divide exists in the northern quadrant of Load Line 12 near former Buildings 903 and 900. Groundwater north of the divide flows to the north, and groundwater south of the divide flows to the south. A potentiometric low exists in the center of the AOC that causes groundwater to converge near Buildings 901 and 905 where groundwater ultimately flows to the east. Groundwater within the vicinity of L12mw-245 flows west toward the western boundary of Load Line 12. There is also a north to south trending groundwater divide or potentiometric high in the southwestern quadrant of the AOC near L12mw-182 and L12mw-088, causing radial flow to the north and east/southeast away from the southwestern boundary of Load Line 12. Groundwater discharge to surface water features (e.g., via base flow to the backwater area of Upper and Lower Cobbs Ponds) occurs outside the AOC boundary. Surface water exits the AOC via the Main Ditch that intersects the Active Area Channel, north of Load Line 12, surface water flows into the Upper and Lower Cobbs Ponds AOC. The average hydraulic gradient at the AOC is 0.0046ft/ft.

Results of slug tests performed at 14 monitoring wells during the Phase II RI in November 2000 and 5 monitoring wells (wells L12mw-242 to L12mw-246) during the Characterization of 14 AOCs in January–February 2005 indicate an average hydraulic conductivity of 5.64E-05 cm/s for the monitoring wells at Load Line 12 (USACE 2004d, MKM 2007).

The primary surface water conveyance enters from the west through a culvert that conveys drainage from Atlas Scrap Yard. This conveyance, termed the Active Area Channel, traverses Load Line 12 from west to east, flows immediately south of the former Building 904, and intersects the primary north-south drainage ditch between the locations of former Buildings 900 and 901. The Former Settling Pond exists east of the former location of Building 904. This pond is approximately 50 by 250 ft and is linked to the Active Area Channel via an overflow pipe.

The primary north-south drainage feature (Main Ditch) originates near former Building FF-19 and flows north until its intersection with the Active Area Channel. From that point, the Active Area Channel flows north until exiting the AOC under Newton Falls Road, into the North of Active Area. From the North of Active Area, surface water flows into the Backwater Area of the Upper and Lower Cobbs Ponds AOC (RVAAP-29). Another tributary that drains portions of Load Line 3 joins the tributary draining the North of Active Area into the headwaters (Backwater Area aggregate) of the Upper and Lower Cobbs Pond AOC.

A number of ditches, collectively termed the West Ditches, exist throughout the former production area near former process buildings. Surface water flow in the Main Ditch (above the intersection with the Active Area Channel) and West Ditches is intermittent and driven primarily by storm events. These ditches serve as the storm runoff control system. No below-grade storm drain system was constructed at Load Line 12. When the sanitary sewer system was operational, the sanitary sewer overflow outfall would have occasionally discharged to the Main Ditch at times that the ejector station (Building SD-4) was not functioning or was overloaded. After the ejector station was shut down, but before its demolition, all drainage through the sanitary sewer would have flowed freely through the sanitary overflow outfall associated with the ejector station.

2.5.2 Co-located or Proximate Sites

The following subsections summarize sites that are co-located or proximate to Load Line 12 but are addressed separately.

2.5.2.1 Facility-wide Sewers

The defunct sanitary sewers within the perimeter of Load Line 12 are being investigated and assessed as part of the Facility-wide Sewers AOC (RVAAP-67). Storm sewers are not present at Load Line 12. Sanitary sewer sediment, pipe bedding material, and sewer water were evaluated as currently summarized in the *Draft Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-wide Sewers* (USACE 2012a). The sanitary sewers in the Load Line 12 FA were part of the Sand Creek Sewage Treatment Plant Network. Demolition activities at former Load Line 12 impacted numerous sewer structures, especially those associated with shallow storm sewers adjacent to buildings and walkways.

Sewer water and sediment samples were collected during the Phase II RI (USACE 2004e); limited video surveys were conducted. Inspections and explosives field screening tests were conducted at the Load Line 12 FA during a 2007 *Summary of CERL Findings, RVAAP Sewer System (*USACE-CERL 2007) and the *Explosive Evaluation of Sewers* (LES 2007a). Both studies collected wipe samples of sewer line inverts for analysis of explosive residues, using field test kit methods (e.g., Expray® 24 and DropEx).

All SRCs found in sewer media samples and evaluated through the stepwise fate and transport screening evaluation were eliminated as posing future impacts to groundwater. The HHRA did not identify a complete exposure pathway for any receptor, and no further action was recommended from an ecological perspective. In summary, the Facility-wide Sewers RI recommended no further action for the Load Line 12 sanitary sewers.

2.5.2.2 Facility-wide Groundwater

As part of the IRP, the Army implements the FWGWMP in accordance with previous agreements made with Ohio EPA. The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP.

In 2015, for the FWGWMP, groundwater samples were collected from the five monitoring wells associated with Load Line 12. Organic constituent concentrations were below site-specific screening levels. Inorganics (arsenic, cobalt, iron, manganese) were detected at concentrations greater than site-specific screening levels at all five monitoring well locations.

Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at Load Line 12 will be addressed as part of that facility-wide AOC.

2.5.2.3 <u>Munitions Response Sites</u>

An SI was conducted at the Load Line 12 (RVAAP-012-R-01) MRS, located within Load Line 12, and concluded no further action was required.

2.5.2.4 <u>Compliance Restoration Sites</u>

UST RV-29 at Building FE-22 and UST RV-73 at Building T-2501 are covered under site CC-RVAAP-72 Facility-wide USTs. No further action is warranted based on the recommendation in the RI for CC-RVAAP-72 Facility-wide USTs (USACE 2015c).

The facility-wide coal storage site, the Power House No. 3, was assessed under site CC-RVAAP-73 as part of the Coal Sites AOC in the HRR (USACE 2011a). As indicated in the HRR, evaluation of the historical data in soil at this site will be addressed in a future CERCLA action and therefore is included in this FS Addendum.

2.5.3 Previous Investigations, Decisions, and Actions

Since 1978, Load Line 12 has been the subject of multiple investigations and/or assessments leading to CERCLA decisions and/or remedial actions at the AOC. The Preliminary Assessment conducted in 1996 concluded that Load Line 12 was a high-priority AOC for future environmental investigations due to primary contaminant release mechanism from process effluent discharges to surface water, sediment, and surface soil. Subsequently, a Phase I RI was conducted and recommended additional investigation in a Phase II RI due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC. During the Phase II RI, a total of 272 environmental samples were collected to determine the nature and extent of surface soil contamination at Load Line 12. Based on the results of the human health and ERAs, Load Line 12 was recommended for further evaluation in an FS.

The *Feasibility Study for Load Line 12 (RVAAP-12)* (herein referred to as the FS) (USACE 2006) presented the remedial alternatives for soil and dry sediment at Load Line 12. Excavation with off-site disposal for the National Guard Trainee FWCUG was recommended to address surface soil, subsurface soil, and dry sediment contamination at Load Line 12. Dry sediment at the Load Line 12 Main Ditch was the only area to be remediated for soil and dry sediment. Previous sample locations and previous remediation areas are presented in Plates 2-9 and 2-10 (located at the end of this section).

Remedial action excavation activities occurred at Load Line 12 in June 2010. A total of 1,212 tons of non-hazardous material were excavated and transported off site for disposal. After completing excavation activities, confirmation ISM samples were collected from the excavation footprint. Laboratory results for all confirmation samples indicated that cleanup goals specified in the ROD had been achieved and no additional removal was required (USACE 2010d).

Additional characterization sampling was completed at Load Line 12 to guide future remedial and administrative measures. The samples collected as part of this investigation helped eliminate data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010a). Two ISM samples were collected in 2009 and eight samples were collected in 2011 at Load Line 12 to further refine previous discrete sample areas that had levels of PAHs above FWCUGs utilized in the *Land Use Control Assessment Report* (USACE 2010a). This investigation concluded that all eight areas exceeding FWCUGs were not fully delineated for PAHs and RVAAP full-suite chemicals (USACE 2013).

A Phase III RI was conducted to address wet sediment and surface water at Load Line 12. At Load Line 12, surface water and sediment is currently being evaluated under another contract; therefore, additional evaluation in this FS Addendum was not required and those media apart from soil will not be detailed in this section.

A data gap analysis was conducted during the PBA13 SAP Addendum and determined additional samples for soil were unnecessary given the spectrum and density of existing ISM and discrete data available for soil.

CERCLA activities completed at Load Line 12 are presented in the timeline illustrated in Figure 2-14, and additional details related to the previous investigations are provided in Appendix A.

2.5.4 Data Assembly and Use Assessment – Load Line 12

All data collected at Load Line 12 were extracted from the REIMS database. This includes data from investigations summarized in the following reports:

- Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 through 4 and 12 (USACE 2013),
- Remedial Design for RVAAP-12 Load Line 12 (USACE 2009d),
- Remedial Action Report for the RVAAP-12 Load Line 12 (USACE 2010d), and
- Phase II RI Report for the Load Line 12 (USACE 2004e).

A data use assessment was conducted by reviewing all data to ensure that the medium sampled is still present and has not been removed during remediation and the data approved for use meet the DQOs. The data from investigations summarized in the following reports were not used in this FS Addendum:

- *Phase I Remedial Investigation Report for the Phase I Remedial Investigation of High Priority Areas of Concern* (USACE 1998) – These data are more than 16 years old and are no longer considered representative of the site (e.g., buildings and slabs have been removed and/or remediated).
- Phase III RI Report for Wet Sediment and Surface Water at RVAAP-12 Load Line 12 (USACE 2016) – These data are addressed in a separate report.

Once the data were assembled and evaluated for use, COIs were identified specific to Load Line 12 media.

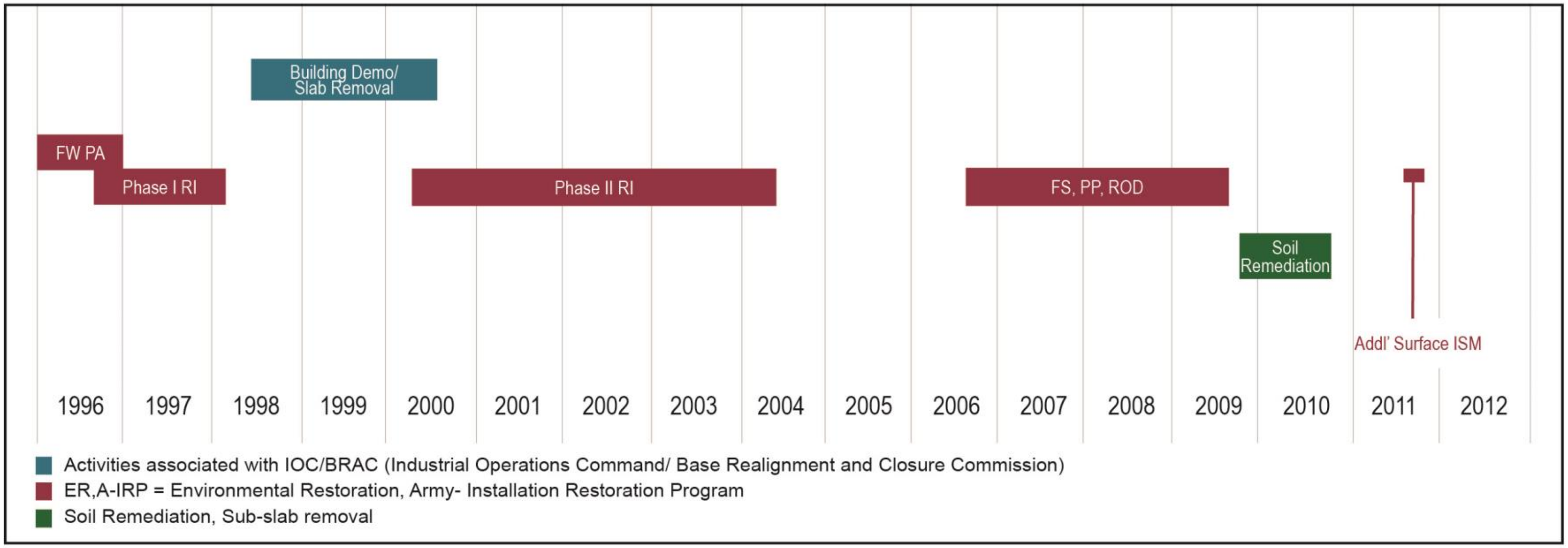

Figure 2-14. Timeline of Remedial Activities at Load Line 12

2.5.5 Load Line 12 Conceptual Site Model

The CSM is a site-specific, systematic planning tool. It provides a concise summary of residual contamination distribution, exposure pathways, migration routes, and assessment of the affects to human health and ecological receptors that supports development of RAOs and the FS. A graphical depiction of the CSM is presented in Figure 2-15. The following sections summarize the COIs identified in soil, surface water, and sediment, and provide results of the fate and transport analysis, HHRA, and ERA.

2.5.5.1 Load Line 12 COIs

The following sections include the soil evaluation for Load Line 12. The soil leaching evaluation is also presented.

Load Line 12 COIs were developed from the chemicals identified as exceeding residential risk targets in the Phase II RI (USACE 2004e). Load Line 12 COIs for exposure of Resident Receptor (Adult and Child) to soil are shown in Table 2-23. The list of COIs shown in Table 2-23 is longer than the list of COCs included in the ROD (USACE 2009a) because the ROD focused on only the National Guard Trainee Receptor and soil.

Table 2-23. COIs in Soil at Load Line 12

	Load Line 12
COI	**Soil**
Metals	
Arsenic	X
Explosives	
2,4,6-TNT	X
2,6-DNT	X
RDX	X
PCBs	
PCB-1260	X
Pesticides	
Dieldrin	X
PAHs	
Benz(a)anthracene	X
Benzo(a)pyrene	X
Benzo(b)fluoranthene	X
Dibenz(a,h)anthracene	X
Indeno(1,2,3-cd)pyrene	X

COI = Chemical of Interest.
DNT = Dinitrotoluene.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TNT = Trinitrotoluene.
X = COI Present in Medium.

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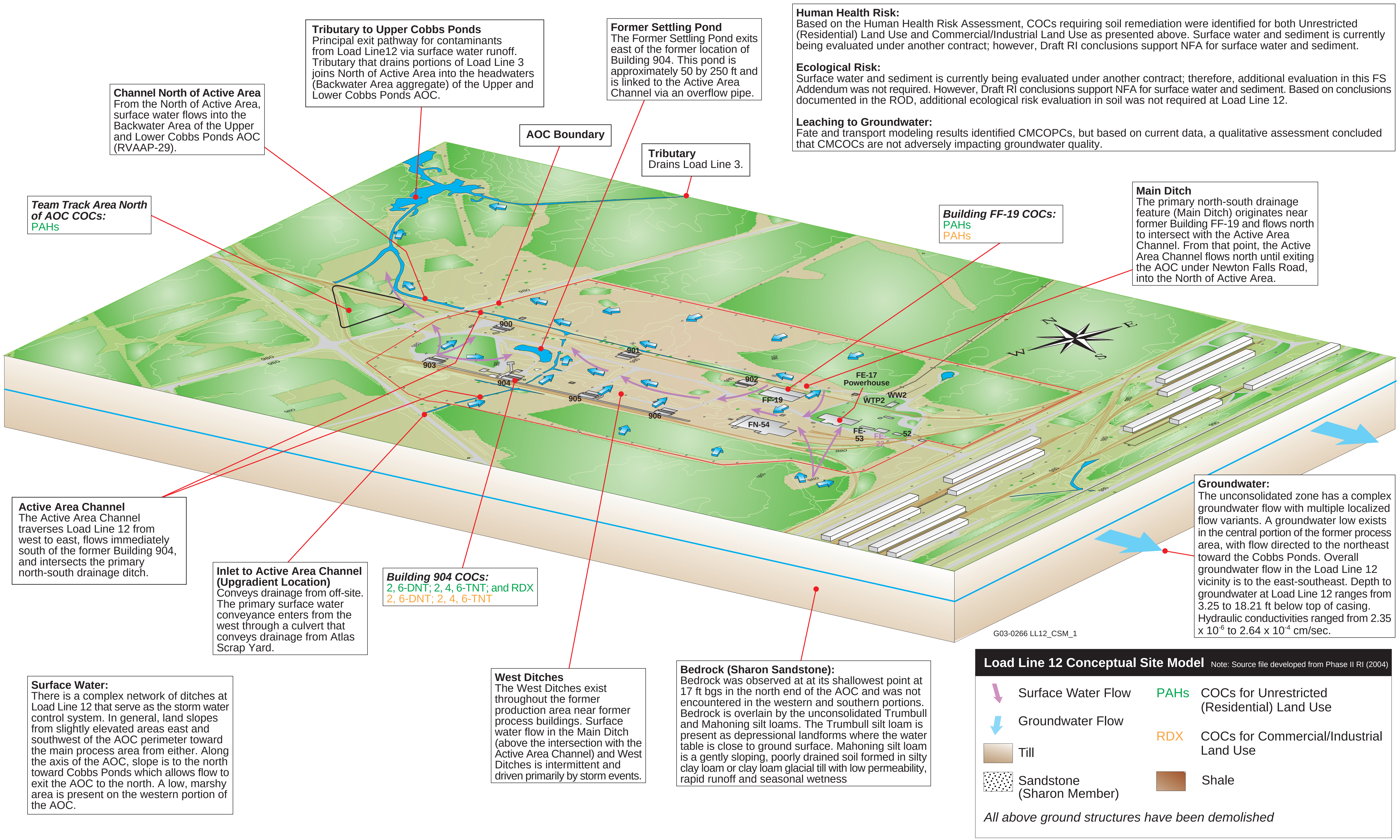

Figure 2-15. Load Line 12 Conceptual Site Model

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2.5.5.2 Fate and Transport

The details of the fate and transport analysis conducted to assess the potential for COIs to leach from surface soil and subsurface soil (defined as soil leaching COIs) at Load Line 12 and impact groundwater beneath the source and at a nearest downgradient receptor location are presented in Appendix G. A summary of the analyses is presented in this section.

Mainly organic COIs (1,3-dinitrobenzene; 2,4-DNT; 2,6-DNT; 3-nitrotoluene; 4-nitrotoluene; nitrobenzene; and RDX) were identified in surface and subsurface soil at the AOC in this FS Addendum. These soil leaching COIs were further evaluated to determine if residual concentrations in surface and subsurface soil may potentially impact groundwater quality and warrant evaluation in an FS. All the soil leaching COIs at the AOC were evaluated through the stepwise fate and transport evaluation that included leachate modeling in the unsaturated zone using the SESOIL model and lateral transport modeling in the saturated zone using the AT123D model.

If the predicted maximum leachate concentration of a COI was lower than the screening criteria, the chemical was eliminated from further evaluation using AT123D modeling. For the remaining COIs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as RVAAP FWCUGs for the Resident Receptor Adult, MCLs, and RSLs. Only the COIs with predicted maximum concentration higher than its facility-wide background concentration, and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), were retained as CMCOCs. These CMCOCs were evaluated with respect to WOE for retaining or eliminating CMCOCs from further consideration as a basis for potential soil remedial actions.

The evaluation of modeling results with respect to current groundwater data for the AOC and model limitations identified the following CMCOCs at Load Line 12:

- The soil leaching COIs (1,3-dinitrobenzene; 2,4-DNT; 2,6-DNT; 3-nitrotoluene; nitrobenzene, and RDX) were predicted to exceed the screening criteria in groundwater beneath the source; however, none of these COIs were predicted to be above criteria in the downgradient receptor location.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if the soil leaching COIs (1,3-dinitrobenzene; 2,4-DNT; 2,6-DNT; 3-nitrotoluene; nitrobenzene; and RDX) at the AOC may impact the groundwater beneath the source or at the downstream receptor location.

1,3-Dinitrobenzene – The maximum soil concentration for 1,3-dinitrobenzene (0.032 mg/kg at LL12so-120-0510) was below its residential soil RGO, and 1,3-dinitrobenzene was not identified as a soil COC in the HHRA. 1,3-Dinitrobenzene modeling results using this maximum concentration indicate groundwater concentrations beneath the source area could potentially exceed its RSL in less than 40 years with peak concentration occurring at approximately 100 years; 1,3-dinitrobenzene was not detected in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). In addition, the maximum predicted 1,3-dinitrobenzene groundwater concentration at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and 1,3-dinitrobenzene would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

2,4-DNT – The maximum soil concentration for 2,4-DNT (0.17 mg/kg at LL12so-120-0510) was below its residential soil RGO. 2,4-DNT modeling results using this maximum concentration indicate groundwater concentrations beneath the source area could potentially exceed its RSL in less than 100 years with peak concentration occurring at approximately 100 years; 2-4-DNT was not detected above its RSL in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). In addition, the maximum predicted 2,4-DNT groundwater concentration at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and 2,4-DNT would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

2,6-DNT – The maximum surface soil concentration for 2,4-DNT (1.7 mg/kg at LL12ss-143-0553) was below its residential soil RGO. 2,6-DNT modeling results using this maximum concentration indicate groundwater concentrations beneath the source area could potentially exceed its RSL in less than 100 years with peak concentration occurring at approximately 100 years; 2,6-DNT was not detected above its RSL in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). In addition, the maximum predicted 2,6-DNT groundwater concentration at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and 2,6-DNT would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

3-Nitrotoluene – The maximum surface soil concentration for 3-nitrotoluene (0.2 mg/kg at LL12ss-236-0695) was below its residential soil RGO, and 3-nitrotoluene was not identified as a soil COC in HHRA. The modeling estimates that 3-nitrotoluene concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 25 years or less with peak concentrations occurring at approximately 50 years or less; the maximum predicted 3-nitrotoluene groundwater concentration at the downgradient receptor location is also expected to be above its RSL (Appendix G, Table G-15). Based on the AOC period of operations, 3-nitrotoluene should have already been detected in groundwater; however, 3-nitrotoluene was not detected in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and 3-nitrotoluene would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

Nitrobenzene – The maximum soil concentration for nitrobenzene (0.12 mg/kg at LL12so-059-0374) was below its residential soil RGO, and nitrobenzene was not identified as a soil COC in the HHRA. The modeling estimates that nitrobenzene concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 25 years or less with peak concentrations occurring at approximately 50 years or less however, the maximum predicted nitrobenzene groundwater; concentration at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). Based on the AOC period of operations, nitrobenzene should have already been detected in groundwater; however, nitrobenzene was not detected in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and nitrobenzene would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

RDX – The maximum soil concentration for RDX (21 mg/kg at LL12so-143-0554) at a depth interval of 1 to 3 ft bgs was below its residential soil RGO. The modeling estimates that RDX concentrations in groundwater beneath the source areas could potentially exceed its RSL at about 5 years or less with peak concentrations occurring at approximately 25 years or less; however, the maximum predicted RDX groundwater concentration at the downgradient receptor location is expected to be below its RSL (Appendix G, Table G-15). Based on the AOC period of operations, RDX should have already been detected in groundwater exceeding its RSL; however, RDX was not detected above its RSL in the AOC groundwater samples collected from 2011–2015 (Appendix G, Table G-15). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and RDX would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

Conclusion –This qualitative assessment concludes that the soil contaminants identified as CMCOCs for evaluation are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts for the AOC groundwater beneath the source and at the downgradient receptor location. Potential additional investigation under the Facility-wide Groundwater AOC may be warranted for the AOC, but based on the fate and transport evaluation, CMCOCs were not identified for Load Line 12, and no further action is required for soil to be protective of groundwater for the AOC.

2.5.5.3 Human Health Risk Assessment Results

The HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to residual contamination in soil, sediment, and surface water at Load Line 12. The approach to risk-based decision making is as follows:

RGOs were compiled for the COIs identified in Section 2.5.5.1. RGOs for Unrestricted (Residential) Land Use are the USEPA Residential RSLs for soil (used for soil and sediment) and tap water (used for surface water) published in May 2016. RSLs for the cancer endpoint were adjusted to correspond to a TR of 1E-05, RSLs for the non-cancer endpoint were used at a target HQ of 1. RGOs for Commercial/Industrial Land Use are the USEPA Industrial RSLs for soil adjusted for a TR of 1E-05 and target HQ of 1. Industrial RSLs are not available to evaluate surface water or sediment because Industrial/Commercial activities are not applicable to surface water (i.e., exposure of industrial and commercial workers is not anticipated for these media). The potential impact of the lack of screening values is addressed in the uncertainty assessment using Industrial RSLs calculated with the on-line USEPA RSL calculator assuming an Industrial Receptor might wade into shallow water bodies. At

Load Line 12 media were previously remediated for COCs that exceeded cleanup goals established for the National Guard Trainee; therefore, this FS Addendum only evaluates the Resident Receptor (Adult and Child) and the Industrial Receptor.

The methodology of comparing COI exposure concentrations to RGOs and determining COCs generally follows guidance presented in the Position Paper for Human Health Cleanup Goals (USACE 2012b) and Technical Memorandum (ARNG 2014) and includes calculating an SOR for all non-carcinogenic and carcinogenic COIs. The EPC for each EU was compared to RGOs. COIs are identified as COCs for a given receptor if:

- The EPC exceeds the most stringent RGO for either the 1E-05 target cancer risk or the 1 target HQ; or
- The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than 1; chemicals contributing at least 5% to an SOR greater than 1 are also considered COCs.

Metals present at concentrations consistent with naturally occurring background concentrations are not identified as COCs.

The results of the COC screening are combined with the results of the uncertainty assessment to identify COCs to be carried forward for remediation. Details of the screening process and identification of COCs recommended for remediation are provided in Appendix H.6. Detailed figures depicting contaminant distribution and results of screening assessments are provided in Figures H.6-1 through H.6-4 in Appendix H. The COCs to be carried forward for potential remediation are summarized below for Unrestricted (Residential) and Industrial Land Use:

- Unrestricted (Residential) Land Use – Explosives (2,6-DNT; 2,4,6-TNT; and RDX), PCB-1260, and PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene) were identified as COCs to be carried forward for potential remediation at Load Line 12. The COCs recommended for remediation are summarized by area below:
  - Building 904 – 2,6-DNT; 2,4,6-TNT; and RDX.
  - Building FF-19 – 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).
  - Team Track Area North of AOC – Five PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; dibenz[a,h]anthracene; and indeno[1,2,3-cd]pyrene).
- Industrial Land Use – Explosives (2,6-DNT; 2,4,6-TNT), PCB-1260, and PAHs (benz[a]anthracene benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene) were identified as COCs to be carried forward for potential remediation at Load Line 12. The COCs recommended for remediation are summarized by area below:
  - Building 904 – 2,6-DNT and 2,4,6-TNT.
  - Building FF-19 – PCB-1260 and four PAHs (benz[a]anthracene; benzo[a]pyrene; benzo[b]fluoranthene; and dibenz[a,h]anthracene).

COCs identified for potential remediation at Load Line 4 are summarized in Tables 2-24 and 2-25.

2.5.5.4 Ecological Risk Assessment Results

An ERA was not conducted for Load Line 12 in this FS Addendum. At Load Line 12, surface water and sediment are currently being evaluated under another contract; therefore, additional evaluation in this FS Addendum was not required. Soil was evaluated for ecological receptors at Load Line 12 during the initial RI. As concluded in the Final ROD at Load Line 12, remediation to meet human health cleanup goals would reduce overall contaminant concentrations and ecological risk. As a result, ecological cleanup goals were not required.

The Final ROD at Load Line 12 concluded: *The ecological risk assessment for LL12 evaluated risk to plants and animals from contaminants in soil, surface water, and wet sediment. Contaminants of ecological concern identified for these media include metals, one explosive compound, pesticides, and SVOCs. The FS (USACE 2006) presents a weight-of-evidence evaluation that no quantitative ecological cleanup goals be developed at LL12. This weight-of-evidence includes field survey results showing the existing ecosystem is healthy with abundant surrounding high-quality habitat. Remediation to meet human health cleanup goals will reduce overall contaminant concentrations and ecological risk* (USACE 2009a).

Based on conclusions documented in the ROD, additional ecological risk evaluation in soil was not required at Load Line 12.

Table 2-24. Summary of Human Health COC Concentrations and Conclusions for Unrestricted (Residential) Land Use at Load Line 12

				COC										Conclusion for Unrestricted (Residential) Land Use
				Explosive			PAH					PCB		
Residential RGO				36	3.6	61	1.6	0.16	1.6	0.16	1.6	2.4		
Sample ID	Date	Depth (ft)	Station	2,4,6-TNT	2,6-DNT	RDX	B(a)A	B(a)P	B(b)F	DA	IP	PCB-1260		
Building 904 EU														
Surface Soil (0–1 ft bgs)				1400	1.7[a]	--	--	0.27[b]	--	--	--	--		Remediate
Subsurface Soil (1–13 ft bgs)				65	1.5[a]	21[a]	0.18[a,b]	0.16[a,b]	0.22[a,b]	--	--	--		Remediate
Building 906 EU														
Surface Soil (0–1 ft bgs)				--	--	--	0.78[a]	0.74	2.2	0.15[a]	0.60[a]	--		NFA
Subsurface Soil (1–13 ft bgs)														
Building 906 ISM Samples														
L12ss-305M-0001-SO	06/26/11	0.0 - 1.0	L12ss-305M	--	--	--	1.6[a]	0.93	2.4	ND	0.72[a]	--		NFA
L12ss-306M-0001-SO	06/26/11	0.0 - 1.0	L12ss-306M	--	--	--	0.87[a]	0.67	0.91[a]	0.14[a]	--	--		NFA
Building FE-17 EU														
Surface Soil (0–1 ft bgs)														
Subsurface Soil (1–13 ft bgs)				--	--	--	0.57[a]	0.3	0.37[a]	--	--	--		NFA
Building FF-19 EU														
Surface Soil (0–1 ft bgs)				--	--	--	24.3	20.9	23.5	3.2	11.7	8.2		Remediate
Subsurface Soil (1–13 ft bgs)				--	--	--	6.5	5.8	7.3	0.87	3.7	--		Remediate
Building FF-19 ISM Samples														
L12ss-300M-0001-SO	07/03/11	0.0 - 1.0	L12ss-300M	--	--	--	5	4.5	5.2	0.75	2.6	--		Remediate
L12ss-303M-0001-SO	06/26/11	0.0 - 1.0	L12ss-303M	--	--	--	9.7	7.7	11	1.4	4	--		Remediate
L12ss-304M-0001-SO	06/26/11	0.0 - 1.0	L12ss-304M	--	--	--	19	15	19	2.6	8.7	--		Remediate
Building FN-54 EU														
Surface Soil (0–1 ft bgs)				--	--	--	0.33[a]	0.27	0.35[a]	--	--	0.56[a]		NFA
Subsurface Soil (1–13 ft bgs)														
Team Track Area EU														
Surface Soil (0–1 ft bgs)				--	--	--	0.98[a]	1.13	1.47[a]	0.23	0.76[a]	--		Remediate
Subsurface Soil (1–13 ft bgs)				--	--	--	--	--	--	--	--	--		--

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
[b]Sample location is recommended for remediation for other chemicals of interest; however, this chemical is not recommended as a COC for remediation.
All units are mg/kg.

B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
bgs = Below Ground Surface.
COC = Chemical of Concern.
DA = Dibenz(a,h)anthracene.
DNT = Dinitrotoluene.
EU = Exposure Unit.
ft = Feet.
ID = Identifier.
IP = Indeno(1,2,3-cd)pyrene.
ISM = Incremental Sampling Methodology.
ND = Not Detected.
NFA = No further action or evaluation required for this COC.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-Trinitro-1,3,5-Triazine.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.
-- = Chemical is not a human health COC in this sample.

Table 2-25. Summary of Human Health COC Concentrations and Conclusions for Commercial/Industrial Land Use at Load Line 12

				COC									
				Explosives			PAHs					PCB	
Industrial RGO				510	15	280	29	2.9	29	2.9	29	9.9	Conclusion for Commercial/Industrial Land Use
Sample ID	Date	Depth (ft)	Station	2,4,6-TNT	2,6-DNT	RDX	B(a)A	B(a)P	B(b)F	DA	IP	PCB-1260	
Building 904 EU													
Surface Soil (0–1 ft bgs)				1400	1.7[a]	--	--	0.27[a,b]	--	--	--	--	Remediate
Building FF-19 EU													
Surface Soil (0–1 ft bgs)				--	--	--	24.3[a]	20.9	23.5[a]	3.2	--	8.2[a]	Remediate
Subsurface Soil (1–13 ft bgs)				--	--	--	6.5[a]	5.8	7.3[a]	0.87[a]	--	--	Remediate
Building FF-19 ISM Samples													
L12ss-300M-0001-SO	07/03/11	0.0 - 1.0	L12ss-300M	--	--	--	5[a]	4.5	5.2[a]	0.75[a]	--	--	Remediate
L12ss-303M-0001-SO	06/26/11	0.0 - 1.0	L12ss-303M	--	--	--	9.7[a]	7.7	11[a]	1.4[a]	--	--	Remediate
L12ss-304M-0001-SO	06/26/11	0.0 - 1.0	L12ss-304M	--	--	--	19[a]	15	19[a]	2.6[a]	--	--	Remediate

[a]Sample concentration is less than RGO; however, this chemical contributes to a sum of ratios greater than 1.
All units are mg/kg.
B(a)A = Benz(a)anthracene.
B(a)P = Benzo(a)pyrene.
B(b)F = Benzo(b)fluoranthene.
COC = Chemical of Concern.
DA = Dibenz(a,h)anthracene.
DNT = Dinitrotoluene.
EU = Exposure Unit.
ft = Feet.
ID = Identifier.
IP = Indeno(1,2,3-cd)pyrene.
ISM = Incremental Sampling Methodology.
PAH = Polycyclic Aromatic Hydrocarbon.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-Trinitro-1,3,5-Triazine.
RGO = Remedial Goal Option.
TNT = Trinitrotoluene.
-- = Chemical is not a human health COC in this sample.

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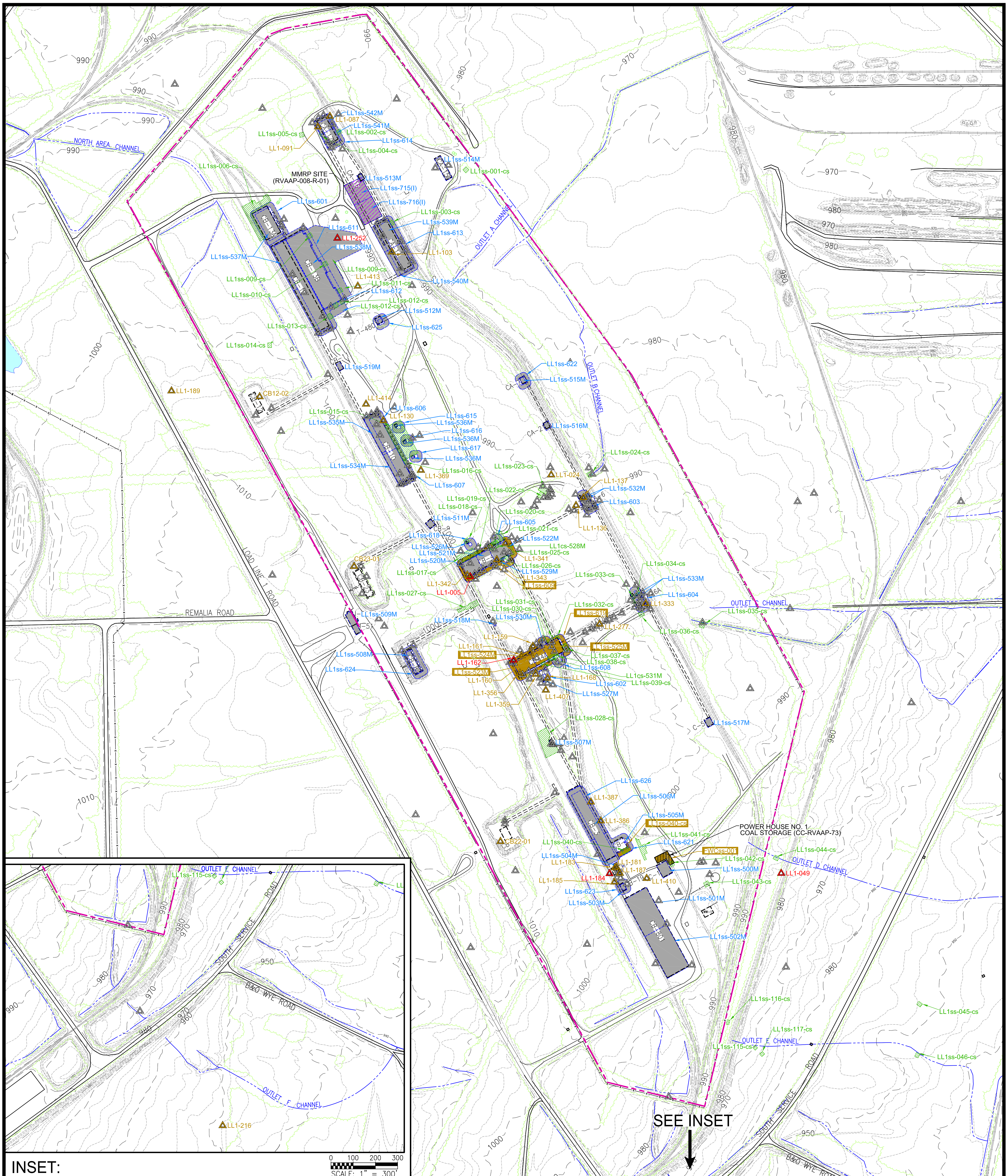

LEGEND:

FENCE LINE
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL1ss-005-cs ..... PREVIOUS REMEDIATION AREA
-CS ..... CONFIRMATION SAMPLE
MMRP SITE (RVAAP-008-R-01)
FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO

SURFACE SOIL DISCRETE SAMPLE (NO ID SHOWN)
XX ..... SURFACE SOIL ISM POLYGON & ID

SURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)

XX ..... DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
XX ..... ISM SAMPLE DETECTED ABOVE RESIDENTIAL
XX ..... DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

NOTE: NO ISM's EXCEEDED FOR BOTH

OHIO STATE PLANE (NAD 83)

0 100 200 300
SCALE: 1" = 300'

US Army Corps of Engineers Louisville District

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Plate 2-1. Load Line 1
Surface Soil Screening Results

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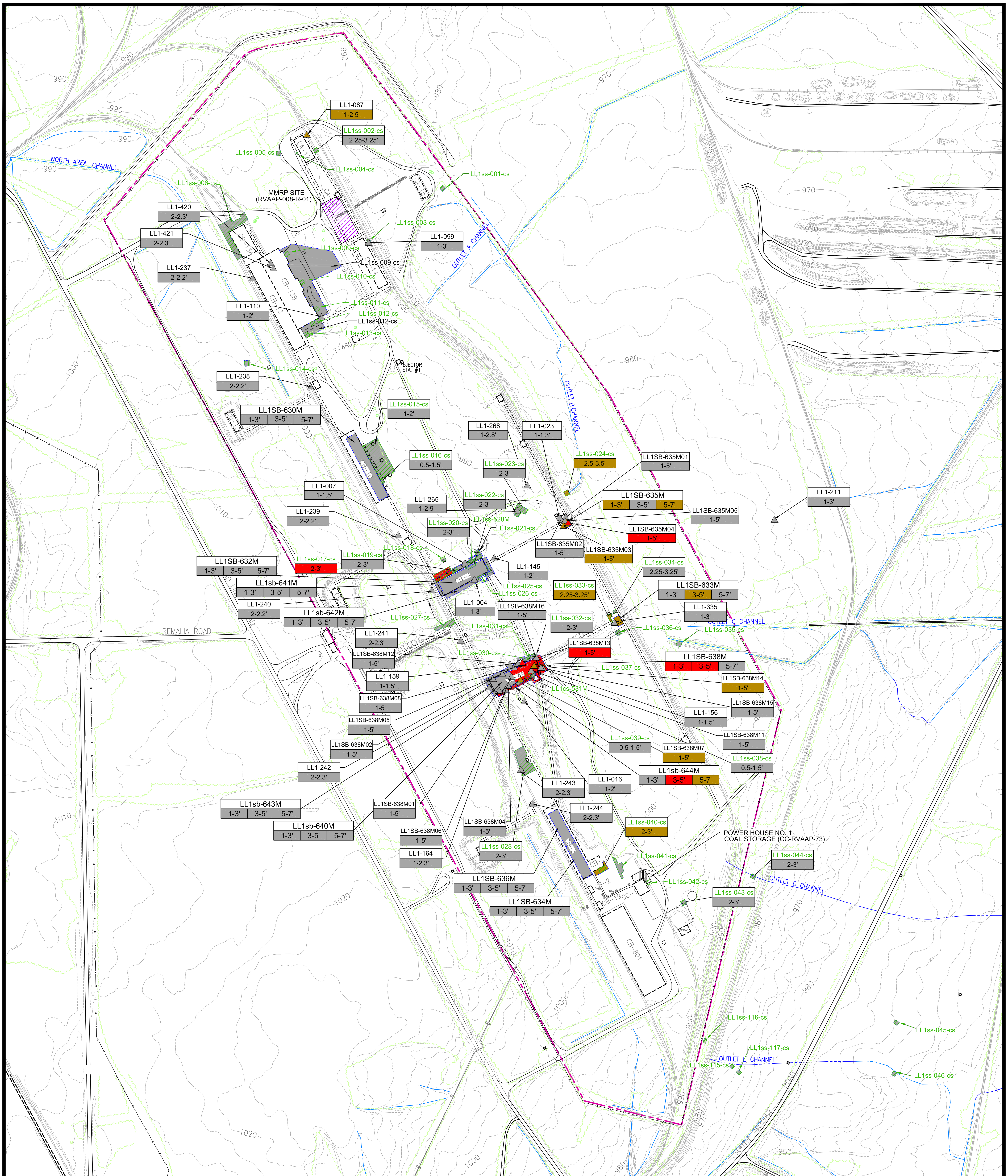

LEGEND:

FENCE LINE
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL2ss-005-cs PREVIOUS REMEDIATION AREA
-CS CONFIRMATION SAMPLE
MMRP SITE (RVAAP-008-R-01)
FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SUBSURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO
SUBSURFACE SOIL DISCRETE SAMPLE
SUBSURFACE SOIL ISM POLYGON & ID

SUBSURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)
DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
ISM SAMPLE DETECTED ABOVE RESIDENTIAL
DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL
ISM SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

LL1sb-xxx			SAMPLE ID
1-3'	3-5'	5-7'	SAMPLE DEPTH

DOES NOT EXCEED RGO
EXCEEDS RESIDENTIAL & INDUSTRIAL RGO
EXCEEDS RESIDENTIAL RGO

0 100 200 300
SCALE: 1" = 300'
OHIO STATE PLANE (NAD 83)

US Army Corps of Engineers Louisville District
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Plate 2-2. Load Line 1
Subsurface Soil Screening Results

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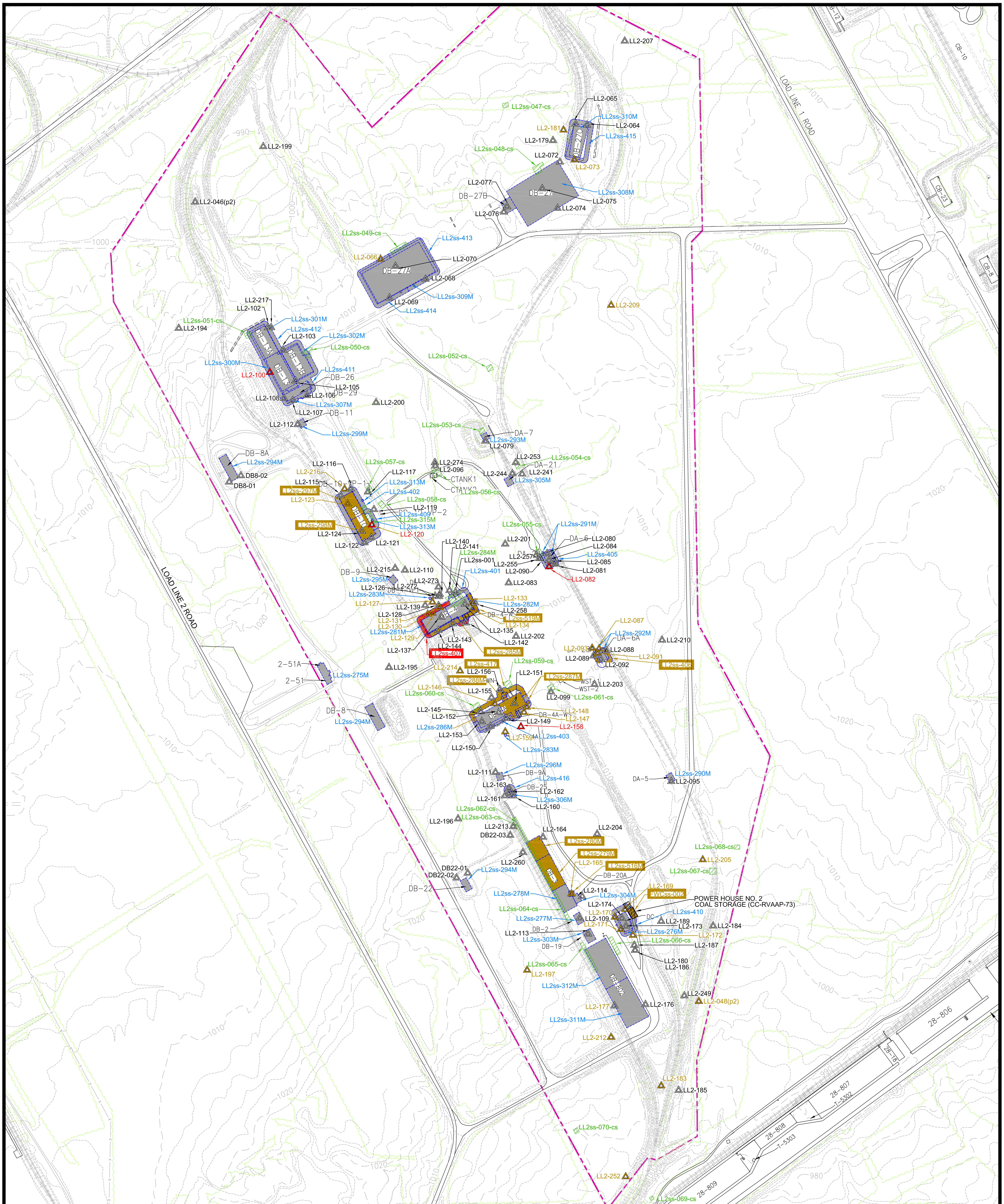

LEGEND:

FENCE LINE
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL1ss-005-cs ..... PREVIOUS REMEDIATION AREA
-CS ..... CONFIRMATION SAMPLE
FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO

XX ..... SURFACE SOIL DISCRETE SAMPLE & ID
XX ..... SURFACE SOIL ISM POLYGON & ID

SURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)

XX ..... DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
XX ..... ISM SAMPLE DETECTED ABOVE RESIDENTIAL
XX ..... DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL
XX ..... ISM SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

OHIO STATE PLANE (NAD 83)

0 100 200 300

SCALE: 1" = 300'

US Army Corps of Engineers Louisville District

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Plate 2-3. Load Line 2
Surface Soil Screening Results

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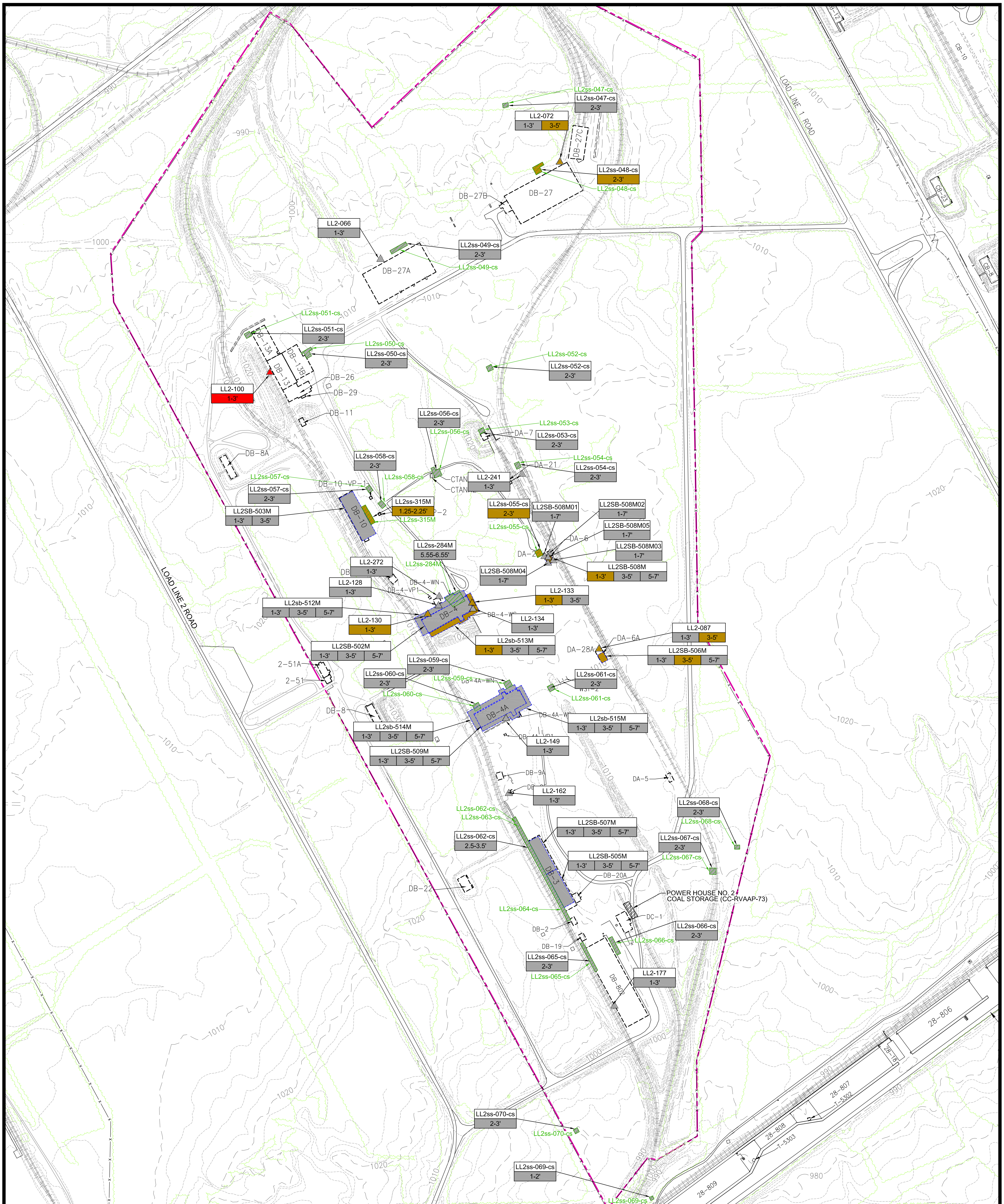
P. HOLM	1/ 11/9/16	R15-LL2-PLATE2-3



LEGEND:

FENCE LINE
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL2ss-005-cs ..... PREVIOUS REMEDIATION AREA
-CS ..... CONFIRMATION SAMPLE
FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SUBSURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO
- SUBSURFACE SOIL DISCRETE SAMPLE
- SUBSURFACE SOIL ISM POLYGON & ID

SUBSURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)
- DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
- ISM SAMPLE DETECTED ABOVE RESIDENTIAL
- DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL
- ISM SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

LL1sb-xxx			SAMPLE ID
1-3'	3-5'	5-7'	SAMPLE DEPTH

5-7' — DOES NOT EXCEED RGO
3-5' — EXCEEDS RESIDENTIAL & INDUSTRIAL RGO
1-3' — EXCEEDS RESIDENTIAL RGO

OHIO STATE PLANE (NAD 83)

0 100 200 300
SCALE: 1" = 300'

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Plate 2-4. Load Line 2 Subsurface Soil Screening Results

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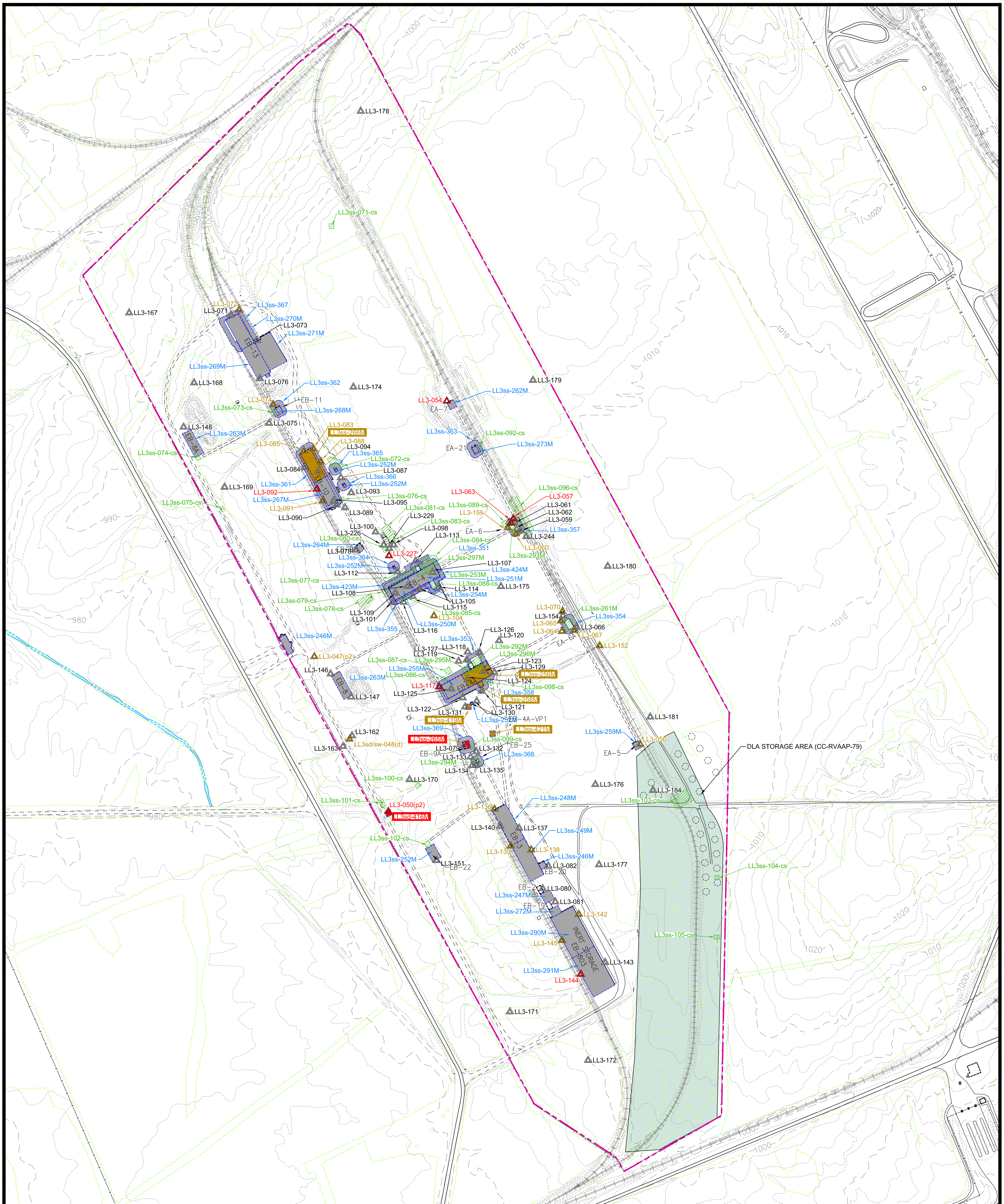

LEGEND:

FENCE LINE

SURFACE WATER

GROUND CONTOUR (10-FT INTERVAL)

GROUND CONTOUR (2-FT INTERVAL)

VEGETATION

AOC BOUNDARY

LL3ss-073-cs PREVIOUS REMEDIATION AREA

-CS CONFIRMATION SAMPLE

DLA STORAGE AREA (CC-RVAAP-79)

SURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO

XX SURFACE SOIL DISCRETE SAMPLE & ID

XX SURFACE SOIL ISM POLYGON & ID

SURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)

XX DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL

XX ISM SAMPLE DETECTED ABOVE RESIDENTIAL

XX DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

XX ISM SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

OHIO STATE PLANE (NAD 83)

0 100 200 300

SCALE: 1" = 300'

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Plate 2-5. Load Line 3 Surface Soil Screening Results

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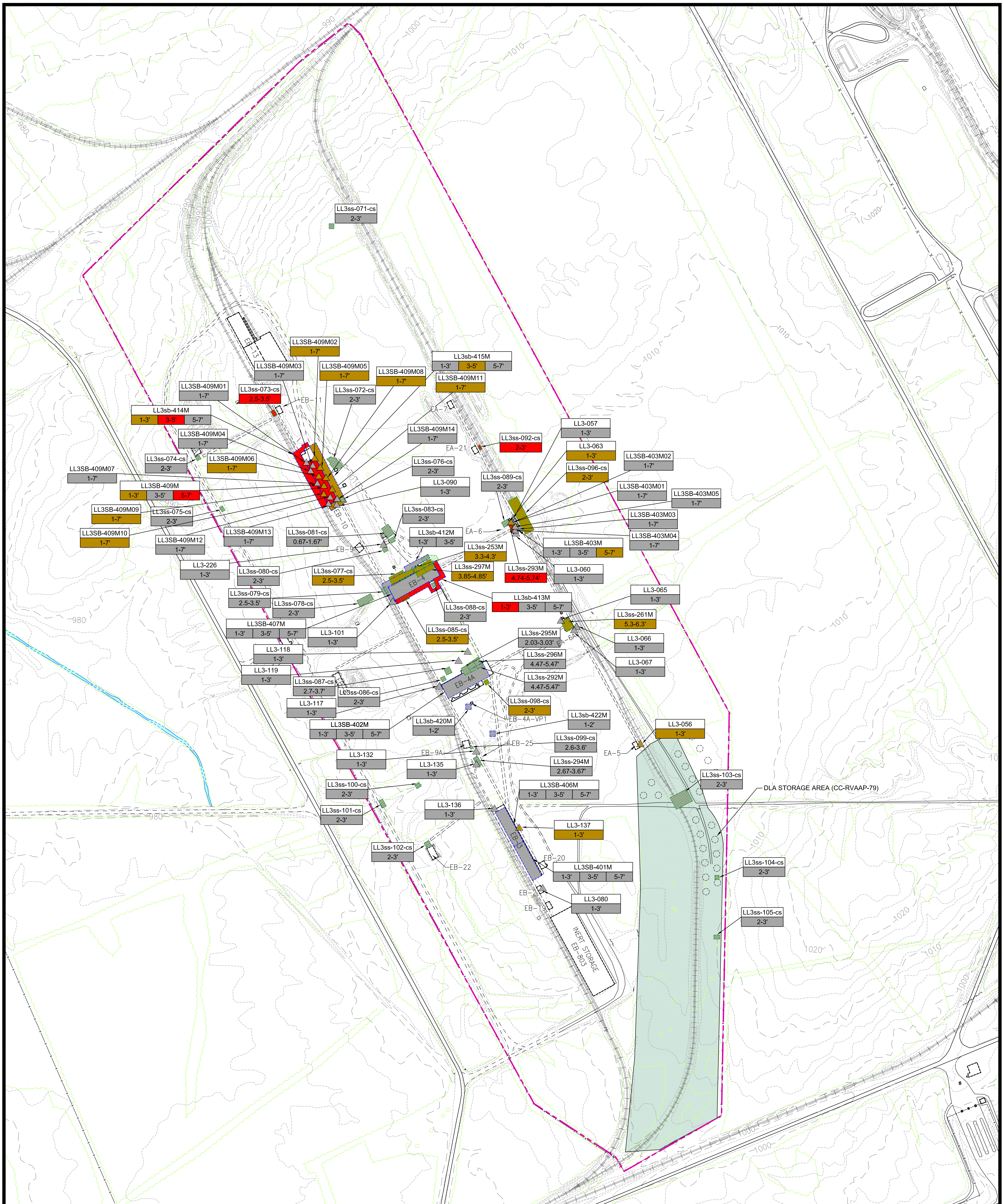

LEGEND:

FENCE LINE
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL3ss-073-cs PREVIOUS REMEDIATION AREA
-CS CONFIRMATION SAMPLE
DLA STORAGE AREA (CC-RVAAP-79)

SUBSURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO
SUBSURFACE SOIL DISCRETE SAMPLE
SUBSURFACE SOIL ISM POLYGON

SUBSURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)
DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
ISM SAMPLE DETECTED ABOVE RESIDENTIAL
DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL
ISM SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

LL3sb-xxx SAMPLE ID
1-3' 3-5' 5-7' SAMPLE DEPTH
DOES NOT EXCEED RGO
EXCEEDS RESIDENTIAL & INDUSTRIAL RGO
EXCEEDS RESIDENTIAL RGO

OHIO STATE PLANE (NAD 83)

0 100 200 300
SCALE: 1" = 300'

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Plate 2-6. Load Line 3 Subsurface Soil Screening Results

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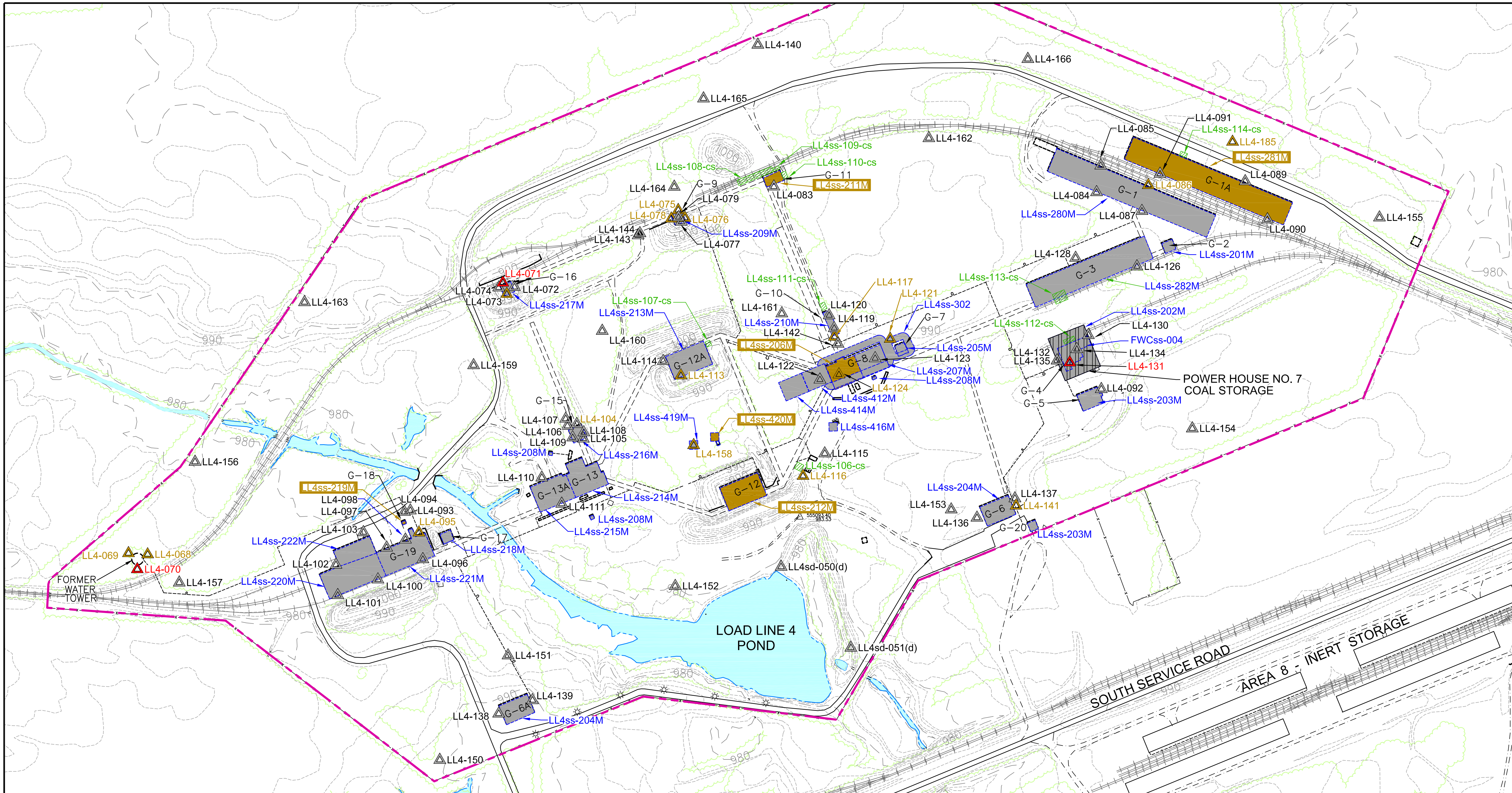

LEGEND:

.... AOC BOUNDARY
.... DEMOLISHED BUILDING
.... ASPHALT ROAD
.... DEMOLISHED WALKWAY
.... FORMER RAILROAD
.... FENCE LINE
.... SURFACE WATER
.... GROUND CONTOUR (10-FT INTERVAL)
.... GROUND CONTOUR (2-FT INTERVAL)
.... VEGETATION

LL4ss-107-cs ..... PREVIOUS REMEDIATION AREA
-CS .... CONFIRMATION SAMPLE
.... FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO

XX .... SURFACE SOIL DISCRETE SAMPLE & ID
XX .... SURFACE SOIL ISM POLYGON & ID

SURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)

XX .... DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
XX .... ISM SAMPLE DETECTED ABOVE RESIDENTIAL
XX .... DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

NOTE: NO ISM's EXCEEDED FOR BOTH

OHIO STATE PLANE (NAD 83)

0 100 200 300

SCALE: 1" = 300'

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Plate 2-7. Load Line 4
Surface Soil Screening Results

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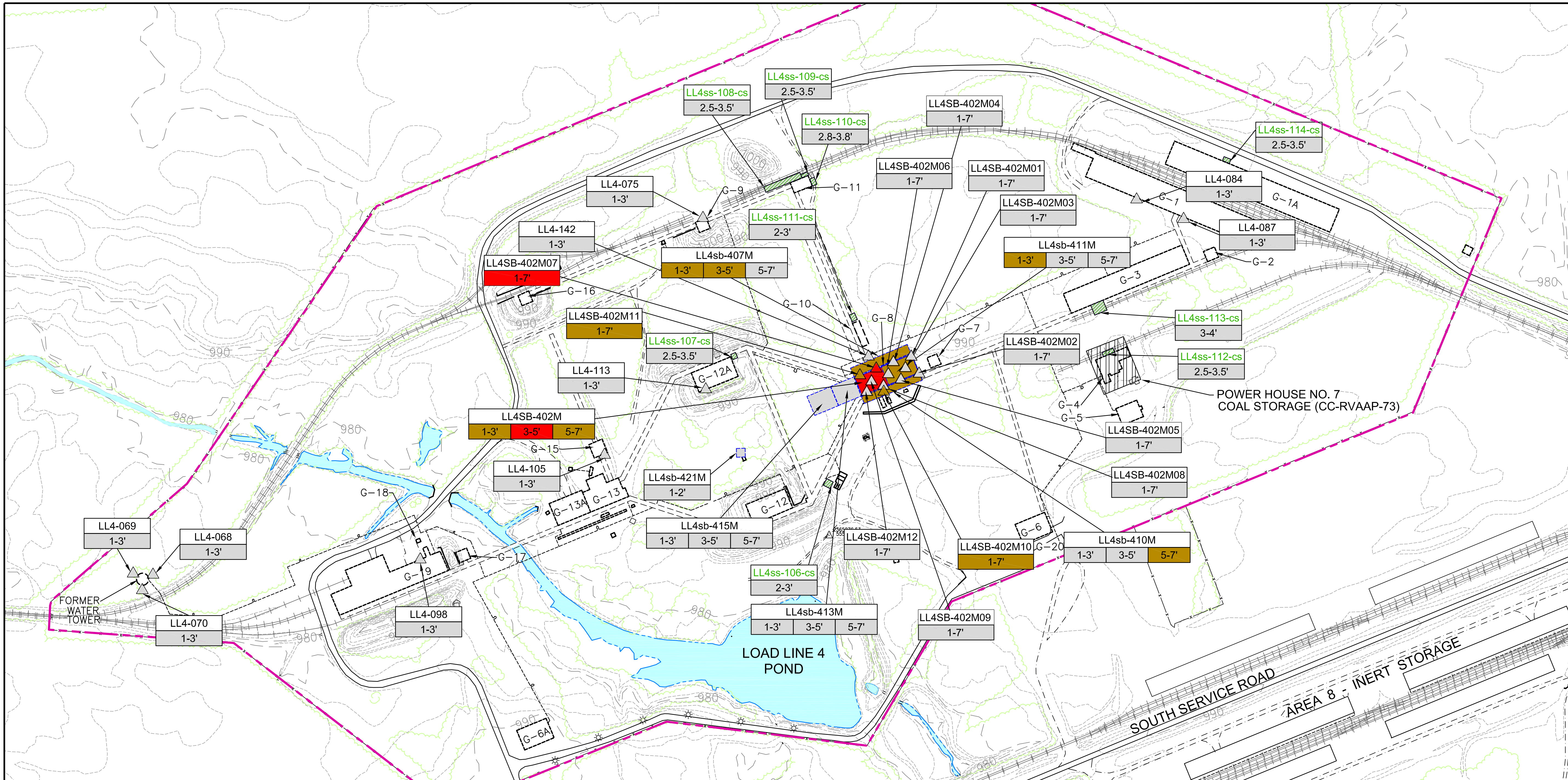

LEGEND:

AOC BOUNDARY
DEMOLISHED BUILDING
ASPHALT ROAD
DEMOLISHED WALKWAY
FORMER RAILROAD
FENCE LINE
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION

LL4ss-107-cs REMEDIATION AREA
-CS CONFIRMATION SAMPLE
FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SUBSURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO
SUBSURFACE SOIL DISCRETE SAMPLE
SUBSURFACE SOIL ISM POLYGON & ID

SUBSURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)
DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
ISM SAMPLE DETECTED ABOVE RESIDENTIAL
DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL
ISM SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

LL1sb-xxx SAMPLE ID
1-3' 3-5' 5-7' SAMPLE DEPTH
DOES NOT EXCEED RGO
EXCEEDS RESIDENTIAL & INDUSTRIAL RGO
EXCEEDS RESIDENTIAL RGO

OHIO STATE PLANE (NAD 83)

0 100 200 300 600
SCALE: 1" = 300'

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Plate 2-8. Load Line 4 Subsurface Soil Screening Results

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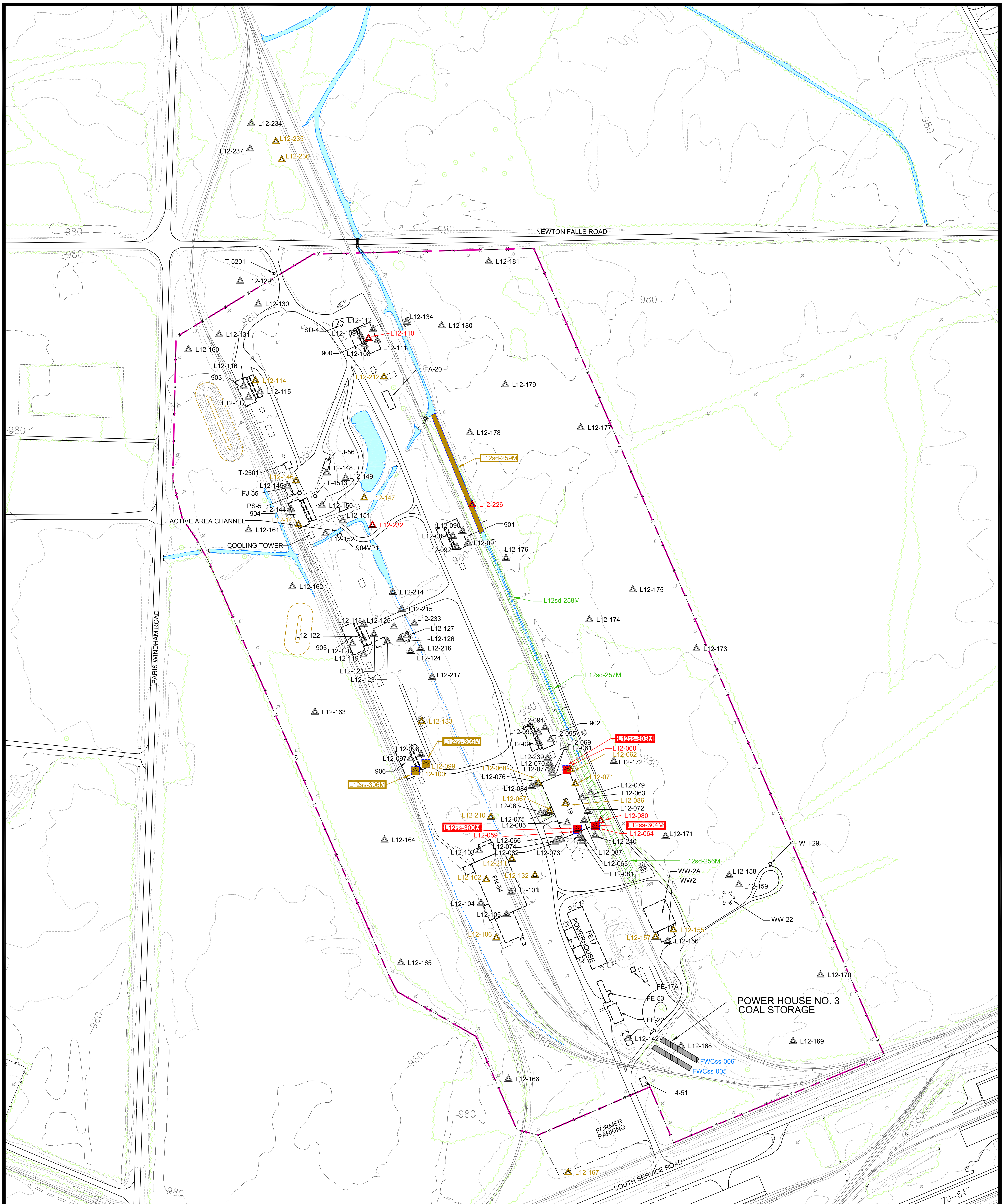

LEGEND:

FENCE LINE
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
PREVIOUS REMEDIATION AREA
FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO

XX SURFACE SOIL DISCRETE SAMPLE & ID
XX SURFACE SOIL ISM POLYGON & ID

SURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)

XX DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
XX ISM SAMPLE DETECTED ABOVE RESIDENTIAL
XX DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL
XX ISM SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

OHIO STATE PLANE (NAD 83)

0 100 200
SCALE: 1" = 200'

US Army Corps of Engineers Louisville District

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Plate 2-9. Load Line 12
Surface Soil Screening Results

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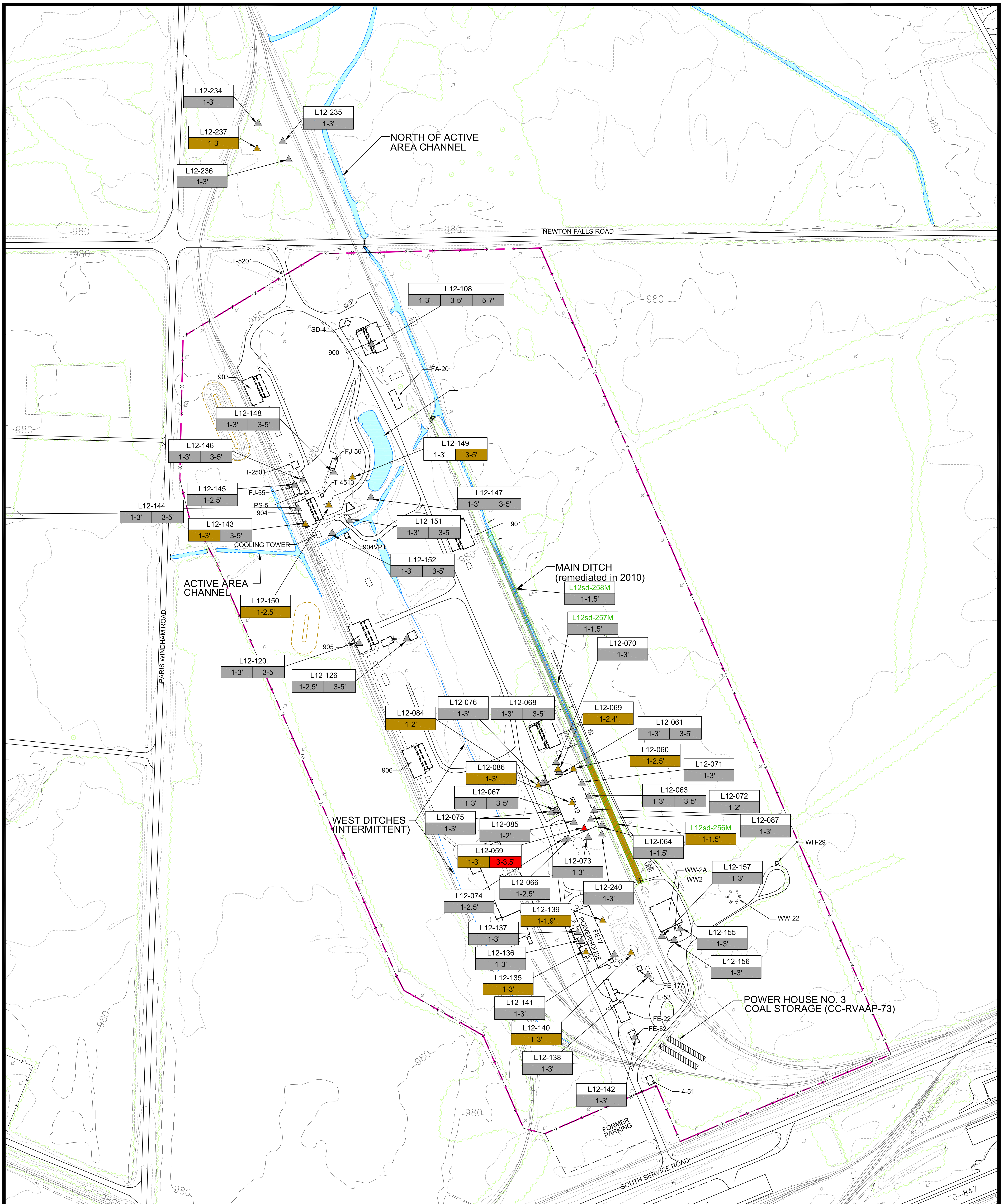
P. HOLM	0/10/3/16	R15-LL12-PLATE2-9



LEGEND:

- FENCE LINE
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- REMEDIATION AREA
- FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)

SUBSURFACE SOIL SAMPLES WITH NO COIs DETECTED ABOVE RGO

- SUBSURFACE SOIL DISCRETE SAMPLE
- SUBSURFACE SOIL ISM POLYGON & ID

SUBSURFACE SOIL SAMPLES DETECTED ABOVE RGO (HQ=1.0, RISK=10-5)

- DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL
- ISM SAMPLE DETECTED ABOVE RESIDENTIAL
- DISCRETE SAMPLE DETECTED ABOVE RESIDENTIAL & INDUSTRIAL

LL1sb-xxx			SAMPLE ID
1-3'	3-5'	5-7'	SAMPLE DEPTH

- DOES NOT EXCEED RGO
- EXCEEDS RESIDENTIAL & INDUSTRIAL RGO
- EXCEEDS RESIDENTIAL RGO

OHIO STATE PLANE (NAD 83)

0 100 200
SCALE: 1" = 200'

US Army Corps of Engineers Louisville District

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Plate 2-10. Load Line 12 Subsurface Soil Screening Results

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P. HOLM	0/10/3/16	R15-LL12-PLATE2-10

3.0 REMEDIAL ACTION OBJECTIVES, CLEANUP GOALS, AND VOLUME CALCULATIONS

This section presents the RAOs, appropriate cleanup goals for remedial actions, and volume estimates of media requiring remediation to attain specific Land Use scenarios. The RAO is in accordance with NCP and CERCLA RI/FS guidance, which specify receptors, exposure routes, and desired exposure levels. The RGOs are cleanup goals that establish acceptable exposure levels to be protective of human health while considering potential Land Uses and provide the basis for screening, evaluating, and selecting a remedial alternative. This section also presents the estimated volume of soil exceeding the respective RGOs. The volume estimates present the estimated quantity and location of media requiring remediation to attain a specific Land Use scenario.

3.1 FUTURE LAND USE

The potential future uses for Load Lines 1 through 4 and 12 are Military Training Land Use or Commercial/Industrial Land Use. Although residential use is not anticipated at the former RVAAP or at these AOCs, Unrestricted (Residential) Land Use was evaluated in this FS in accordance with Defense Environmental Restoration Program (DERP) Manual 4715.20 (DoD 2012) in order to make appropriate risk management decisions. Descriptions of these Land Uses, as outlined in the Technical Memorandum (ARNG 2014), are provided in the following subsections.

3.1.1 Military Training Land Use

Military Training Land Use describes potential exposure for military and civilian personnel that would train or work on any AOC or MRS within the former RVAAP/Camp Ravenna. This Land Use is characterized by activities that are necessary to properly train soldiers and operate/maintain a training base as defined by the Army. This Land Use has specific assumptions that would require a land use control (LUC) to be enacted that would limit personnel exposure to the AOC for the duration assumed for the National Guard Trainee in the Facility-wide Human Health Risk Assessors Manual (FWHHRAM). Given the requirements for the Trainee limiting site usage by the National Guard Trainee, the Army has elected to evaluate only the Commercial/Industrial and Unrestricted (Residential) Land Use alternatives in this FS Addendum, which are protective of all full-time occupational exposures, including Military Training Land Use.

3.1.2 Commercial/Industrial Land Use

Commercial/Industrial Land Use represents receptors who work full time at the former RVAAP/Camp Ravenna AOCs. The Industrial Receptor is the representative receptor for Commercial/Industrial Land Use.

This Land Use is characterized by activities consistent with full-time employees or career military personnel who are expected to work daily at the facility over their career. Activities can include work that would be conducted in office buildings, schools, maintenance buildings, as well as manufacturing facilities. Activities will also include outdoor work that will be conducted by full-time personnel to maintain military training lands. Commercial/Industrial Land Use would provide protectiveness for the National Guard Trainee and would not require LUCs limiting exposure for on-site permanent and repeat users of the AOC.

3.1.3 Unrestricted (Residential) Land Use

Unrestricted (Residential) Land Use is considered protective for, and may be applied to, all categories of Land Use on the former RVAAP/Camp Ravenna, without further restriction. The Resident Receptor is the representative receptor for Unrestricted (Residential) Land Use.

3.2 REMEDIAL ACTION OBJECTIVES

Extensive investigations of each load line concluded that substantial areas of each load line did not require further action to attain Unrestricted (Residential) Land Use. Limited areas of surface and subsurface soil at each load line were identified as posing unacceptable risk to the Industrial Receptor and/or Resident Receptor. The RAO for Load Lines 1 through 4 and 12 is as follows:

- Reduce risk from COCs in surface and subsurface soil and sediment to acceptable levels (RGOs) (Section 3.3) for the likely future land use (i.e., Industrial and/or Military Training) that are protective of human health at Load Lines 1 through 4 and 12.

3.3 REMEDIAL ACTION CLEANUP GOALS

The HHRA recommended RGOs for COCs for the Industrial Receptor support the remedial alternative selection process. RGOs for the Resident Receptor are also provided to support alternatives selection in the absence of LUCs. Table 3-1 presents RGOs for each COC requiring remediation to attain Commercial/Industrial Land Use and Unrestricted (Residential) Land Use.

Table 3-1. Remedial Goal Options

Media	Chemical of Concern	Cleanup Goals (mg/kg)	
		Industrial RGO	**Residential RGO**
Load Line 1			
Soil	Antimony	470	31
	Lead	800	400
	2,4,6-TNT	510	36
	RDX	280	61
	Benz(a)anthracene	29	1.6
	Benzo(a)pyrene	2.9	0.16
	Benzo(b)fluoranthene	29	1.6
	PCB-1254	9.7	1.2
Load Line 2			
Soil			
	2,4,6-TNT	510	36
	2,4-DNT	N/A	17
	Benz(a)anthracene	N/A	1.6
	Benzo(a)pyrene	N/A	0.16
	Benzo(b)fluoranthene	N/A	1.6
	Dibenz(a,h)anthracene	N/A	0.16
	PCB-1254	N/A	1.2

Table 3-1. Remedial Goal Options (continued)

Media	Chemical of Concern	Cleanup Goals (mg/kg)	
		Industrial RGO	Residential RGO
Sediment[a]	Benz(a)anthracene	N/A	1.6
	Benzo(a)pyrene	N/A	0.16
	Benzo(b)fluoranthene	N/A	1.6
	Dibenz(a,h)anthracene	N/A	0.16
	Indeno(1,2,3-cd)pyrene	N/A	1.6
Load Line 3			
Soil	Lead	N/A	400
	2,4,6-TNT	510	36
	Benz(a)anthracene	29	1.6
	Benzo(a)pyrene	2.9	0.16
	Benzo(b)fluoranthene	29	1.6
	Dibenz(a,h)anthracene	2.9	0.16
	Indeno(1,2,3-cd)pyrene	N/A	1.6
	PCB-1254	9.7	1.2
	PCB-1260	N/A	2.4
Load Line 4			
Soil	Lead	800	400
	Benz(a)anthracene	29	1.6
	Benzo(a)pyrene	2.9	0.16
	Benzo(b)fluoranthene	29	1.6
	Dibenz(a,h)anthracene	2.9	0.16
	Indeno(1,2,3-cd)pyrene	N/A	1.6
	PCB-1254	N/A	1.2
	PCB-1260	9.9	2.4
Load Line 12			
Soil	2,4,6-TNT	510	36
	2,6-DNT	15	3.6
	RDX	N/A	61
	Benz(a)anthracene	29	1.6
	Benzo(a)pyrene	2.9	0.16
	Benzo(b)fluoranthene	29	1.6
	Dibenz(a,h)anthracene	2.9	0.16
	Indeno(1,2,3-cd)pyrene	N/A	1.6

[a]Residential RGOs are the same for soil and sediment, resulting in a very conservative evaluation of sediment.

DNT = Dinitrotoluene.
mg/kg = Milligrams per Kilogram.
N/A = Not applicable. The chemical of concern does not require remediation for the receptor within the specified AOC.
PCB = Polychlorinated Biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RGO = Remedial Goal Option.
TNT = 2,4,6-Trinitrotoluene.

Unrestricted (Residential) Land Use RGOs for both soil and sediment are USEPA Residential soil RSLs and serve as non-site-specific cleanup goals for the FS evaluation. This is a very conservative approach for sediment because residential exposure to sediment will be much less than that assumed for soil (e.g., direct and frequent contact with exposed soil in a yard versus incidental contact with sediment present under surface water). This conservative approach is adequate for the current evaluation; however, if future land use changes (i.e., becomes unrestricted/residential), sediment cleanup goals may be reconsidered to evaluate a more realistic exposure scenario.

3.4 VOLUME CALCULATIONS OF MEDIA REQUIRING REMEDIATION

Using recommendations from the HHRA for the Industrial Receptor and Resident Receptor, the volumes of soil requiring remedial response action within each load line was calculated based on the lateral and vertical extent of soil containing one or more COCs above the RGOs presented in Table 3-1. Figures 3-1 through 3-10 present the estimated extent of contamination with unacceptable risk for each receptor at each of the five load lines. The volumes presented in this section are estimates. In the event that confirmation samples determine RGOs are still exceeded, the treatment area will be adjusted accordingly.

The following general assumptions are made for the estimation of soil volumes for Load Lines 1 through 4 and 12:

- Vertical extent of treatment areas
    - For study areas with RGO exceedances in the surface soil only, the depth of the remedial response action is assumed to be 1 ft bgs.
    - At locations where the deepest sample contained COC exceedances of the RGOs and the vertical extent was not confirmed, the maximum depth for a remedial response action was assumed to be 1 ft below the deepest sample.
    - If proposed remediation areas are collocated with areas where previous excavation occurred, the clean backfill from the previous removal activities will be stockpiled and reused as backfill.
    - At locations where the proposed remediation area overlies clean ISM samples, the depth of remediation is assumed to extend to the depth interval of the clean ISM sample.
- Lateral extent of treatment area
    - Assumptions for the lateral extent of contamination are determined on a site-specific basis.
    - If an ISM sample exceeded RGOs and required remediation, it is assumed that the lateral extent of remediation area is the footprint of the ISM sample.
    - At discrete locations, the lateral extent of excavation is defined by half the distance between a sample with a human health RGO exceedance and an adjacent sample without a RGO exceedance.
    - If no adjacent samples are available, the lateral extent is assumed to be 10 feet from the sample with the RGO exceedance.

The soil volume estimates for Load Lines 1 through 4 and 12 are presented in Tables 3-2 and 3-3.

Table 3-2. Estimated Volume Requiring Remediation for Commercial/Industrial Land Use

Commercial/Industrial						
			In-situ		Ex-situ	
Remediation Area	Area (ft^2)	Impacted Interval (ft bgs)	Volume (yd^3)	Volume with Constructability[a] (yd^3)	Volume[b] (yd^3)	Weight (tons)
Load Line 1	11,815	varies (max depth = 5 ft bgs)	1,491	1,864	2,236	2,795
Load Line 2	400	0-2	30	37	46	56
Load Line 3	25,056	varies (max depth = 6 ft bgs)	1,649	2,062	2,474	3,093
Load Line 4	5,994	varies (max depth = 7 ft bgs)	474	592	710	888
Load Line 12	2,633	varies (max depth = 4.5 ft bgs)	248	310	372	465
Total	**45,898**		**3,892**	**4,865**	**5,838**	**7,297**

[a]Constructability factor accounts for over excavation, sloping of sidewalls, and addresses limitations of removal equipment. The in-situ volume is increased by 25% for a constructability factor.
[b]Includes 20% swell factor.

bgs = Below Ground Surface.
ft = Feet.
ft^2 = Square Feet.
yd^3 = Cubic Yards.

Table 3-3. Estimated Volume Requiring Remediation for Unrestricted (Residential) Land Use

Unrestricted (Residential)						
			In-situ		Ex-situ	
Remediation Area	Area (ft^2)	Impacted Interval (ft bgs)	Volume (yd^3)	Volume with Constructability[a] (yd^3)	Volume[b] (yd^3)	Weight (tons)
Load Line 1	49,017	varies (max depth = 8 ft bgs)	4,584	5,730	6,876	8,595
Load Line 2 soil	31,616	varies (max depth = 6 ft bgs)	1,972	2,465	3,081	3,698
Load Line 2 sediment	53,027	0-1	1,966	2,457	3,071	3,686
Load Line 3	69,435	varies (max depth = 7 ft bgs)	8,865	11,082	13,298	16,622
Load Line 4	31,337	varies (max depth = 7 ft bgs)	2,940	3,674	4,409	5,512
Load Line 12	4,233	varies (max depth = 4.5 ft bgs)	475	593	712	890
Total	**238,665**		**20,802**	**26,001**	**31,447**	**39,003**

[a]Constructability factor accounts for over excavation, sloping of sidewalls, and addresses limitations of removal equipment. The in-situ volume is increased by 25% for a constructability factor.
[b]Includes 20% swell factor.

bgs = Below Ground Surface.
ft = Feet.
ft^2 = Square Feet.
yd^3 = Cubic Yards.

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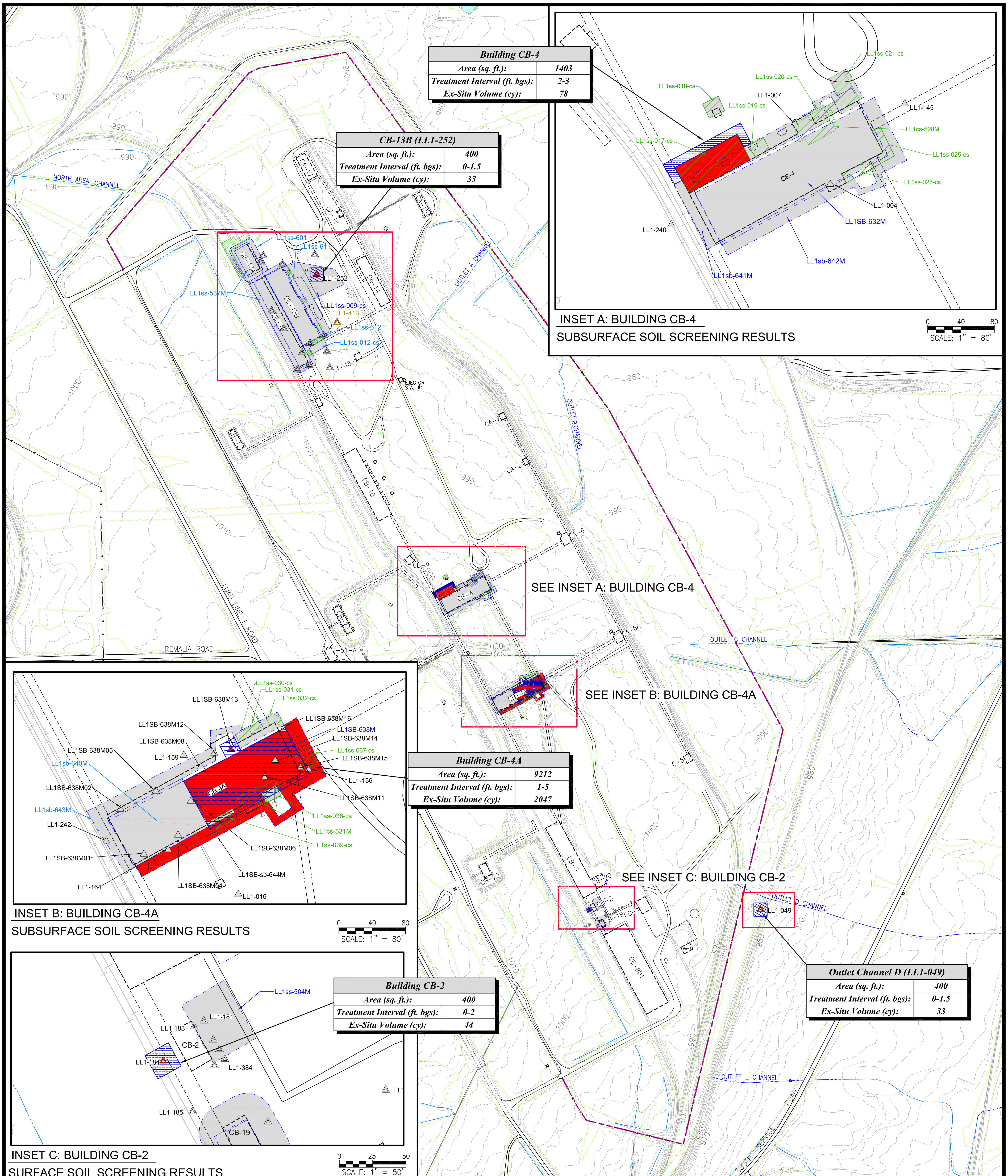

Building CB-4	
Area (sq. ft.):	1403
Treatment Interval (ft. bgs):	2-3
Ex-Situ Volume (cy):	78

CB-13B (LL1-252)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1.5
Ex-Situ Volume (cy):	33

Building CB-4A	
Area (sq. ft.):	9212
Treatment Interval (ft. bgs):	1-5
Ex-Situ Volume (cy):	2047

Building CB-2	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	44

Outlet Channel D (LL1-049)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1.5
Ex-Situ Volume (cy):	33

LEGEND:

DEMOLISHED BUILDING
WALKWAY
FENCE LINE
FORMER RAILROAD
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL2ss-005-cs ... REMEDIATION AREA
-CS ... CONFIRMATION SAMPLE

SURFACE SOIL DISCRETE SAMPLE
SUBSURFACE SOIL DISCRETE SAMPLE
LL1sb-642M ... SOIL ISM
GENERAL AREA OF REMEDIATION
INDUSTRIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES
NO COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10^{-5})
COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10^{-5})

NOTE:

SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

SCALE: 1" = 300'

OHIO STATE PLANE (NAD 83)

US Army Corps of Engineers Louisville District

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Plate 3-1. Load Line 1 Industrial Remediation Areas

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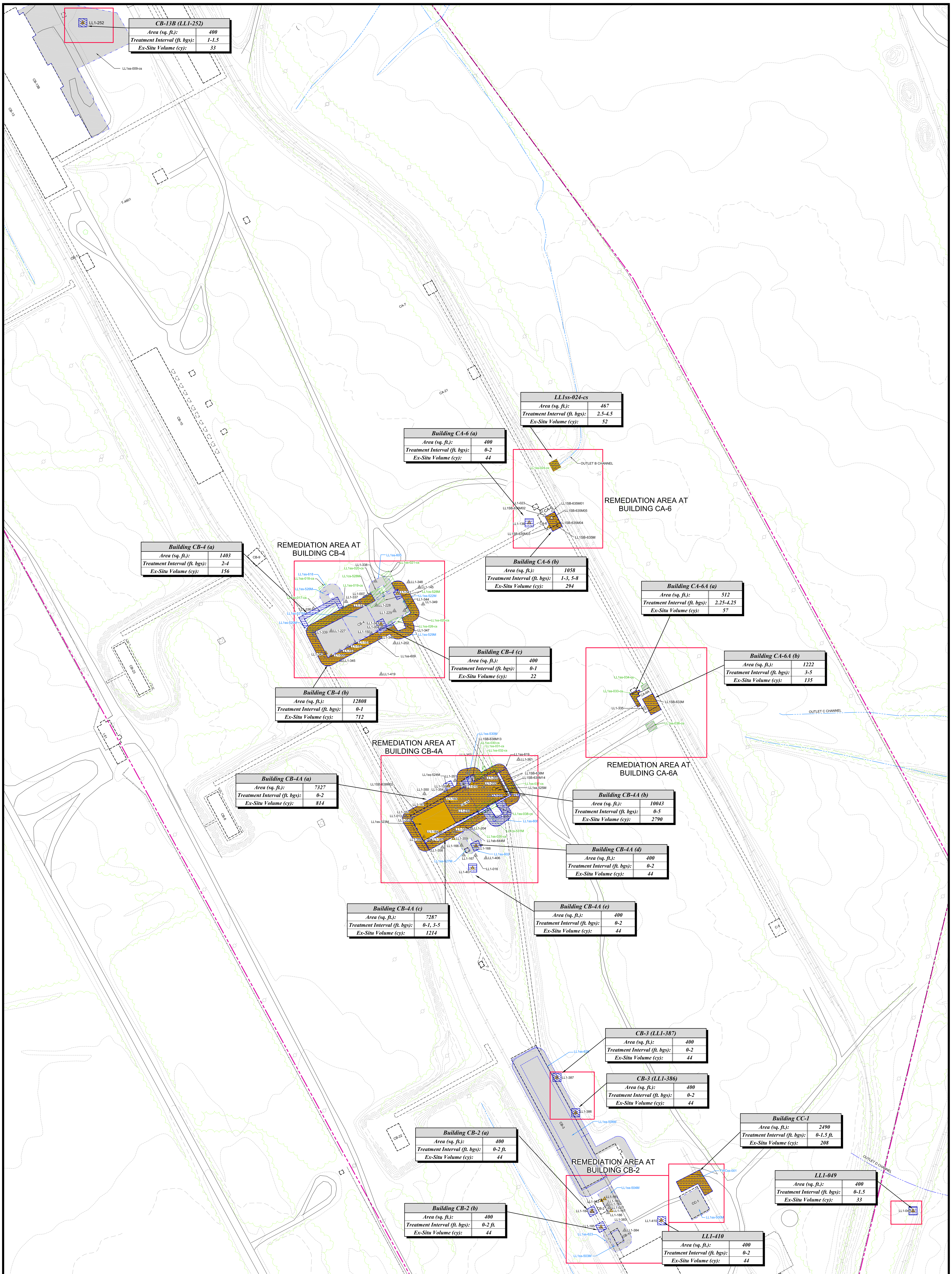
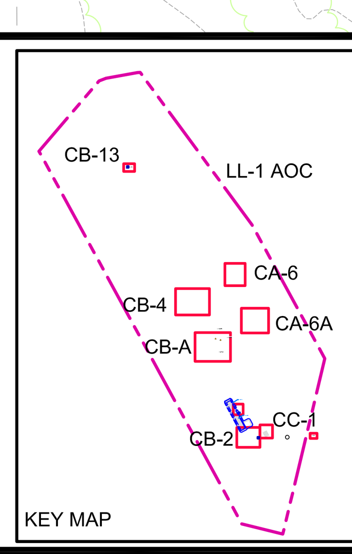
P. HOLM	R1/ 6/16/17	R15-LL1-PLATE3-1



LEGEND:

- DEMOLISHED BUILDING
- WALKWAY
- FENCE LINE
- FORMER RAILROAD
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- LL2ss-005-cs REMEDIATION AREA
- -CS CONFIRMATION SAMPLE
- SURFACE SOIL DISCRETE SAMPLE
- SUBSURFACE SOIL DISCRETE SAMPLE
- LL1sb-642M SOIL ISM
- GENERAL AREA OF REMEDIATION
- RESIDENTIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES
- NO COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10-5)
- COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10-5)



NOTE:

SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

OHIO STATE PLANE (NAD 83)

0 40 80 160

SCALE: 1" = 80'

US Army Corps of Engineers Louisville District

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Plate 3-2. Load Line 1
Residential Remediation Areas

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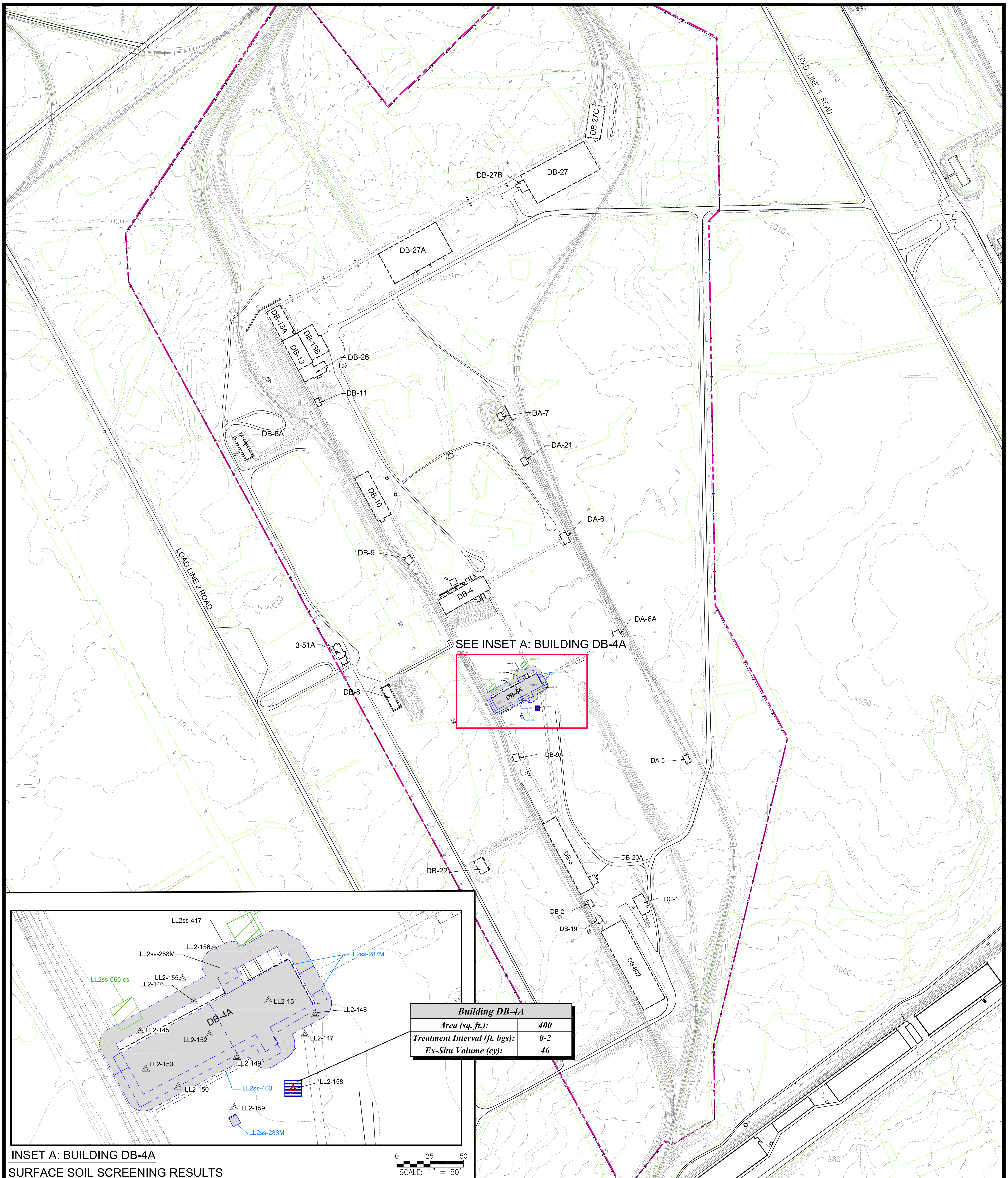

INSET A: BUILDING DB-4A

SURFACE SOIL SCREENING RESULTS

Building DB-4A	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	46

LEGEND:

- DEMOLISHED BUILDING
- WALKWAY
- FENCE LINE
- FORMER RAILROAD
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- LL2ss-005-cs .... REMEDIATION AREA
- -CS .... CONFIRMATION SAMPLE
- LL1sb-642M .... SOIL ISM
- GENERAL AREA OF REMEDIATION
- INDUSTRIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES

- NO COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10^{-5})
- COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10^{-5})

NOTE:

SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

0 100 200 300
SCALE: 1" = 300'

OHIO STATE PLANE (NAD 83)

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Plate 3-3. Load Line 2
Industrial Remediation Areas

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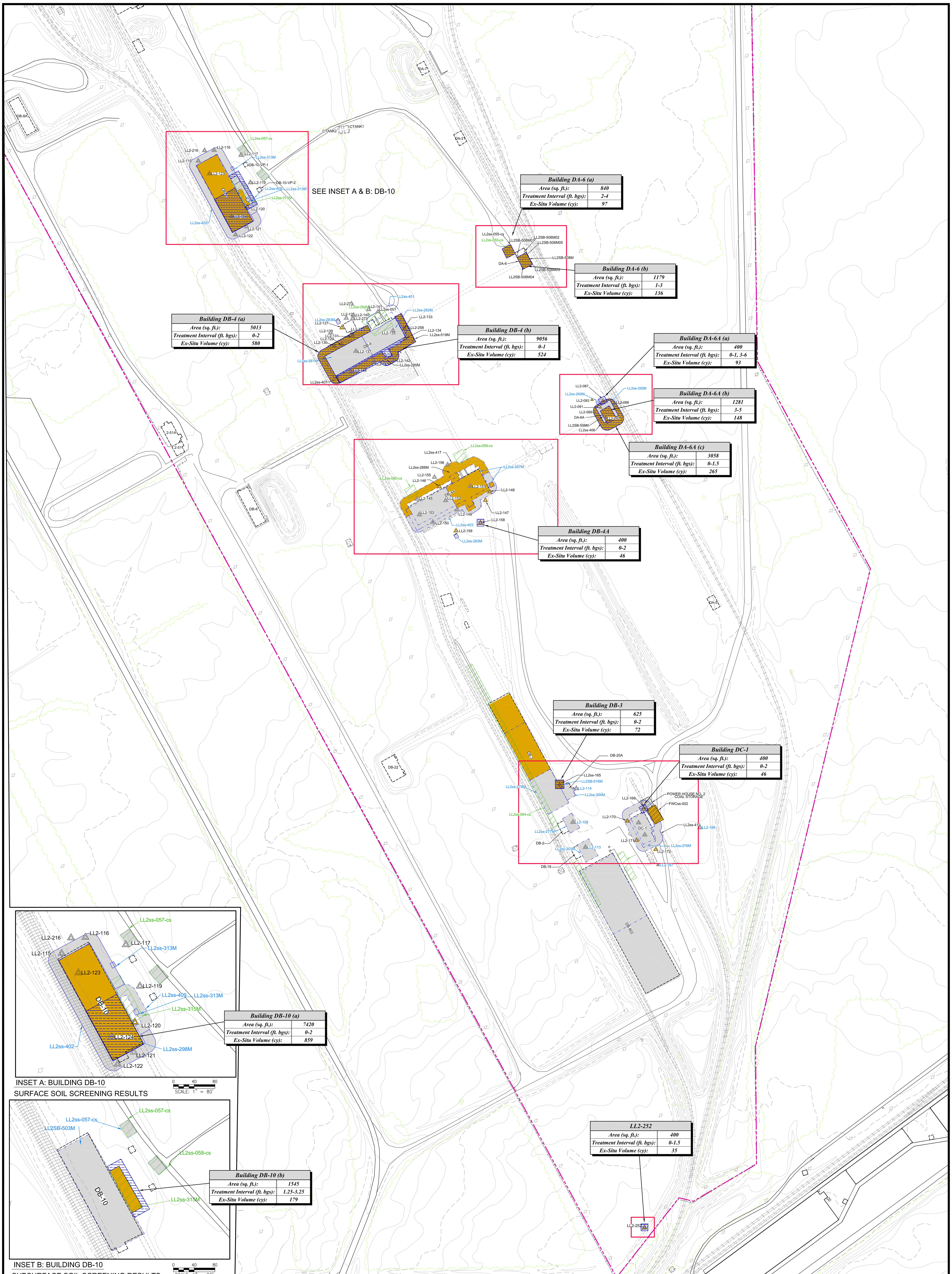
P. HOLM	1/11/16	R15-LL2-PLATE3-3



Building DA-6 (a)	
Area (sq. ft.):	840
Treatment Interval (ft. bgs):	2-4
Ex-Situ Volume (cy):	97

Building DA-6 (b)	
Area (sq. ft.):	1179
Treatment Interval (ft. bgs):	1-3
Ex-Situ Volume (cy):	136

Building DB-4 (a)	
Area (sq. ft.):	5013
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	580

Building DB-4 (b)	
Area (sq. ft.):	9056
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	524

Building DA-6A (a)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1, 3-6
Ex-Situ Volume (cy):	93

Building DA-6A (b)	
Area (sq. ft.):	1281
Treatment Interval (ft. bgs):	3-5
Ex-Situ Volume (cy):	148

Building DA-6A (c)	
Area (sq. ft.):	3058
Treatment Interval (ft. bgs):	0-1.5
Ex-Situ Volume (cy):	265

Building DB-4A	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	46

Building DB-3	
Area (sq. ft.):	625
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	72

Building DC-1	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	46

Building DB-10 (a)	
Area (sq. ft.):	7420
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	859

Building DB-10 (b)	
Area (sq. ft.):	1545
Treatment Interval (ft. bgs):	1.25-3.25
Ex-Situ Volume (cy):	179

LL2-252	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1.5
Ex-Situ Volume (cy):	35

LEGEND:

DEMOLISHED BUILDING
WALKWAY
FENCE LINE
FORMER RAILROAD
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL2ss-005-cs .... REMEDIATION AREA
-CS .... CONFIRMATION SAMPLE
SURFACE SOIL DISCRETE SAMPLE
SUBSURFACE SOIL DISCRETE SAMPLE
LL2ss-027M .... SOIL ISM
GENERAL AREA OF REMEDIATION
RESIDENTIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES
NO COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10^{-5})
COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10^{-5})

NOTE:

SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

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Plate 3-4. Load Line 2
Residential Remediation Areas

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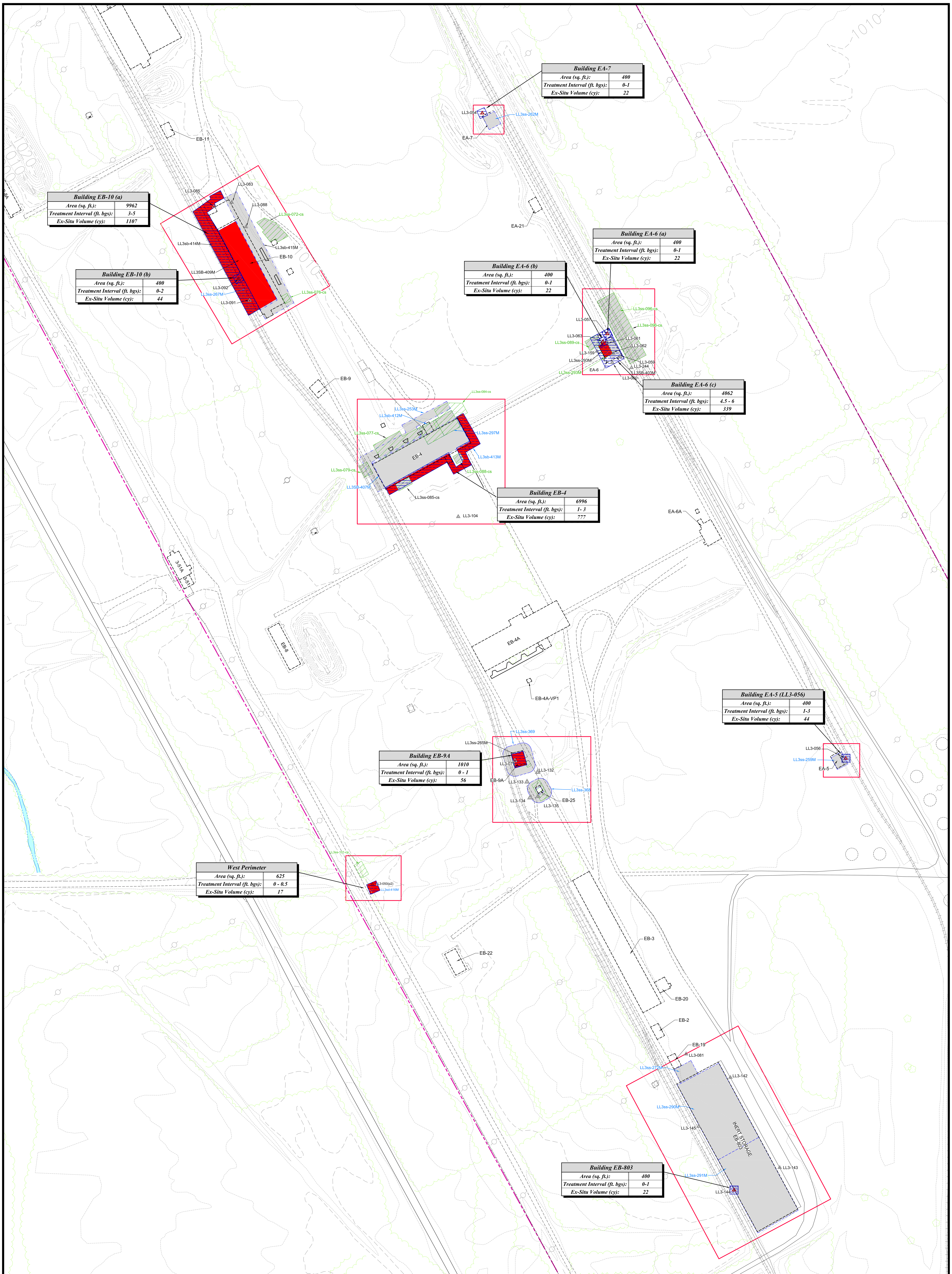

LEGEND:

DEMOLISHED BUILDING
WALKWAY
FENCE LINE
FORMER RAILROAD
SURFACE WATER
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
VEGETATION
AOC BOUNDARY
LL2ss-005-cs REMEDIATION AREA
-CS CONFIRMATION SAMPLE
SURFACE SOIL DISCRETE SAMPLE
SUBSURFACE SOIL DISCRETE SAMPLE

LL3ss-027M SOIL ISM
GENERAL AREA OF REMEDIATION
INDUSTRIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES
NO COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10-5)
COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10-5)

LL-3 AOC
EA-7
EB-10
EA-6
EB-4
EA-5
EB-9A
EB-803
KEY MAP

NOTE:
SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

OHIO STATE PLANE (NAD 83)
0 50 100 200
SCALE: 1" = 100'

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Plate 3-5. Load Line 3
Industrial Remediation Areas

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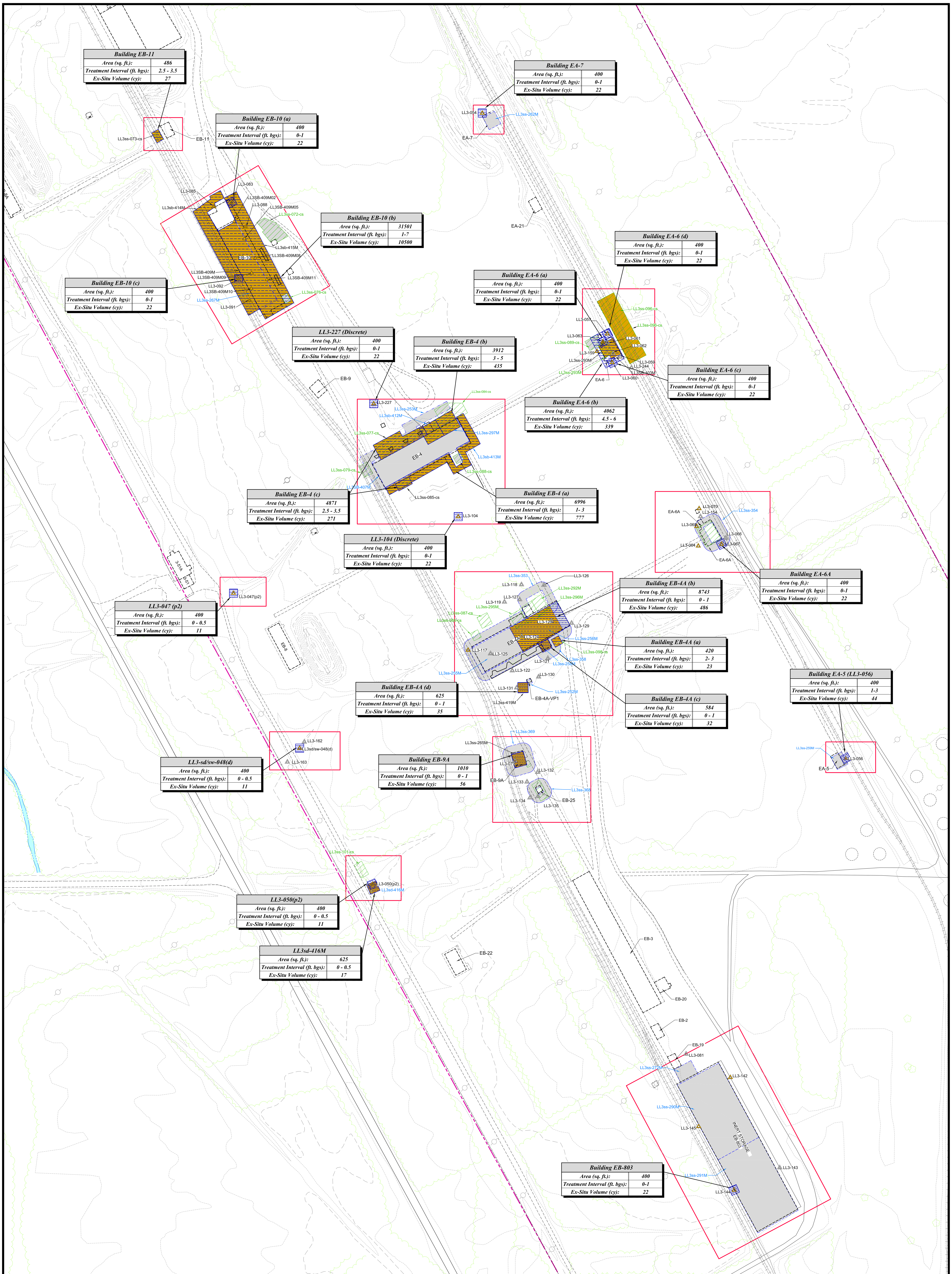
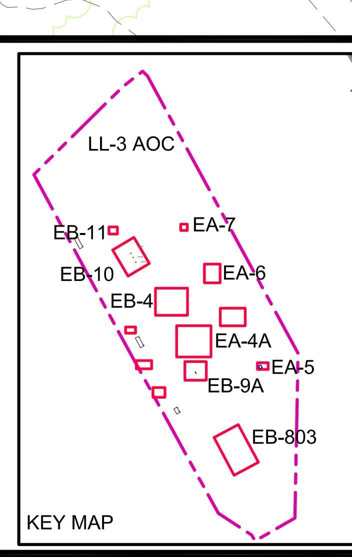


LEGEND:

- DEMOLISHED BUILDING
- WALKWAY
- FENCE LINE
- FORMER RAILROAD
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- LL2ss-005-cs REMEDIATION AREA
- -CS CONFIRMATION SAMPLE
- SURFACE SOIL DISCRETE SAMPLE
- SUBSURFACE SOIL DISCRETE SAMPLE
- LL3ss-027M SOIL ISM
- GENERAL AREA OF REMEDIATION
- RESIDENTIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES

- NO COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10^{-5})
- COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10^{-5})



NOTE:
SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

OHIO STATE PLANE (NAD 83)

0 50 100 200
SCALE: 1" = 100'

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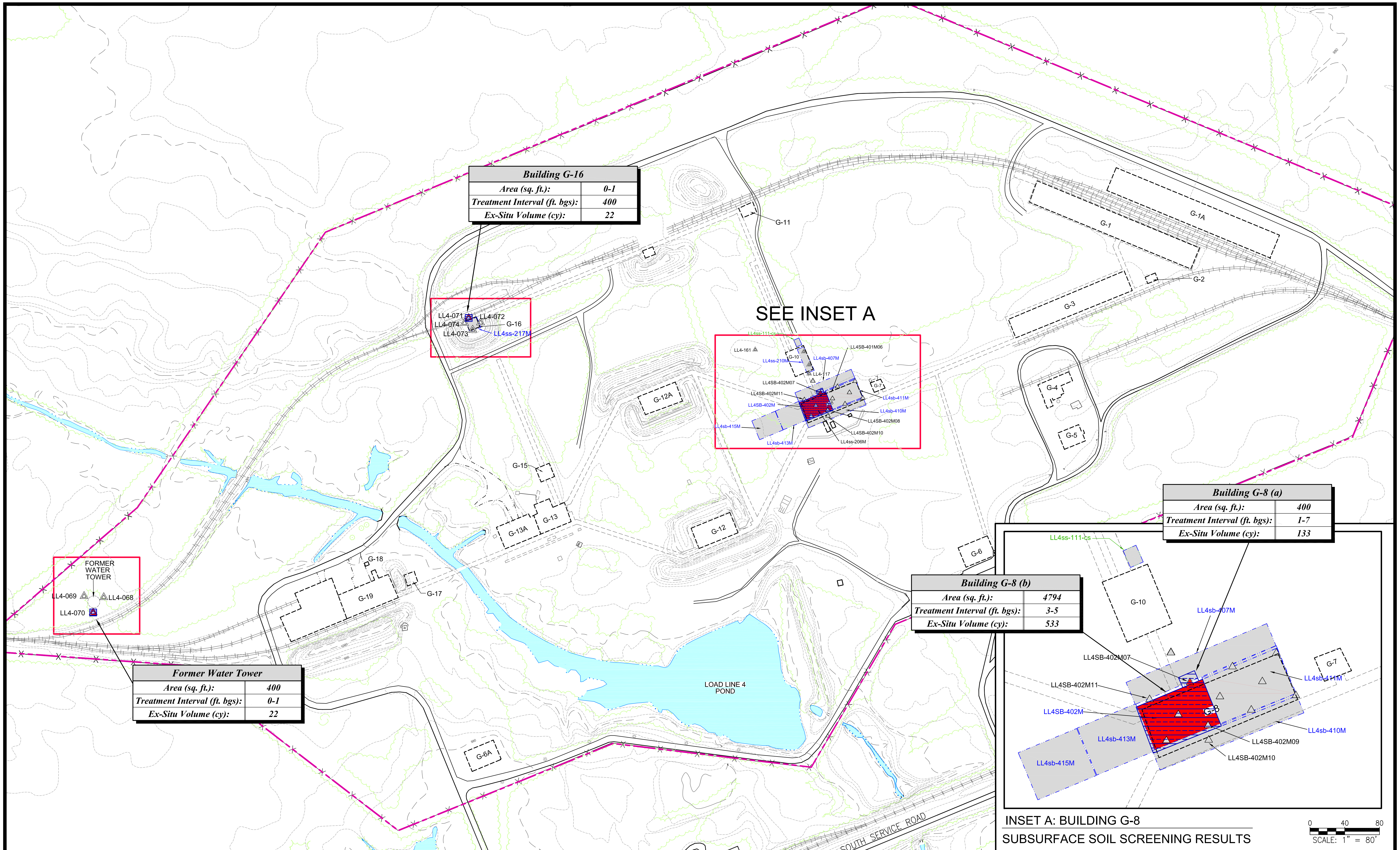
Plate 3-6. Load Line 3 Residential Remediation Areas

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\14015\DWGS
P. HOLM	6/9/17	R15-LL3-PLATE3-6



LEGEND:

- DEMOLISHED BUILDING
- WALKWAY
- FENCE LINE
- FORMER RAILROAD
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- LL2ss-005-cs ...... REMEDIATION AREA
- -CS ...... CONFIRMATION SAMPLE
- SURFACE SOIL DISCRETE SAMPLE
- SUBSURFACE SOIL DISCRETE SAMPLE
- LL4ss-027M ...... SOIL ISM
- GENERAL AREA OF REMEDIATION
- INDUSTRIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES

- NO COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10^{-5})
- COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10^{-5})

NOTE:

SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

OHIO STATE PLANE (NAD 83)

0 100 200 400

SCALE: 1" = 200'

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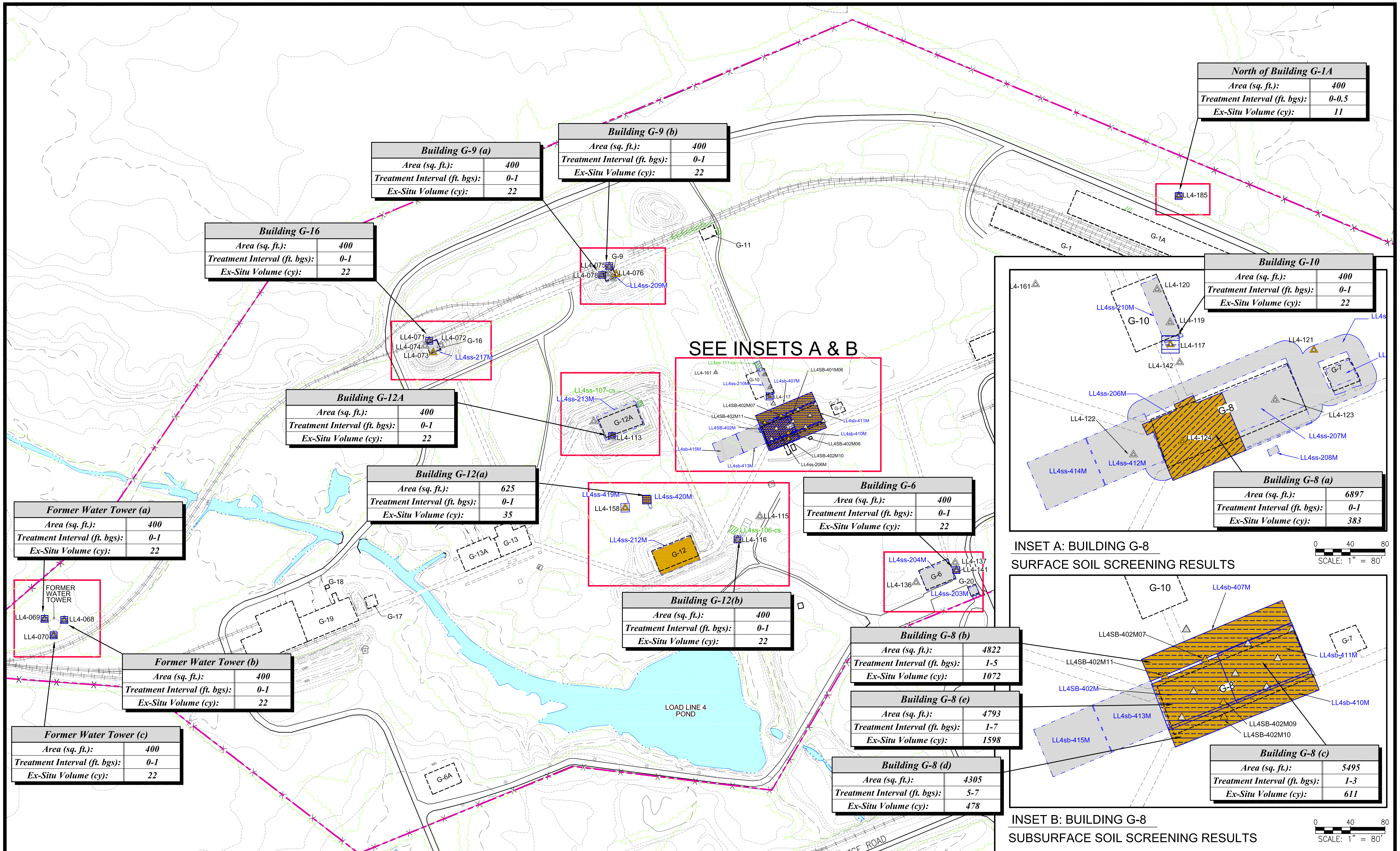
Plate 3-7. Load Line 4 Industrial Remediation Areas

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\14015\DWGS
P. HOLM	R1/ 11/13/16	R15-LL4-PLATE3-7



North of Building G-1A	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-0.5
Ex-Situ Volume (cy):	11

Building G-9 (b)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-9 (a)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-16	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-10	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-12A	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-12(a)	
Area (sq. ft.):	625
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	35

Building G-6	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-8 (a)	
Area (sq. ft.):	6897
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	383

Former Water Tower (a)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-12(b)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-8 (b)	
Area (sq. ft.):	4822
Treatment Interval (ft. bgs):	1-5
Ex-Situ Volume (cy):	1072

Former Water Tower (b)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-8 (e)	
Area (sq. ft.):	4793
Treatment Interval (ft. bgs):	1-7
Ex-Situ Volume (cy):	1598

Former Water Tower (c)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-1
Ex-Situ Volume (cy):	22

Building G-8 (c)	
Area (sq. ft.):	5495
Treatment Interval (ft. bgs):	1-3
Ex-Situ Volume (cy):	611

Building G-8 (d)	
Area (sq. ft.):	4305
Treatment Interval (ft. bgs):	5-7
Ex-Situ Volume (cy):	478

LEGEND:

- DEMOLISHED BUILDING
- WALKWAY
- FENCE LINE
- FORMER RAILROAD
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- LL4ss-005-cs REMEDIATION AREA
- -CS CONFIRMATION SAMPLE
- SURFACE SOIL DISCRETE SAMPLE
- SUBSURFACE SOIL DISCRETE SAMPLE
- LL4ss-027M SOIL ISM
- GENERAL AREA OF REMEDIATION
- RESIDENTIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES

- NO COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10-5)
- COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10-5)

NOTE:

SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

OHIO STATE PLANE (NAD 83)

0 100 200 400

SCALE: 1" = 200'

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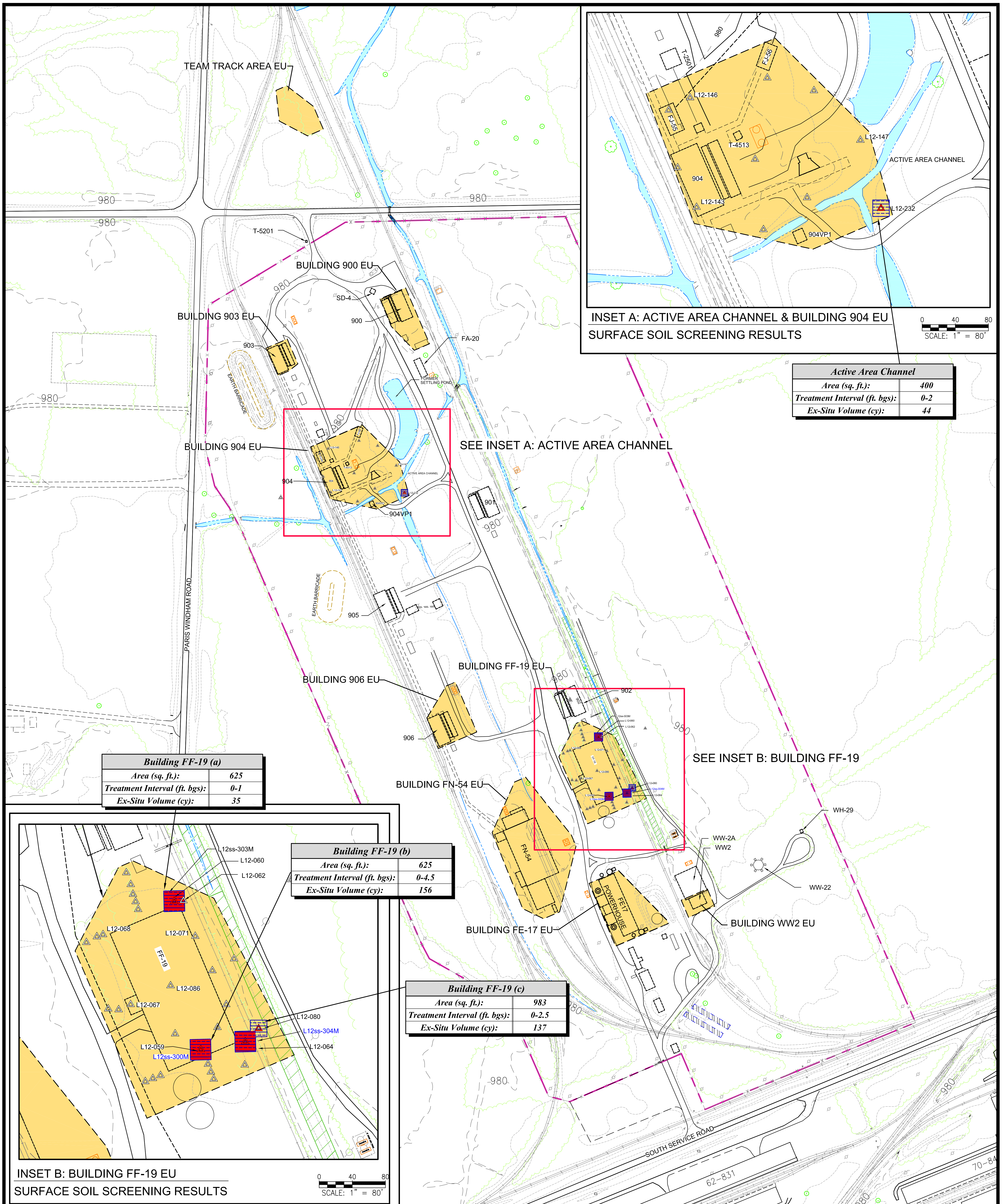
Plate 3-8. Load Line 4
Residential Remediation Areas

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\14015\DWGS
P. HOLM	R1/ 11/13/16	R15-LL4-PLATE3-8



Active Area Channel	
Area (sq. ft.):	*400*
Treatment Interval (ft. bgs):	*0-2*
Ex-Situ Volume (cy):	*44*

Building FF-19 (a)	
Area (sq. ft.):	*625*
Treatment Interval (ft. bgs):	*0-1*
Ex-Situ Volume (cy):	*35*

Building FF-19 (b)	
Area (sq. ft.):	*625*
Treatment Interval (ft. bgs):	*0-4.5*
Ex-Situ Volume (cy):	*156*

Building FF-19 (c)	
Area (sq. ft.):	*983*
Treatment Interval (ft. bgs):	*0-2.5*
Ex-Situ Volume (cy):	*137*

LEGEND:

- FENCE LINE
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- REMEDIATION AREA
- FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)
- EXPOSURE UNIT (EU)
- SURFACE SOIL DISCRETE SAMPLE
- LLxss-027M SOIL ISM
- GENERAL AREA OF REMEDIATION
- INDUSTRIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES

- NO COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10-5)
- COCs DETECTED ABOVE INDUSTRIAL RGO (HQ=1.0, RISK=10-5)

NOTE:
SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

OHIO STATE PLANE (NAD 83)

0 100 200
SCALE: 1" = 200'

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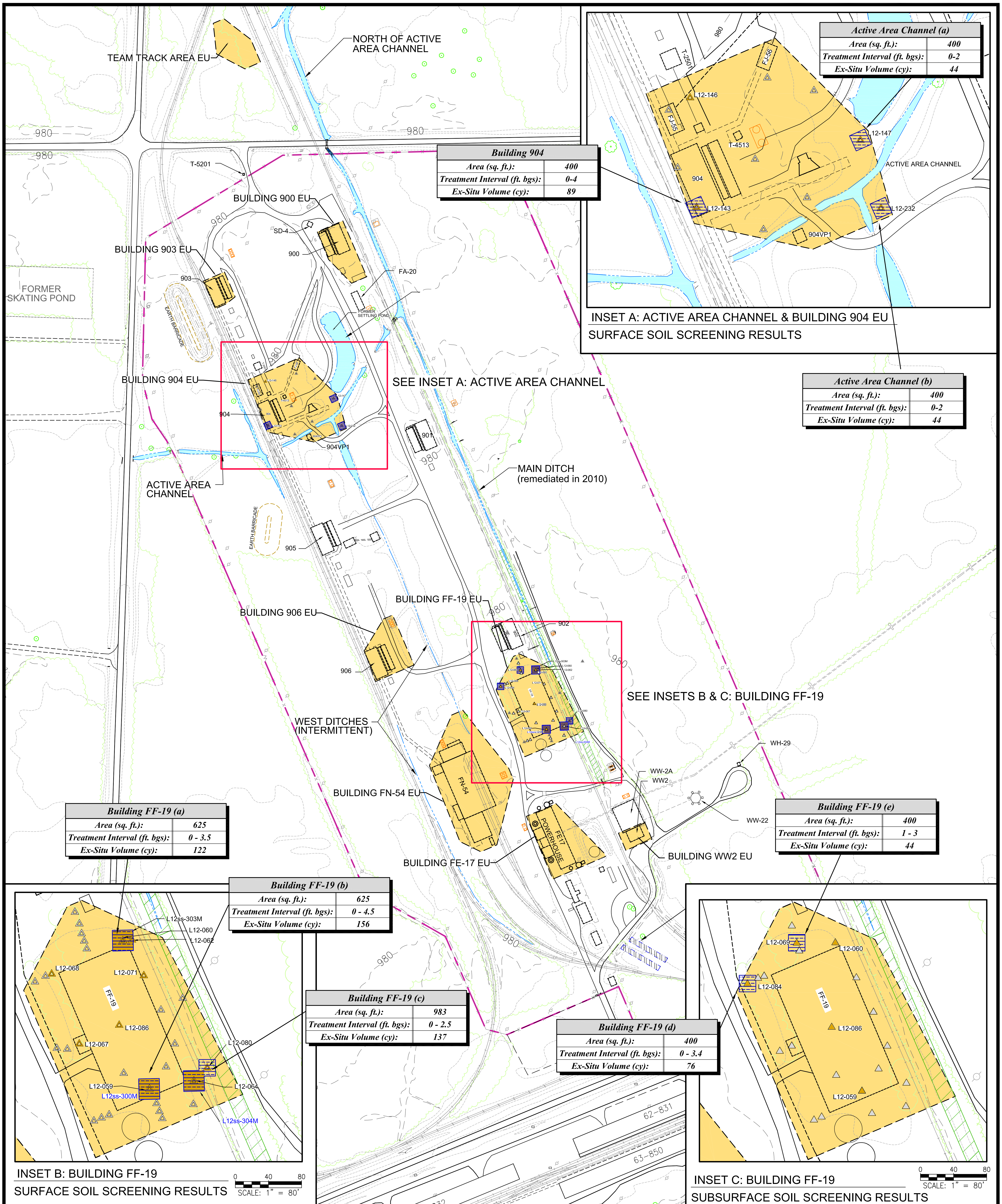
Plate 3-9. Load Line 12 Industrial Remediation Areas

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\14015\DWGS
P. HOLM	11/13/16	R15-LL12-PLATE3-9



Building 904	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-4
Ex-Situ Volume (cy):	89

Active Area Channel (a)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	44

Active Area Channel (b)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0-2
Ex-Situ Volume (cy):	44

Building FF-19 (a)	
Area (sq. ft.):	625
Treatment Interval (ft. bgs):	0 - 3.5
Ex-Situ Volume (cy):	122

Building FF-19 (b)	
Area (sq. ft.):	625
Treatment Interval (ft. bgs):	0 - 4.5
Ex-Situ Volume (cy):	156

Building FF-19 (c)	
Area (sq. ft.):	983
Treatment Interval (ft. bgs):	0 - 2.5
Ex-Situ Volume (cy):	137

Building FF-19 (d)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	0 - 3.4
Ex-Situ Volume (cy):	76

Building FF-19 (e)	
Area (sq. ft.):	400
Treatment Interval (ft. bgs):	1 - 3
Ex-Situ Volume (cy):	44

LEGEND:

- FENCE LINE
- SURFACE WATER
- GROUND CONTOUR (10-FT INTERVAL)
- GROUND CONTOUR (2-FT INTERVAL)
- VEGETATION
- AOC BOUNDARY
- REMEDIATION AREA
- FACILITY-WIDE COAL STORAGE (CC-RVAAP-73)
- EXPOSURE UNIT (EU)
- SURFACE SOIL DISCRETE SAMPLE
- LLxss-027M SOIL ISM
- GENERAL AREA OF REMEDIATION
- RESIDENTIAL REMEDIATION AREA

DISCRETE & ISM SAMPLES

- NO COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10-5)
- COCs DETECTED ABOVE RESIDENTIAL RGO (HQ=1.0, RISK=10-5)

NOTE:

SAMPLE LOCATIONS SHOWN ONLY IN REMEDIATION AREAS

OHIO STATE PLANE (NAD 83)

0 100 200
SCALE: 1" = 200'

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Plate 3-10. Load Line 12 Residential Remediation Areas

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\14015\DWGS
P. HOLM	11/13/16	R15-LL12-PLATE3-10

4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section presents the chemical-, location-, and action-specific ARARs for these sites.

4.1 INTRODUCTION

CERCLA Section 121 specifies that remedial actions must comply with requirements or standards under federal or more stringent state environmental laws that are "applicable or relevant and appropriate to the hazardous substances or particular circumstances at the AOC." Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured. This section summarizes potential federal and state chemical-, location-, and action-specific ARARs for potential remedial actions at the AOC.

ARARs include those federal and state regulations that are designed to protect the environment. Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (40 CFR 300.5). USEPA has stated in the NCP that applicable requirements are those requirements that would apply if the response action were not taken under CERCLA.

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site" (40 CFR 300.5).

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding, but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs, but are to-be-considered (TBC) guidance (40 CFR 300.400[g][13]).

CERCLA on-site remedial response actions must only comply with the substantive requirements of a regulation and not the administrative requirements. Both the definitions of "applicable" and "relevant and appropriate" require that the federal or state requirement be substantive (i.e., cleanup standards, standards of control, and other substantive requirements, criteria, or limitations) (40 CFR §300.5). Substantive is further defined in USEPA guidance as "those requirements that pertain directly to actions in the environment (CERCLA Compliance with Other Laws Manual: Interim Final, page 1-11, USEPA, Office of Emergency and Remedial Response, EPA/540/G-89/006, August 1988). Administrative requirements are not considered ARARs and are described as those mechanisms of laws or regulation that facilitate implementation of the substantive requirements or methods or procedures by which substantive requirements are made effective. Certain administrative requirements should be observed if they are useful in determining cleanup standards at the site (55 Federal Register [FR] 8666, 8757, March 8, 1990). Offsite actions, on the other hand, are subject to the full requirements of the applicable standards or regulations, including all administrative and procedural requirements.

Although remedial actions for AOCs at National Priorities List (NPL) sites must comply only with the substantive requirements of federal or state environmental regulations, the Ohio Revised Code does not provide a similar permit waiver for actions conducted under the Ohio EPA Remedial Response Program Policy. Ohio EPA's DERR Policy DERR-00-RR-034 states "it has been DERR's policy to require responsible parties to acquire and comply with all necessary permits, including the substantive and administrative requirements." However, a DFFO was entered into on June 10, 2004 that provided certain exemptions from the Ohio Administrative Code (OAC) administrative requirements and required groundwater monitoring and remediation at RVAAP to be performed under the CERCLA process. The DFFO includes provisions for compliance that may result in the potential negation of all provided exemptions within the DFFO in the event non-compliant activities are identified.

4.2 POTENTIAL ARARs

USEPA classifies ARARs as chemical-, action-, and location-specific to provide guidance for identifying and complying with ARARs (USEPA 1988):

- Chemical-specific ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, allow numerical values to be established. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment (USEPA 1988).
- Action-specific ARARs are rules, such as performance-, design-, or other activity-based rules, which place requirements or limitations on actions.
- Location-specific ARARs are rules that place restrictions on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations (USEPA 1988).

As explained in the following paragraph, rules from each of these categories are ARARs only to the extent that they relate to the degree of cleanup.

CERCLA Section 121 governs cleanup standards at CERCLA sites. ARARs originate in the subsection of CERCLA that specifies the degree of cleanup at each AOC: CERCLA Section 121(d). In Section 121(d)(2), CERCLA expressly directs that ARARs are to address specific contaminants of concern at each AOC, specifying the level of protection to be attained by any chemicals remaining at the AOC. CERCLA Section 121(d)(2) provides that, with respect to hazardous substances, pollutants, or contaminants remaining on-site after completing a remedial action, ARARs are:

> "Any standard, requirement, criteria, or limitation under any federal environmental law … or any promulgated standard, requirement, criteria, or limitation under a State environmental or

facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation."

CERCLA Section 121(d)(2) further states that the remedial action must attain a level of control established in rules determined to be ARARs. CERCLA Section 121(d)(1) dictates that remedial actions must achieve a degree of cleanup that is protective of human health and the environment. An evaluation of the regulatory requirements has shown there are no chemical-specific ARARs for the chemicals identified in various media at the AOC.

4.2.1 Potential Chemical-specific ARARs

A review of the regulations indicated there are no potential chemical-specific ARARs for any of the site COCs.

4.2.2 Potential Action-specific ARARs

Potential excavation and disposal of contaminated environmental media at the AOC will trigger potential ARARs associated with land disturbance and emission controls. OAC 3745-15-07 requires that nuisance air pollution emissions be controlled. This includes controlling potential fugitive dust from soil handling excavation activities. In addition, any construction (e.g., soil disturbance activities encompassing over an acre) would trigger the storm water requirements found in 40 CFR Part 450. These requirements mandate that erosion and sedimentation control measures be designed and implemented to control erosion and sediment runoff.

Because excavation would include generating and managing contaminated media, Resource Conservation and Recovery Act (RCRA) requirements would be considered potential ARARs for this activity. RCRA requirements mandate that a generator must determine whether a material is (or contains in the case of environmental media) a hazardous waste under OAC 3745-52-11. If a material is determined to be or contain a listed hazardous waste, or exhibits a hazardous waste characteristic, additional management requirements under RCRA must be followed as an ARAR under CERCLA.

These requirements include how hazardous waste is stored, treated, transported, and disposed of. In addition to the substantive requirements associated with managing and storing material RCRA hazardous waste (or found to contain such waste), prescribe standards for disposing of hazardous material, including land disposal restrictions (LDRs) prohibiting disposal of specific chemicals until they are treated to a specified level, or by a specific treatment technology.

USEPA cautions that LDRs should not be used to determine site-specific cleanup levels for soil (USEPA 2002). The purpose of LDRs is to require appropriate treatment of RCRA hazardous waste that is to be disposed of to minimize short- and long-term threats to human health or the environment based upon available technology. Performing treatment to meet LDR standards is different from the CERCLA approach to remediation, which analyzes risk and develops soil cleanup standards based on the risk present. This approach may result in soil cleanup levels that are different from those of a risk-based approach. Nevertheless, if RCRA hazardous waste is generated from the CERCLA action and is disposed of on site, the material must meet the established LDR standards.

In order for LDRs to be triggered as potential ARARs, RCRA hazardous waste must be present. This requires that (1) soil contain contaminants derived from RCRA-listed waste or exhibits a characteristic of RCRA hazardous waste, and (2) soil is managed in a way that “generates” hazardous waste. One exception to generation when managing wastes during remediation is the AOC approach. Specified management of wastes within USEPA’s AOC policy does not generate hazardous waste.

If soil is managed in a manner that generates hazardous waste, such as removing it to an aboveground container and then redepositing it within the land unit for disposal, then LDRs become potential ARARs. Potential LDR ARARs in Ohio are variances from treatment standards in OAC Section 3745-270-44, LDR standards for contaminated debris in OAC Section 3745-270-45, Universal Treatment Standards (UTS) in OAC Section 3745-270-48, and Alternative Standards for Contaminated Soil in OAC Section 3745-270-49. Only the alternative soil treatment standards are explained in this document.

Ohio has adopted the alternative soil treatment standards promulgated by USEPA in its Phase IV LDR rule, in effect since August 1998. Under the alternative soil treatment standards, all soil subject to treatment must be treated as follows:

1. For non-metals except carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in total constituent concentration, subject to item three below.
2. For metals and carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in constituent concentrations, as measured in leachate from the treated media (tested according to the toxicity characteristic leaching procedure [TCLP]), or 90% reduction in total constituent concentrations (when a metal removal treatment technology is used), subject to item three below.
3. When treating any constituent subject to a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. This is commonly referred to as “90% capped by 10xUTS.”

USEPA and Ohio EPA RCRA regulations provide for a site-specific variance from the soil treatment standards for contaminated soil. If approved, alternative risk-based LDR treatment standards can be applied that minimize short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede soil treatment standards.

If soil is found to be contaminated but not a RCRA hazardous waste, management and disposal of this material would be subject to the requirements associated with managing and disposing of solid waste within the State of Ohio. The transportation, temporary storage, and treatment of the soil are not directly regulated; however, the treated soil is still considered a solid waste after treatment and its ultimate reuse on site would require an exemption by the Ohio Division of Materials and Waste Management Solid Waste program.

A permit-by-rule (PBR) is a specific permit exemption in the OAC that applies to certain types of low-emitting air pollution sources. Soil vapor emissions from a thermal treatment system would require exemption under OAC 3745-31-03 PBR. The PBR contains qualifying criteria, emission limitations, conditions for operation, and requirements for record keeping and reporting. Potential action-specific ARARs are listed in Table 4-1.

4.2.3 Potential Location-specific ARARs

Location requirements include, but are not limited to, those established for potential remedial activities conducted within wetlands, within a floodplain area, or with respect to federal- or state-listed species. Generally, for wetlands and floodplains, alternatives are required to be developed to conduct remedial activities outside the sensitive area; if that is not feasible, adverse effects from any actions taken within the sensitive area must be mitigated to the extent possible. These requirements do not relate to specific chemicals, nor do they change the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances. Rather, their purpose is to protect sensitive areas to the extent possible. Under CERCLA Section 121(d), relevance and appropriateness are related to the circumstances presented by the release of hazardous substances, with the goal of attaining a degree of cleanup and controlling further releases to ensure protection of human health and the environment.

No location-specific ARARs have been identified for Load Lines 1 through 4 and 12. However, because sensitive resources (e.g., wetlands) have been identified within the Load Lines 1 through 4 and 12, if any remedial activities at the Load Lines 1 through 4 and 12affect these wetlands, Executive Order (EO) 11990 (40 CFR 6, Appendix A) would be considered TBC guidance and OAC 3745-1-54 would be considered an ARAR for the site. The following actions have the potential to minimize impact to wetlands during the design and implementation of remedial actions:

- Identify potential wetland impacts caused by the selected remedial alternative:
  - Changes to wetlands hydrology
  - Impact to water quality
  - Impact to habitat quality
  - Impact to vegetative community
- Demonstrate compliance with mitigation provisions by:
  - Avoiding wetland and water impacts where practicable
  - Minimizing potential impacts to wetlands and water
  - Compensating for any remaining, unavoidable impacts to wetlands or waters through activities to enhance or create wetlands and/or waters.

Although no location-specific standards have been identified as ARARs, any action taken by the federal government must be conducted in accordance with requirements established under the National Environmental Policy Act, Endangered Species Act, National Historic Preservation Act, Native American Graves Protection and Repatriation Act, state burial laws, and federal and state wetlands and floodplains construction and placement of materials considerations, even though these laws and rules do not establish standards, requirements, limitations, or criteria relating to the degree of cleanup for chemicals remaining on site at the close of the response actions.

Table 4-1. Potential Action-specific ARARs

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Prohibition of air pollution nuisances (e.g., fugitive dust) OAC Section 3745-15-07	These rules prohibit releasing nuisance air pollution that endangers health, safety, or welfare of the public or cause personal injury or property damage.	Applies to any activity that could result in the release of a nuisance air pollutant. This would include dust from excavation or soil management processes.	Any person undertaking an activity is prohibited from emitting nuisance air pollution.
Storm water requirements at construction sites 40 CFR Part 450	These rules require that storm water controls be employed at construction sites that exceed 1 acre.	Applies to any construction activity that exceeds 1 acre.	Persons undertaking construction activities (including grubbing and land clearing) at an AOC where the construction footprint is more than 1 acre must design and implement erosion and runoff controls.
Generation of contaminated soil or debris OAC Section 3745-52-11	These rules require that a generator determine whether a material generated is a hazardous waste.	Applies to any material that is or contains a solid waste. Must be characterized to determine whether the material is or contains a hazardous waste.	Any person that generates a waste as defined must use prescribed methods to determine if waste is considered characteristically hazardous using the prescribed methods.
Temporary on-site storage of remediation waste in staging piles OAC Section 3745-57-74	These rules require hazardous wastes to be staged in a pile that is designed to facilitate a reliable, effective, and protective remedy; and be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross-media transfer as necessary to protect human health and the environment (e.g., use of liners, covers, runoff/run-on controls as appropriate).	Applies to the accumulation of non-flowing hazardous remediation waste.	In setting the standards and design criteria, the director must consider the following factors: • Length of time pile will be in operation; • Volumes of waste you intend to store in the pile; • Physical and chemical characteristics of the wastes to be stored in the unit; • Potential for releases from the unit; • Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and • Potential for human and environmental exposure to potential releases from the unit.

Table 4-1. Potential Action-specific ARARs (continued)

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
			At closure, a staging pile must be closed by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate. Any contaminated subsoil in a previously contaminated area must be decontaminated in a manner the director determines will protect human health and the environment. In uncontaminated areas, contaminated subsoil must be decontaminated or removed. If they cannot be practicably removed, post closure care must be provided.
Management of contaminated soil or debris that is or contains a hazardous waste OAC Sections 3745-52-30 through 3745-52-34	These rules require that hazardous waste be properly packaged, labeled, marked, and accumulated on site pending on- or off-site disposal.	Applies to any hazardous waste, or media containing a hazardous waste that is generated from on-site activities.	All hazardous waste must be accumulated in a compliant manner that includes proper marking, labeling, and packaging in accordance with the specified regulations. This includes inspecting containers or container areas where hazardous waste is accumulated on site.
Soil contaminated with RCRA hazardous waste OAC Section 3745-270-49 OAC Section 3745-270-48 UTS	These rules prohibit land disposal of RCRA hazardous wastes subject to them, unless the waste is treated to meet certain standards that are protective of human health and the environment. Standards for treating hazardous waste-contaminated soil prior to disposal are set forth in the two cited rules. Using the greater of either technology-based standards or UTS is prescribed.	LDRs apply only to RCRA hazardous waste. This rule is considered for ARAR status only upon generating a RCRA hazardous waste. If any soil is determined to be RCRA hazardous waste, and if it will be disposed of on site, this rule is potentially applicable to disposal of the soil.	All soil subject to treatment must be treated as follows: (1) For non-metals except carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in total constituent concentration (primary constituent for which the waste is characteristically hazardous as well as for any organic or inorganic UHC), subject to item 3 below. (2) For the inorganic chemicals and carbon disulfide, cyclohexanone,

Table 4-1. Potential Action-specific ARARs (continued)

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
			and methanol, treatment must achieve 90% reduction in constituent concentrations as measured in leachate from the treated media (tested according to the TCLP) or 90% reduction in total constituent concentrations (when a metal removal treatment technology is used), subject to item 3 below. (3) When treating any constituent subject to achieve a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. This is commonly referred to as "90% capped by 10x UTS."
Soil/debris contaminated with RCRA hazardous waste – variance OAC Section 3745-270-44	The Ohio EPA Director will recognize a variance approved by USEPA from the alternative treatment standards for hazardous contaminated soil or for hazardous debris.	Potentially applicable to RCRA hazardous soil or debris that is generated and placed back into a unit and that will be disposed of on site.	A site-specific variance from the soil treatment standards that can be used when treatment to concentrations of hazardous constituents higher than those specified in the soil treatment standards and minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the soil treatment standards.

Table 4-1. Potential Action-specific ARARs (continued)

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Treatment of hazardous waste in a miscellaneous treatment unit OAC Section 3745-57-91	These standards address the management and treatment of hazardous wastes when such activities do not fall under the descriptions or prerequisites of other hazardous waste units covered in the regulations.	Potentially applicable to the thermal treatment of RCRA hazardous waste.	Unit must be located, designed, constructed, operated and maintained, and closed in a manner that will ensure protection of human health and the environment. Protection of human health and the environment includes, but is not limited to, prevention of any release that may have adverse effects on human health or the environment due to migration of waste constituents in the air, considering the factors listed in OAC Section 3745-57-91.
Reuse of treated soil as fill ORC 3734.02	Ohio considers the soil that will be excavated and treated to be a solid waste. The transportation, temporary storage, and treatment of the soil are not directly regulated; however, the treated soil is still considered a solid waste after treatment and its ultimate disposal is regulated by our Division of Materials and Waste Management Solid Waste program. An exemption in this case, would exempt the treated soil from solid waste disposal and closure requirements, thus allowing its unrestricted use or placement on the facility.	Applies to treated soil reused as fill at the facility	The director, by order, may exempt any person generating, collecting, storing, treating, disposing of, or transporting solid wastes, in such quantities or under such circumstances that, in the determination of the director, are unlikely to adversely affect the public health or safety or the environment from any solid waste requirement.
Permits-to-install, exemptions and permits-by-rule OAC Section 3745-31-03	A PBR is a specific permit provision in the OAC that applies to certain types of low-emitting air pollution sources.	Potentially applicable if a thermal treatment system is selected for remedy.	Requires a generator to obtain a PBR exemption for low-emitting air pollution sources prior to operating a thermal treatment system.

AOC = Area of Concern.
ARAR = Applicable or Relevant and Appropriate Requirement.
CFR = Code of Federal Regulations.
LDR = Land Disposal Restriction.
OAC = Ohio Administrative Code.
Ohio EPA = Ohio Environmental Protection Agency.
PBR = Permit-By-Rule.
RCRA = Resource Conservation and Recovery Act.
TCLP = Toxicity Characteristic Leaching Procedure.
UHC = Underlying Hazardous Constituent.
USEPA = U.S. Environmental Protection Agency.
UTS = Universal Treatment Standards.

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5.0 TECHNOLOGY TYPES AND PROCESS OPTIONS

This section identifies and describes GRAs that may be implemented to achieve RGOs. In addition, this section summarizes the remedial technologies and process options available to remediate COCs in soil and sediment, as identified in Section 3.0.

The procedure for identifying and screening potential remedial technologies followed the method established in the USEPA guidance document, *Guidance for Conducting Remedial Investigation/Feasibility Studies Under CERCLA* (USEPA 1988). This guidance document provides the framework for identifying and screening all available and most appropriate remedial technologies based on the COCs and AOC characteristics (e.g., soil type).

5.1 GENERAL RESPONSE ACTION

GRAs are actions that may be implemented to satisfy RAOs. The actions may be individual or a combination of responses. The HHRA identified metals, explosives, PCBs, and PAHs above RGOs in surface and subsurface soil and sediment contributing to human health risk for the Industrial Receptor and Resident Receptor. The following GRAs are applicable and are defined in greater detail for Load Lines 1 through 4 and 12:

- No action,
- Institutional controls,
- Containment,
- Removal, and
- Treatment.

5.1.1 No Action

No action is required for evaluation under the NCP and is the baseline to which other remedial alternatives are compared. No action may be an appropriate alternative if no unacceptable risk is present at Load Lines 1 through 4 and 12. This GRA provides a baseline against which to compare other more proactive alternatives. Under this alternative, no action would be taken at Load Lines 1 through 4 and 12 to reduce risk to human health or the environment. Any existing actions, such as restrictions or monitoring, would be discontinued.

5.1.2 Institutional Controls

Institutional controls include engineering measures (i.e., fencing and warning signs) and non-engineering measures, such as administrative or legal controls, that are used to prevent or limit exposure to hazardous substances. Institutional controls do not reduce contaminant mobility, volume, or toxicity.

If institutional controls are selected as a component of a remedial alternative, the effectiveness of the remedy must undergo 5-year reviews. The primary goal of the 5-year reviews is to evaluate the implementation and performance of the remedy to determine if the remedy is or will be protective of human health and the environment. The 5-year reviews are discontinued when the remedy achieves RGOs for Unrestricted (Residential) Land Use.

5.1.3 Containment

Containment technologies are often used to prevent, or significantly reduce, the migration of contaminants in soil or sediment. In general, containment is performed when extensive subsurface contamination at a site precludes excavation and removal of wastes because of potential hazards, technical impracticality, and/or unrealistic cost.

The main advantage of containment methods is that they can prevent further migration of contaminant plumes by minimizing infiltration and leaching. Containment requires periodic inspections for leaks and ponding of liquids and periodic sampling to confirm integrity of the containment system.

Common types of containment technologies include capping (e.g., a clay cap, a multi-layered cap that includes clay and synthetic liners, or an asphalt or concrete cap) and soil covers.

5.1.4 Removal

Removing contaminated media from Load Lines 1 through 4 and 12 will reduce or eliminate the potential for long-term human and environmental exposure to chemicals exceeding concentrations determined to be protective for a given Land Use. Removed soil may or may not undergo pre-treatment prior to off-site disposal.

Disposal and handling, after removal, involves the final and permanent placement of waste material in a manner protective of human health and the environment. The impacted media could be disposed of on site in an engineered facility or off site in a permitted or licensed facility, such as a regulated landfill. Similarly, concentrated waste resulting from treatment processes could be disposed of on-site in a permanent disposal cell or in an off-site approved disposal facility.

Transportation of waste materials could be accomplished utilizing various methods, including truck, railcar, and/or barge.

5.1.5 Treatment

Treatment is conducted either in- or ex-situ to reduce contaminant concentrations to acceptable levels. Common types of treatment include biological, chemical, physical, and thermal treatment. Biological treatment involves using microbes to degrade contaminants. Chemical treatment processes add chemicals to react with contaminants to reduce their toxicity or mobility. Physical processes involve either physically binding the contaminant(s) to reduce mobility or the potential for exposure (e.g., encapsulation) or extracting the contaminant(s) from a medium to reduce volume. Thermal treatment, such as incineration, uses high temperatures to volatilize, decompose, or melt contaminants. For soil treated by ex-situ methods, the treatment may allow soil to be placed back into the excavation, or soil may be treated to reduce the chemical concentration or stabilize the soil prior to off-site disposal.

5.2 INITIAL SCREENING OF TREATMENT TECHNOLOGIES

Table 5-1 summarizes the remedial technologies and process options available for treating metals, explosives, PCBs, and PAHs above RGOs in surface and subsurface soil and sediment at Load Lines 1 through 4 and 12. The initial screening focuses on technology types capable of remediating the metals, explosives, PCBs, and PAHs and evaluates the implementability of the technology. If treatment technologies are evaluated and retained as potentially viable treatment options for Load Lines 1 through 4 and 12, the retained technology will undergo a more detailed evaluation described in Section 5.3.

5.3 DETAILED SCREENING OF TECHNOLOGIES

The remedial action technologies retained from the initial screening process are evaluated against criteria of effectiveness, implementability, and cost (three of the NCP balancing criteria). The rationale for either retaining or eliminating treatment options for Load Lines 1 through 4 and 12 is presented and summarized in Table 5-2. The remedial options retained from the detailed screening process used to develop the remedial alternatives are presented in Section 6.0.

5.3.1 Effectiveness

The effectiveness criterion assesses the ability of a remedial technology to protect human health and the environment by reducing the toxicity, mobility, or volume of contaminants. Each technology is evaluated for its ability to achieve RAOs, potential impacts to human health and the environment during construction and implementation, and overall reliability of the technology.

5.3.2 Implementability

Each process option/technology is evaluated for implementability in terms of technical feasibility; administrative feasibility; and availability of the necessary material, equipment, and work force. The assessment considers each technology's short- and long-term implementability. Short-term implementability considers constructability of the remedial technology, near-term reliability, ability to obtain necessary approvals with other agencies, and likelihood of obtaining a favorable community response. Long-term implementability evaluates the ease of undertaking additional remedial actions (if necessary), monitoring the effectiveness of the remedy, and operations and maintenance (O&M).

5.3.3 Cost

The cost criterion evaluates each remedial process in terms of relative capital and O&M costs. Costs for each technology are rated qualitatively, on the basis of engineering judgment, in terms of cost effectiveness. Therefore, a low cost remedial technology is rated as highly cost effective, while a costly technology is evaluated as being of low cost effectiveness.

Table 5-1. Initial Screening of Technologies

General Response Actions	Technology Type	Process Options	Description	Screening Results
No Action	None	None	No action is taken at Load Lines 1 through 4 and 12. Current LUCs, access restrictions, and monitoring programs will be discontinued. No remedial technologies are implemented to reduce hazards to potential human or ecological receptors.	Retained. Required under NCP to be carried through CERCLA analysis.
Institutional Controls	Access Restrictions	LUCs with CERCLA 5-Year Reviews	Implement LUCs at Load Lines 1 through 4 and 12 to restrict access and Land Use. LUCs will be administered and enforced as part of the Property Management Plan and reviewed in CERCLA 5-year reviews. Five-year reviews include reviewing sampling and monitoring plans and results of monitoring activities, conducting interviews and inspections, and reviewing status.	Retained.
		Fencing	Place fencing around areas of contamination (at a minimum) to restrict access and exposure to contamination left in place.	Not retained. Fencing will inhibit active use of the site for Commercial/Industrial Land Use.
Containment	Capping	Native Soil/Sediment	Uses native soil or sediment to cover contamination and reduce migration by wind and water erosion.	Not retained. Using a cap, liner, or asphalt/concrete in areas with contamination will inhibit active use of the site for Military Training or Commercial/Industrial Land Use.
		Clay	Clay layers are used to cover contamination and prevent exposure. Installing clay cap will limit water infiltration. Susceptible to weathering effects (e.g., cracking).	
		Synthetic Liner	A synthetic liner is used to cover contamination and prevent exposure. Synthetic material is used to limit water infiltration, which is not as susceptible to cracking as clay.	
		Multi-layered	Multiple layers of different soil types are used to limit water infiltration, which is not as susceptible to cracking as clay.	
		Asphalt/Concrete	Asphalt or concrete layers are used to cover contamination and prevent exposure. Additionally, this technology limits water infiltration; however, it is susceptible to cracking if not properly maintained.	
Removal	Bulk Removal	Excavation and Off-site Disposal	Contaminated material is removed and transported to permitted off-site treatment and disposal facilities.	Retained.

Table 5-1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
Treatment	In-situ Biological Treatment	Bioventing	Oxygen is delivered to contaminated unsaturated soil by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation.	Not retained. Although the technology successfully remediates organic chemicals, the presence of saturated soil and shallow groundwater impacts performance. In addition, the soil at the site has lower permeability than needed for this treatment. Not effective for metals.
		Enhanced Bioremediation	Adding oxygen and nutrients aids indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) in degrading (metabolizing) organic contaminants found in soil and/or groundwater, converting them to innocuous end products.	Retained.
		Phytoremediation	Using plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment.	Retained.
	In-situ Physical/Chemical Treatment	Chemical Oxidation	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	Not retained. The technology is not very effective for high molecular weight SVOCs in soil.
		Electrokinetic Separation	Removing inorganic chemicals and organic contaminants from low-permeability soil, mud, sludge, and marine dredging. Electrokinetic remediation uses electrochemical and electrokinetic processes to desorb and then remove inorganic chemicals and polar organic chemicals.	Not retained. The targeted contaminants for electrokinetics are heavy metals and polar organics. Technology is not effective for non-polar organics (e.g., SVOCs).
		Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to soil or injected into groundwater to raise the water table into the contaminated soil zone. Contaminants are leached into the groundwater, which is then extracted and treated.	Not retained. The soil permeability at the site is not conducive for effective soil flushing contaminant removal.

Table 5-1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
		Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to be removed from soil through extraction wells. This technology is also known as in-situ soil venting, in-situ volatilization, enhanced volatilization, or soil vacuum extraction.	Not retained. Technology focuses on remediating media contaminated with VOCs and some fuels. Not applicable for contaminants with low volatilization (e.g., metals, SVOCs).
		Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Not retained. This technology has limited effectiveness for explosives and SVOCs.
	In-situ Thermal Treatment	Thermal Treatment	Steam/hot air injection or electrical resistance/electromagnetic/fiber optic/radio frequency heating is used to increase the volatilization rate of semi-volatiles and facilitate extraction.	Not retained. Soil borings indicated debris exists within remediation areas. Debris or other large objects buried in the media can cause operating difficulties. Additionally, high moisture content has a reduced permeability to air, hindering the operation.
	Ex-situ Biological Treatment	Biopiles	Excavated soil is mixed with soil amendments and placed in aboveground enclosures. It is an aerated static pile composting process in which compost is formed into piles and aerated with blowers or vacuum pumps.	Retained.
		Land farming	Contaminated soil, sediment, or sludge is excavated, applied into lined beds, and periodically turned over or tilled to aerate the waste.	Not retained. Technology focuses on remediating media contaminated with volatile petroleum hydrocarbons. Not applicable for metals and SVOCs, as volatility is limited. Also, there is a chance of contaminant movement to previously non-contaminated areas of the site.

Table 5-1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
		Slurry Phase Biological Treatment	Aqueous slurry is created by combining soil, sediment, or sludge with water and other additives. The slurry is mixed to keep solids suspended and micro-organisms in contact with the soil contaminants. Upon completing the process, the slurry is dewatered, and the treated soil is disposed of.	Not retained. Due to the estimated quantities of soil requiring remediation, development, and the need for construction of a treatment area to dewater the slurry, this is not a practical technology.
	Ex-situ Physical/Chemical Treatment	Chemical Extraction	Waste-contaminated soil and extractant are mixed in an extractor, thereby dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment and further use.	Not retained. Technology focuses on remediating media contaminated with PCBs, VOCs, halogenated solvents, and petroleum waste. Although the technology is considered suitable for site contaminants, clay content (similar to site soil) reduces treatment efficiency.
		Chemical Reduction/Oxidation	Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert.	Not retained. The target contaminant group for this technology is inorganics. It has low effectiveness for high molecular weight SVOCs.
		Soil Washing	Contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organic chemicals and heavy metals.	Retained.

Table 5-1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
		Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Not retained. This technology has limited effectiveness for SVOCs and explosives.
	Ex-situ Thermal Treatment	Hot Gas Decontamination	Raises the temperature of the contaminated equipment or material for a specified period of time. The gas effluent from the material is treated in an afterburner system to destroy all volatilized contaminants.	Not retained. The technology is specific to addressing contaminated equipment or material, as opposed to contaminated soil.
		Incineration	High temperatures, 870-1,200°C (1,600-2,200°F), are used to combust (in the presence of oxygen) organic constituents in hazardous waste.	Retained.
		Pyrolysis	Chemical decomposition is induced in organic material by heat in the absence of oxygen. Organic material is transformed into gaseous components and a solid residue (coke) containing fixed carbon and ash.	Retained.
		Thermal Treatment	Waste is heated in a mobile thermal treatment system to volatilize organic contaminants. The vapor emissions are treated using air filters, and the treated vapor is reused as an energy source for the operation of the thermal treatment system.	Retained.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
LUC = Land Use Control.
NCP = National Oil and Hazardous Substances Pollution Contingency Plan.
PCB = Polychlorinated Biphenyl.
SVOC = Semi-volatile Organic Compound.
VOC = Volatile Organic Compound.

Table 5-2. Detailed Screening of Technologies

General Response Actions	Technology Type	Process Options	Effectiveness	Implementability	Cost	Screening Comments
No Action	None	None	Not effective. Exposure to contaminants left in place goes unsupervised and uncontrolled.	Easy to implement. No activities are implemented.	No cost. No activities driving cost.	Retained. Required by CERCLA.
Institutional Controls	Access Restrictions	LUCs with CERCLA 5-Year Reviews	Effective. Restricting exposure to contaminants is accomplished through training of people accessing the AOC. Enforcement comes from a Property Management Plan.	Easy to implement. LUCs and administrative controls currently take place at the former RVAAP. Most access to facility is by trained National Guardsmen. A facility fence deters trespassers. Five-year reviews are conducted at other AOCs.	Moderate cost.	Retained.
Removal	Bulk Removal	Excavation and Off-site Disposal	Effective. Once the contaminated soil is removed to achieve goals of a specific receptor, contaminant exposure to human health and the environment are eliminated for that receptor.	Moderately easy to implement. Technology has been implemented at the former RVAAP in the past. Equipment for implementation is readily available and disposal facilities are available within a reasonable distance.	Moderate cost.	Retained.
Treatment	In-situ Biological Treatment	Enhanced Bioremediation	Moderate effectiveness. Requires applying and mixing amendments in-situ for treatment.	Requires moderate effort for implementation. Long treatment times are required for reducing the high molecular weight PAH concentrations to below RGOs. These treatment times may extend beyond desirable schedule for the Army to start using the site.	Moderate cost.	Not retained. The time required for enhanced bioremediation to reduce PAH concentrations in soil to below RGOs is not practical given the desired Army schedule to begin using the site.
		Phytoremediation	Moderate to low effectiveness. Phytoremediation can be designed to address PAH constituents; however, effectiveness is limited.	Not easy to implement. The time required for phytoremediation to reduce PAH concentrations in the soil may extend beyond desirable schedule for the Army to start using the site. Phytoremediation usually takes more than one growing season. This technology is currently at the demonstration stage and not widely recognized by regulators. Additionally, concentrations can be hazardous to plants and may be mobilized into groundwater or bioaccumulated in animals.	Moderate cost. The cost effectiveness increases as the remedial footprint increases. The area requiring remediation is small; therefore, there is not optimal cost effectiveness.	Not retained. The time required for phytoremediation to reduce PAH concentrations in soil to below RGOs is not practical given the desired Army schedule to begin using the site.
	Ex-situ Biological Treatment	Biopiles	Moderate to low effectiveness. Biopiles are generally applied to VOCs and fuel hydrocarbons. The effectiveness of this technology decreases when applied to PAHs.	Moderate to low implementability. The time required for implementing biopiles (including a treatability study) may extend beyond desirable schedule for the Army to start using the site.	Moderate cost relative to anticipated soil quantity.	Not retained. Technology is not very effective for PAHs. Additionally, the time required for biopile treatment (including a treatability study) may extend beyond desirable schedule for the Army to start using the site.
	Ex-situ Physical/ Chemical Treatment	Soil Washing	Moderate effectiveness. Soil washing is more effective at reducing soil with high concentrations of contaminants (e.g., hazardous waste levels). Only a moderate reduction in concentration is required to achieve RGOs.	Not easy to implement. Treatability study may be required to demonstrate effectiveness. Implementing a treatability study is not practical given time constraints to transfer the AOC to NGB. An additional treatment step of washing the solvent (potentially a hazardous waste) will be required.	High cost. Soil washing is cost effective with high soil volumes. However, a relatively low volume of soil requires remediation.	Not retained. The volume of soil requiring remediation does not result in cost efficiency for this technology.

Table 5–2. Detailed Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Effectiveness	Implementability	Cost	Screening Comments
	Ex-situ Thermal Treatment	Incineration	Effective. PAHs are a main contaminant group for incineration.	Not easy to implement. Incineration uses combustors, fluidized beds, or kilns to combust the chemicals in soil. These are not readily available, nor would obtaining and installing the equipment be appropriate for a small removal quantity.	High cost. Incineration uses combustors, fluidized beds, or kilns to remediate the chemicals in soil. These are generally put in place for remediating large soil volumes and are not cost effective for the smaller volumes of soil requiring remediation.	Not retained. The technology is not easy to implement, as combustors, fluidized beds, or kilns are not readily available. There would be high cost relative to implementing incineration for the relatively small removal volume.
		Pyrolysis	Effective. PAHs are a main contaminant group for pyrolysis.	Not easy to implement. Pyrolysis uses kilns or furnaces to serve as a heating chamber for the contaminated soil. These are not readily available, nor would obtaining and installing a kiln or furnace be appropriate for a small removal quantity.	High cost. Pyrolysis includes a rotary kiln or fluidized bed furnace. These are generally put in place for remediating large soil volumes and are not cost effective for the smaller volumes of soil requiring remediation.	Not retained. The technology is not easy to implement, as kilns or furnaces are not readily available. There would be high cost relative to implementing pyrolysis for the relatively small removal volume.
		Thermal Treatment	Effective. PAH concentrations can be reduced to low levels meeting unrestricted use criteria. It is a green and sustainable technology that minimizes secondary waste generation and reduces carbon footprint. Thermal treatment is a demonstrated remedial technology for the treatment of PCBs in soil (USEPA 1993) and effective for soil impacted by explosives (FRTR table). Thermal treatment is not effective for inorganics.	Not easy to implement. However, a mobile treatment system is not as complex as the incineration or pyrolysis technology and can be easily mobilized onsite.	High cost if mobilization is required for such a small quantity. Thermal treatment is cost effective with high soil volumes; however, a relatively low volume of soil requires remediation. Cost can be considered low if on-site treatment system is readily available at the former RVAAP.	Retained. The volume of soil requiring remediation does not result in cost efficiency for this technology if mobilization of the thermal treatment system is required. However, if a treatment system is readily available at the former RVAAP, this alternative can be feasible.

AOC = Area of Concern.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
LUC = Land Use Control.
NGB = National Guard Bureau.
PAH = Polycyclic Aromatic Hydrocarbon.
RGO = Remedial Goal Option.
RVAAP = Ravenna Army Ammunition Plant.
VOC = Volatile Organic Compound.

6.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

This section describes the remedial alternatives developed and retained from the initial and detailed technology screening process. The retained remedial alternatives are composed of implementable and cost-effective technology types and process options that address COCs in soil at Load Lines 1through 4 and 12.

The retained remedial alternatives are:

- Alternative 1: No Action.
- Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs.
- Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs.
- Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment.
- Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment.

A detailed description of each remedial alternative is provided in the following sections.

6.1 ALTERNATIVE 1: NO ACTION

This alternative involves no remedial actions to prevent exposure to soil or sediment containing COCs at Load Lines 1 through 4 and 12. The NCP requires that the no action alternative be evaluated to establish a baseline for comparison with other alternatives, especially in terms of cost and protection to human health and the environment.

6.2 ALTERNATIVE 2: COMMERCIAL/INDUSTRIAL LAND USE – EXCAVATION AND OFF-SITE DISPOSAL OF SOIL AND ADMINISTRATIVE LUCs

This alternative would include the removal and off-site disposal of surface and subsurface soil containing COCs at concentrations above the Industrial RGOs to achieve Commercial/Industrial Land Use. The assumed extent of the excavation for each Load Line is presented on Plates 3-1 (Load Line 1), 3-3 (Load Line 2), 3-5 (Load Line 3), 3-7 (Load Line 4), and 3-9 (Load Line 12). Implementation of Alternative 2 would result in excavation and off-site disposal of approximately 5,838 cubic yards of soil from Load Lines 1 through 4 and 12. The volume of soil being removed from each excavation area and each load line is presented in Table 3-2.

Under this alternative, unacceptable risk will remain on site for the Resident Receptor at each load line; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to contaminants in soil in those areas. It will be the Army's responsibility to implement, inspect, maintain, and enforce LUCs at the former RVAAP. This remedial alternative requires coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. Components of this remedial alternative include:

- Remedial design (RD),
- Excavation and confirmation soil sampling,
- Waste characterization sampling,
- Off-site disposal of soil,
- Restoration,
- Land use control remedial design (LUCRD), and
- Five-year reviews.

Remedial Design – An RD will be developed prior to initiating remedial actions. This RD will outline construction permitting requirements; site preparation activities (e.g., staging and equipment storage areas, truck routes, storm water controls); the extent of the excavation; sequence and description of excavation and site restoration activities; decontamination; and segregation, transportation, and disposal of various waste streams. Erosion and health and safety controls will be enforced during the active construction period to ensure remediation workers and the environment are protected.

Excavation and Off-site Disposal of Soil – Site preparation would include clearing any obstacles, surface structures, or vegetation that would interfere with excavation, identifying utilities, and setting up temporary decontamination facilities. In addition, sediment and erosion control measures including a silt fence would be installed to control runoff from the work area. Soil removal will be accomplished using conventional construction equipment, such as backhoes, bulldozers, front-end loaders, and scrapers. Oversized debris will be crushed or otherwise processed to meet disposal facility requirements.

Excavated soil will be hauled by truck to a licensed and permitted disposal facility. All trucks will be inspected prior to exiting the AOC. Appropriate waste manifests will accompany each waste shipment. Only regulated and licensed transporters and vehicles will be used. All trucks will travel pre-designated routes within RVAAP.

Excavated soil will be disposed of at an existing off-site facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the type of waste, location, transportation options, and cost.

Waste Characterization Sampling – Waste characterization analysis would be completed to confirm the excavated material is non-hazardous. The excavated soil would be sampled and analyzed for TCLP metals, TCLP SVOCs, TCLP pesticides, TCLP herbicides, reactive cyanide, reactive sulfide, and PCBs to support waste profiling requirements for off-site disposal or as required by the receiving landfill. Based on available site data and for cost estimating purposes, the excavated soil is assumed to be non-hazardous and would be disposed of at a RCRA Subtitle D permitted landfill.

Confirmation Sampling – Upon completing the excavations at each load line, confirmatory ISM samples will be collected from each floor and sidewall of the excavation areas to ensure contaminated soils has been successfully removed. ISM samples collected for confirmation will include 30 to 50 aliquots per sample and be collected in duplicate to achieve DQOs. The confirmatory soil samples will be analyzed for COCs associated with each respective excavation area. The laboratory results will be compared to Industrial Receptor RGOs and additional excavation will be conducted at locations with exceeding results until RGOs are met. Once the laboratory analysis determines COC concentrations upon final excavation are below RGOs, the AOC will meet requirements for Commercial/Industrial Land Use.

Restoration **–** Upon completing soil excavation, all disturbed and excavated areas will be backfilled with clean soil and graded to meet neighboring contours. The backfill soil will come from a clean source that was previously sampled and approved for use by Ohio EPA. After the area is backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch. Restored areas will be inspected and monitored as required in the storm water best management practices established in the RD.

Land Use Control Remedial Design – Unacceptable risk will remain on site for the Resident Receptor in portions of each of the load lines; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to COCs in soil in those areas. An LUCRD will be developed to present the land use constraint (i.e., no residential use) and RAOs, and will specify the LUC requirements for Load Lines 1 through 4 and 12.

The LUC requirements will include LUC objectives, land restrictions (i.e., no residential use), potential modification and termination of LUCs, monitoring and reporting requirements, CERCLA 5-year reviews, LUC enforcement, and property transfers. This information will be presented in an attachment to the Property Management Plan for the Designated Areas of Concern and Munitions Response Sites (USACE 2012c). The Project Management Plan (PMP) identifies LUCs and restrictions for specific AOCs/MRSs within the former RVAAP. The procedures within the PMP are intended to comply with the Department of Defense Manual, DERP Management, Number 4715.20, March 9, 2012, (Department of Defense Office of the Under Secretary of Defense for Acquisition, Technology and Logistics) and Ohio Revised Code 5913.10.

Five-year Reviews – CERCLA Section 121(c) 5-year reviews will be conducted for the load lines to assess the effectiveness of the LUCs and whether there is a need to modify the LUCs. The Army will verify whether the LUCs continue to be properly documented and maintained. Each review of the remedy will evaluate whether land use has changed. If the risk levels have changed since initial LUC implementation, LUC modifications will be considered, which may include a change in monitoring frequency. A 5-year review report will be submitted.

6.3 ALTERNATIVE 3: COMMERCIAL/INDUSTRIAL LAND USE – EX-SITU THERMAL TREATMENT OF SOIL AND ADMINISTRATIVE LUCs

This alternative would utilize ex-situ thermal treatment, such as the Vapor Energy Generation (VEG©) treatment, for soil with PAH, explosives, or PCB contamination above Industrial RGOs in conjunction with excavation and off-site disposal of soil with metals concentrations above the cleanup goals. Implementing these remedial technologies will attain Commercial/Industrial Land Use. The evaluation of this alternative assumes that a mobile thermal treatment system is already on site and readily available for use. The assumed extent of the excavation for each load line is presented on Plates 3-1 (Load Line 1), 3-3 (Load Line 2), 3-5 (Load Line 3), 3-7 (Load Line 4), and 3-9 (Load Line 12). Implementation of Alternative 3 would result in thermal treatment of 5,683 cubic yards of soil and excavation and off-site disposal of approximately 156 cubic yards of soil from Load Lines 1 through 4 and 12. The volume of soil being removed from each load line is presented in Table 3-2.

Unacceptable risk will remain on site for the Resident Receptor at each load line; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to contaminants in soil in those areas. It will be the Army's responsibility to implement, inspect, maintain and enforce LUCs at the former RVAAP. This remedial alternative requires coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. Components of this remedial alternative include:

- RD,
- Excavation and thermal treatment of soil,
- Confirmation sampling,
- Waste characterization sampling,
- Off-site disposal,
- Restoration,
- LUCRD, and
- Five-year reviews.

Remedial Design – In addition to the RD elements discussed for Alternative 2, design will include details of the thermal desorption system, including requirements for bench-scale or treatability testing. The estimated carbon dioxide emissions will be calculated, and a PBR will be acquired prior to full-scale implementation.

Thermal Treatment of Soil – The contaminated soil will undergo ex-situ thermal treatment. The treatment system, such as the VEG© treatment system, will be pre-heated to the optimal treatment temperature based on results of past bench- and pilot-scale tests previously conducted using VEG© technology at the former RVAAP. Additional treatability testing may be conducted as necessary during the RD phase to ensure optimal conditions for treatment of all COCs. While the system is being heated, soil will be excavated using conventional construction equipment, such as backhoes, bulldozers, front-end loaders, and scrapers, and will be stockpiled immediately adjacent to the treatment system into approximately 50 cubic yards piles.

Contaminated soil will be fed directly into the fully enclosed, preheated chamber by being placed onto a conveyor. Steam at a temperature of 1,300°F will be vented into the renewal/treatment chamber, where it will serve as the heat source for thermally treating soil. As the soil moves through the system via a rotational auger, the soil contaminants will be desorbed at specified temperatures and residence times and passed as vapors into the box head space within the enclosed chamber.

Induced vapors from the contaminated soil will be routed through a filtration system to remove the acidic gases (i.e., nitrous oxides, sulfur oxides, and hydrogen chloride) and carbon dioxide components by using an engineered mixture of sodium hydroxide, lime, zero valent iron, steam, and water within a slender packed column. The filtration system converts remaining vapors into a synthetic gas to continue operating the VEG© treatment system, creating a renewable source of fuel to replace the propane that was used initially to generate steam.

Relying on this fully enclosed looping system, there will be no emissions to the atmosphere, and the limited carbon dioxide generated through the process may be further reduced (by some 90% to levels below background) using the water-lime component of the patented filtration process. After treatment, the soil will be stockpiled into approximately 50 cubic yards stockpiles on tarp and covered with plastic sheeting.

Excavation and Off-site Disposal – The VEG© treatment system has limited effectiveness at treating metals; therefore, soil with metals concentrations above RGOs will be excavated and disposed of off-site. The excavation and disposal activities would occur as described in Alternative 2.

Waste Characterization Sampling – Waste characterization analysis would be completed for the metals-contaminated soil, as described in Alternative 2. No waste characterization samples are required for the soil undergoing thermal treatment, as the treated soil is being placed back in the excavation area.

Confirmation Sampling – In addition to ISM confirmation samples collected from the excavation areas as described in Alternative 2, soil samples also will be collected from the individual stockpiles of thermally treated soil and will be analyzed for COCs. The laboratory results will be compared to RGOs. Once the laboratory analysis determines COCs are below RGOs, the treated soil will be used for backfill and site restoration. Should confirmation samples indicate that any contaminants are not sufficiently treated, then the soil will be rerun through the VEG© system, likely at a higher temperature, until the target post-treatment levels are reached.

Restoration – Excavation areas where soil with metals concentrations above RGOs were removed and disposed of offsite will be restored as described in Alternative 2.

After confirming that thermally treated soil is below RGOs, all treated soil will be placed back into the excavated area and graded to meet neighboring contours. To ensure adequate vegetation is established within the excavated area, a layer of topsoil from a clean source that was previously sampled and approved for use by Ohio EPA will be placed on the treated soil.

After the areas are backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch. Restored areas will be inspected and monitored as required in the storm water best management practices established in the RD.

Land Use Control Remedial Design – Unacceptable risk will remain on site for the Resident Receptor in portions of each of the load lines; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to COCs in soil in those areas. An LUCRD will be developed as described in Alternative 2 to present the land use constraint (i.e., no residential use) and RAOs, and will specify the LUC requirements for Load Lines 1 through 4 and 12.

Five-year Reviews – Five-year reviews will be conducted as described in Alternative 2.

6.4 ALTERNATIVE 4: UNRESTRICTED (RESIDENTIAL) LAND USE – EXCAVATION AND OFF-SITE DISPOSAL OF SOIL/SEDIMENT

This alternative would include the excavation and off-site disposal of surface soil, subsurface soil, and sediment from Kelly's Pond containing COCs at concentrations above the Residential RGOs to achieve Unrestricted (Residential) Land Use. LUCs will not be required for any receptor upon completion of the excavation and disposal activities. The assumed extent of the excavation for each load line is presented on Plates 3-2 (Load Line 1), 3-4 (Load Line 2), 3-6 (Load Line 3), 3-8 (Load Line 4), and 3-10 (Load Line 12). Implementation of Alternative 4 would result in excavation and off-site disposal of approximately 31,447 cubic yards of soil and sediment from Load Lines 1 through 4 and 12. The volume of soil being removed from each load line is presented in Table 3-3.

This remedial alternative will require coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. The time period to complete this remedial action is relatively short and will not require long-term management of the AOC associated with LUCs because Unrestricted (Residential) Land Use scenario will be achieved. Components of this remedial alternative include:

- RD,
- Excavation and off-site disposal of soil,
- Sediment Removal at Kelly's Pond (Load Line 2),
- Waste characterization sampling,
- Confirmation sampling, and
- Restoration.

The RD, excavation and off-site disposal, waste characterization sampling, confirmation sampling, and site restoration are anticipated to occur as described in Alternative 2.

Sediment Removal at Kelly's Pond (Load Line 2) – It is estimated that approximately 3,071 cubic yards of sediment will be removed from Kelly's Pond under the alternative. Sediment excavation at the pond would involve site preparation, excavation area dewatering, removal of sediment, dewatering of excavated material, and offsite disposal. Site preparation would include clearing any obstacles (i.e., fencing) and vegetation that would interfere with the implementation of the remedy, identifying utilities, constructing an access road, and setting up temporary decontamination facilities. Sediment removal activities would be initiated with installation of a temporary stream diversion system using 24-inch (or appropriate size determined during the RD) corrugated, high-density polyethylene (HDPE) piping. Approximately 500 ft of piping will be used to divert the water from the inlet channels to the Kelly's Pond exit drainage area via an outlet structure extending from the eastern shore of Kelly's Pond. The outlet structure for the former retention basin contains a control mechanism able to drain the surface water from Kelly's Pond. Sediment from the pond bottom would be excavated and staged in the dry pond bottom for dewatering. Dewatering fluid would be discharged to the outlet structure or exit drainage area east of Kelly's Pond. In addition to the excavation of 52,270 square feet (1.2 acres) of the pond bottom, approximately 400 square feet of sediment will be removed around LL2sd-632 and LL2sd-633. A total of approximately 3,071 cubic yards of contaminated sediment will be removed for off-site disposal as non-hazardous waste, following appropriate characterization. Following completion of excavation activities, confirmatory ISM samples will be collected from the excavation areas for COC analysis to ensure contaminated sediment has been successfully removed. The laboratory results will be compared to Resident Receptor RGOs and additional excavation will be conducted at locations with exceeding results until RGOs are met. Once the laboratory analysis determines COCs are below RGOs, the AOC will meet requirements for Unrestricted (Residential) Land Use. Restoration of Kelly's Pond will include removal of the temporary stream diversion and revegetation of disturbed areas.

6.5 ALTERNATIVE 5: UNRESTRICTED (RESIDENTIAL) LAND USE – EX-SITU THERMAL TREATMENT OF SOIL/SEDIMENT

This alternative would utilize ex-situ thermal treatment, such as the VEG© treatment, for soil with PAH, explosives, or PCB contamination above Residential RGOs in conjunction with excavation and off-site disposal of soil with metals concentrations above the cleanup goals. Implementing these remedial technologies will attain Unrestricted (Residential) Land Use. The evaluation of this alternative assumes that a mobile thermal treatment system is already on site and readily available for use. The assumed extent of the excavation for each load line is presented on Plates 3-2 (Load Line 1), 3-4 (Load Line 2), 3-6 (Load Line 3), 3-8 (Load Line 4), and 3-10 (Load Line 12). Implementation of Alternative 5 would result in thermal treatment of 30,121 cubic yards of soil and sediment and excavation and off-site disposal of approximately 1,327 cubic yards of soil from Load Lines 1 through 4 and 12. The volume of soil being removed from each load line is presented in Table 3-3.

This remedial alternative will require coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. The time period to complete this remedial action is relatively short and will not require long-term management of the AOC associated with LUCs because Unrestricted (Residential) Land Use scenario will be achieved. Components of this remedial alternative include:

- RD,
- Thermal treatment of soil,

- Sediment removal and thermal treatment at Kelly’s Pond (Load Line 2),
- Excavation and off-site disposal,
- Waste characterization sampling,
- Confirmation sampling, and
- Restoration.

The RD, thermal treatment of soil, excavation and off-site disposal, waste characterization sampling, confirmation sampling, and site restoration are anticipated to occur as described in Alternative 3.

Sediment Removal and Thermal Treatment at Kelly’s Pond (Load Line 2) – Pond dewatering and sediment excavation at Kelly’s Pond would occur similar to that described in Alternative 4. A total of approximately 3,071 cubic yards of sediment is estimated to be excavated under this alternative. Sediment will be stockpiled within the dry pond bottom for dewatering prior to implementation of treatment as described for soil. Upon completion of treatment, sediment samples will be collected from the individual stockpiles of thermally treated sediment and will be analyzed for COCs. The laboratory results will be compared to RGOs. Once the laboratory analysis determines COCs are below RGOs, the treated sediment will be stockpiled at Camp Ravenna for future use. Should confirmation samples indicate that any contaminants are not sufficiently treated, then the sediment will be rerun through the VEG© system, likely at a higher temperature, until the target post-treatment levels are reached.

Following completion of excavation activities, confirmatory ISM samples will be collected from the excavation areas for COC analysis to ensure contaminated sediment has been successfully removed. The laboratory results will be compared to Resident Receptor RGOs and additional excavation will be conducted at locations with exceeding results until RGOs are met. Once the laboratory analysis determines COCs are below RGOs, the AOC will meet requirements for Unrestricted (Residential) Land Use.

7.0 ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents a detailed analysis of the viable remedial alternatives retained and developed throughout the technology screening process. The purpose of this detailed analysis is to provide stakeholders ample information to identify and select an appropriate remedy and prepare the PP. Based on this detailed analysis of the retained alternatives, one or more is recommended for media requiring remediation at Load Lines 1 through 4 and 12.

7.1 INTRODUCTION

CERCLA guidance suggests the principal element of the selected remedy should reduce volume, toxicity, or mobility. If the selected remedy's principal element does not meet this criterion, an explanation as to why must be presented. In addition, the remedy must meet the following four statutory requirements:

- Be protective of human health and the environment,
- Comply with ARARs (or provide justification for a waiver),
- Be cost effective, and
- Use permanent solutions and treatment or recovery technologies to the maximum extent practicable.

There are nine established NCP evaluation criteria used to perform a detailed analysis of remedial alternatives to ensure the selected alternative meets the above CERCLA statutory requirements. The nine criteria are grouped into three categories: threshold, balancing, and modifying criteria.

7.1.1 Threshold Criteria

There are two evaluation criteria classified as threshold criteria. This criteria group relates directly to statutory findings. Threshold criteria must be met by the selected remedy. The evaluation criteria in this group are:

1. Overall protection of human health and the environment, and
2. Compliance with ARARs.

Each alternative must be evaluated to determine how it achieves and maintains protection of human health and the environment. An alternative is considered to be protective of human health and the environment if it complies with medium-specific RGOs. Similarly, each remedial alternative must be assessed to determine how it complies with ARARs or, if a waiver is required, an explanation of why a waiver is justified.

7.1.2 Balancing Criteria

There are five evaluation criteria classified as balancing criteria. This group represents the primary criteria upon which the detailed and comparative analysis of each remedial alternative are based. The evaluation criteria in this group are:

1. Long-term effectiveness and permanence;
2. Reduction of toxicity, mobility, or volume through treatment;
3. Short-term effectiveness;
4. Implementability; and
5. Cost.

Long-term effectiveness and permanence evaluates the magnitude of residual risk (risk remaining after implementing the alternative) and the adequacy and reliability of controls used to manage the remaining waste (untreated waste and treatment residuals) over the long term. Alternatives that provide the highest degree of long-term effectiveness and permanence leave little or no untreated waste at the AOC, make long-term maintenance and monitoring unnecessary, and minimize the need for LUCs.

Reduction of toxicity, mobility, or volume through treatment evaluates the ability of the alternative to reduce the toxicity, mobility, or volume of waste. The irreversibility of the treatment process and the type and quantity of residuals remaining after treatment are also assessed.

Short-term effectiveness addresses the protection of workers and the community during the remedial action, the environmental effects of implementing the action, and the time required to achieve media-specific preliminary RGOs.

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. Technical feasibility assesses the ability to construct and operate a technology, the reliability of the technology, the ease in undertaking additional remedial actions, and the ability to monitor the effectiveness of the alternative. Administrative feasibility is addressed in terms of the ability to obtain approval from federal, state, and local agencies.

Cost analyses estimate the dollar cost of each alternative. The cost estimates in this report are based on reference manuals, historical costs, vendor quotes, and engineering estimates. Costs are reported in base year 2016 dollars. The cost estimates are for guidance in project evaluation and implementation and are believed to be accurate within a range of -30% to +50%, in accordance with USEPA guidance (USEPA 1988). Actual costs could be higher than estimated due to unexpected conditions or potential delays. Details and assumptions used in developing cost estimates for each of the alternatives are provided in Appendix J.

7.1.3 Modifying Criteria

There are two evaluation criteria categorized as modifying criteria. Modifying criteria are formally evaluated as part of the ROD and after the public has had an opportunity to comment on the PP. This criteria group consists of:

1. State acceptance, and
2. Community acceptance.

State Acceptance considers comments received from agencies of the State of Ohio. Ohio EPA is the primary state agency supporting the remedy for soil and sediment at Load Lines 1 through 4 and 12. Ohio EPA, as well as other state agencies, will provide comments on the FS Addendum and the preferred remedy presented in the PP. This criterion is addressed in the responsiveness summary of the ROD.

Ohio EPA has provided input during the ongoing investigation and report development to ensure the remedy ultimately selected for Load Lines 1 through 4 and 12 is protective of human health and the environment and fulfills the requirements of the DFFO (Ohio EPA 2004). Ohio EPA will provide comments on this FS Addendum Report and the subsequent PP and ROD. The Army will obtain Ohio EPA concurrence prior to the final selection of the remedy for soil and sediment at the AOCs.

Community Acceptance considers comments made by the community, including stakeholders, on the alternatives being considered. CERCLA 42 United States Code (U.S.C.) 9617(a) emphasizes early, constant, and responsive community relations. The Army has prepared a *Community Relations Plan for the Ravenna Army Ammunition Plant Restoration Program* (Vista 2015) to facilitate communication between the former RVAAP and the community surrounding Ravenna, Ohio during environmental investigations and potential remedial action. The plan was developed to ensure the public has convenient access to information regarding project progress. The community relations program interacts with the public through news releases, public meetings, public workshops, and Restoration Advisory Board meetings with local officials, interest groups, and the general public. As required by the CERCLA regulatory process and the Community Relations Plan (Vista 2015), the Army will hold a public meeting and request public comments on the PP for Load Lines 1 through 4 and 12. This criterion is addressed in the responsiveness summary of the ROD.

CERCLA 42 U.S.C. 9617(a) requires an Administrative Record to be established “at or near the facility at issue.” Relevant documents regarding the former RVAAP have been made available to the public for review and comment.

The Administrative Record for this project is available at the following location:

Camp Ravenna
Environmental Office
1438 State Route 534 SW
Newton Falls, Ohio 44444

Access to Camp Ravenna is restricted but can be obtained by contacting the environmental office at (614) 336-6136. In addition, an Information Repository of current information and final documents is available to any interested reader at the following libraries:

Reed Memorial Library
167 East Main Street
Ravenna, Ohio 44266

Newton Falls Public Library
204 South Canal Street
Newton Falls, Ohio 44444-1694

Additionally, there is an online resource for restoration news and information. This website is available at: www.rvaap.org.

Modifying criteria are future activities. These actions are the same for the retained alternatives. Therefore, the detailed analysis of the remedial alternatives does not evaluate modifying criteria. The detailed analysis of the retained remedial alternatives for Load Lines 1 through 4 and 12 is presented in the following sections. This analysis is based on seven evaluation criteria (two threshold and five balancing criteria).

7.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

A detailed analysis of each alternative against the seven NCP evaluation criteria is contained in the following sections. The detailed analysis further defines each alternative (if necessary), compares the alternatives against one another, and presents considerations common to the alternatives.

As presented in Section 7.0, the following remedial alternatives were retained for Load Lines 1 through 4 and 12:

- Alternative 1: No Action,
- Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs,
- Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs,
- Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment, and

- Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment.

7.2.1 Alternative 1: No Action

This alternative involves no remedial actions to prevent exposure to soil or sediment containing the COCs. The NCP requires that the no action alternative be evaluated to establish a baseline for comparison with other alternatives, especially in terms of cost and protection to human health and the environment.

7.2.1.1 Overall Protection of Human Health and the Environment

The no action alternative would not provide any protection because no remedial actions would be implemented to prevent the potential exposure to soil COCs at the load lines.

7.2.1.2 Compliance with ARARs

Potential ARARs for remediating soil and sediment at Load Lines 1 through 4 and 12 are presented in Section 4.0. The action- and location-specific ARARs and TBC guidance are not applicable because no remedial action would be implemented under this alternative.

7.2.1.3 Long-term Effectiveness and Permanence

This alternative does not provide long-term effectiveness and permanence. There would be no reduction in the potential for exposure because no remedial action would be implemented, and there is no concern about the adequacy and reliability of controls because none would be applied.

7.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

There would be no reduction in toxicity, mobility, or volume through treatment with the no action alternative.

7.2.1.5 Short-term Effectiveness

There would be no additional risks posed to the community, workers, or the environment as a result of implementing this alternative.

7.2.1.6 Implementability

This alternative is readily implementable.

7.2.1.7 <u>Cost</u>

The total estimated cost (present worth) of the no action alternative is $0.

7.2.2 Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs

Alternative 2 will achieve Commercial/Industrial Land Use by implementing excavation and off-site disposal of contaminated soil from each load line. The excavated soil will be transported to an off-site permitted disposal facility. Upon removing the contaminated soil, no LUCs will be required for Commercial/Industrial Land Use. However, contaminated soil will be left in place to prevent Unrestricted (Residential) Land Use. Consequently, LUCs are put in place to restrict use of this AOC (i.e., no residential use).

7.2.2.1 <u>Overall Protection of Human Health and the Environment</u>

This alternative would provide adequate protection of human health and the environment through the removal of contaminated soil above Industrial RGOs. Following the implementation of this alternative, the human health risks associated with Industrial receptor would be removed from the site. The administrative LUCs would be protective of human health and the environment by restricting land development for residential purposes.

7.2.2.2 <u>Compliance with ARARs</u>

There are no identified chemical- or location-specific ARARs for Alternative 2. Alternative 2 would meet requirements of action-specific ARARs for excavating soil presented in Section 4.0. Those requirements identified as ARARs deal primarily with characterizing, managing, and disposing of contaminated soil generated from excavation. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially erosion control measures.

7.2.2.3 <u>Long-term Effectiveness and Permanence</u>

This alternative would provide a high degree of long-term effectiveness and permanence for the Industrial Receptor because risks from soil with COCs above Industrial RGOs would be eliminated. Resident Receptor exposure to surface soil containing COCs would be mitigated through administrative controls on soil use at the site. Long-term effectiveness and permanence would be achieved by effectively enforcing the LUCs.

Because Unrestricted (Residential) Land Use is not achieved, 5-year reviews would be conducted. These reviews would review Land Use to ensure effectiveness over the long term.

7.2.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Since this alternative does not involve treatment, no reduction in toxicity, mobility, or volume would occur through treatment. However, the contaminated soil and landfill waste would be removed from the site, resulting in a reduction in toxicity, mobility, or volume of contaminants at the site.

7.2.2.5 Short-term Effectiveness

There will be potential short-term worker and community exposures associated with Alternative 2. Short-term impact to on-site workers from safety hazards associated with the soil removal process would be mitigated and addressed in a Health and Safety Plan (HASP).

The community near the excavation area and along the route to the disposal facility may be exposed during removal and transportation activities. Environmental risks to the community would be minimal due primarily to the transportation of contaminated soil on public roads. Proper soil handling techniques would be implemented to prevent or minimize adverse environmental impacts due to soil erosion or soil transport.

7.2.2.6 Implementability

Alternative 2 is technically and administratively feasible. Excavation is a commonly used remedial technology for addressing contaminated soil and, therefore, services and materials required for this alternative are readily available. Multiple off-site disposal facilities will be available to accept generated waste. Resources (e.g., equipment, material, trained personnel) to implement this alternative will be readily available.

Administrative controls likely would require working with state and local jurisdictions to establish land use restrictions. All services and materials required for the implementation of this alternative are readily available.

7.2.2.7 Cost

The present value cost to complete Alternative 2 is approximately $2,011,655 (in base year 2016 dollars). The total estimated costs for Alternative 2 at each load line are summarized in Table 7-1. See Appendix J for a detailed description of Alternative 2 costs.

7.2.3 Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs

This alternative utilizes a combination of ex-situ thermal treatment and excavation with off-site disposal to achieve Commercial/Industrial Land Use. Upon removing the contaminated soil that poses unacceptable risk to the Industrial Receptor, contaminated soil will be left in place to prevent Unrestricted (Residential) Land Use; consequently, LUCs will be put in place to restrict access and use of this AOC.

Table 7-1. Alternative 2 Cost Summary for Load Lines 1 Through 4 and 12

Alternative 2 Commercial/Industrial Land Use - Excavation and Off-site Disposal of Soil and Administrative LUCs					
	Non discounted Cost				
Cost by Phase	**Load Line 1**	**Load Line 2**	**Load Line 3**	**Load Line 4**	**Load Line 12**
Remedial Design	$18,609	$11,711	$20,907	$20,005	$18,841
Remedial Action	$406,055	$36,093	$458,926	$142,860	$97,664
Completion Report	$21,942	$24,804	$21,942	$23,850	$24,804
Contingency	$63,199	$10,275	$71,006	$26,422	$19,997
Total Capital Costs:	**$509,805**	**$82,882**	**$572,781**	**$213,137**	**$161,306**
Operations and Maintenance (O&M)	$79,373	$79,373	$79,373	$79,373	$79,373
Contingency	$14,976	$14,976	$14,976	$14,976	$14,976
Total O&M Costs:	**$94,349**	**$94,349**	**$94,349**	**$94,349**	**$94,349**
Total Alternative Cost	**$604,154**	**$177,231**	**$667,130**	**$307,486**	**$255,654**

7.2.3.1 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment. Ex-situ treatment in conjunction with excavation and off-site disposal would reduce the COC concentrations below the Industrial RGOs. These remedial activities will result in the AOCs being protective of human health for the Industrial Receptor. The inclusion of administrative LUCs as part of this alternative ensures protectiveness for the Resident Receptor.

7.2.3.2 Compliance with ARARs

There are no identified chemical- or location-specific ARARs for Alternative 3. However, there are action-specific ARARs for this alternative. Those requirements identified as ARARs deal primarily with characterizing, managing, and treating contaminated soil generated from excavation, as well as obtaining a PBR exemption for low-emitting air pollution sources prior to operating the thermal treatment system. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially may trigger ARARs for erosion-control measures. Potential ARARs for excavating soil are presented in Section 4.0.

7.2.3.3 Long-term Effectiveness and Permanence

Ex-situ thermal treatment would reduce contaminant concentrations in soil at the AOCs to below RGOs. Limited areas with metals contaminated soil would be addressed by removing the soil and disposing of it at a licensed facility off site. The implementation of these combined technologies would eliminate risks to the Industrial Receptor at Load Lines 1 through 4 and 12. Therefore, this alternative would be effective in the long term because COCs would be permanently removed from the soil at the AOCs. Exposure of Resident Receptor to soil containing COCs would be mitigated through administrative controls on soil use at the site. Long-term effectiveness and permanence would be achieved by effectively enforcing LUCs. Because Unrestricted (Residential) Land Use is not achieved, 5-year reviews would be conducted. These reviews would evaluate the LUCs to ensure effectiveness.

The VEG© technology thermal treatment is a green and highly sustainable alternative for on-site treatment. This technology converts contaminants into a renewable source of fuel to run treatment operations, and reduces or eliminates air emissions, including carbon dioxide, which may normally result if vehicles are used to transport contaminated soil to a disposal facility.

7.2.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 3 will involve excavating contaminated soil and on-site treatment. Although a small quantity of soil will be placed in an engineered, lined disposal cell at the landfill, a majority of the soil will be thermally treated on site. This alternative will reduce the toxicity, mobility, and volume of COCs through treatment.

7.2.3.5 Short-term Effectiveness

Workers may be exposed during excavation activities, stockpiling soil, and loading soil into the treatment system with Alternative 3. A HASP that identifies appropriate personal protective equipment (PPE) for workers will minimize and/or eliminate exposures.

Mitigation measures during excavation, such as erosion and dust control, will minimize/eliminate potential short-term impacts. Soil treatment will occur in a fully enclosed chamber, thus minimizing worker exposure to heat from the treatment process or resulting vapors. Treating the soil and restoring the AOC is estimated to be completed in less than 1 year. Upon completing the excavation, treatment, and site restoration activities, Load Lines 1 through 4 and 12 would be released for Commercial/Industrial Land Use.

7.2.3.6 Implementability

The implementability of Alternative 3 is predicated on commercial availability of the mobile thermal treatment system given the limited number of systems in operation. Once on site, the treatment system can efficiently mobilize from within the former RVAAP. Alternative 3 will be implementable after using historical bench-scale tests to establish optimal treatment temperature and residence times; developing an RD that is approved by stakeholders; and completing all appropriate coordination with local, state, and federal agencies. Excavating soil, constructing temporary roads, and waste handling are conventional, straightforward construction techniques and methods.

Soil treatment activities will be coordinated with Camp Ravenna and OHARNG to minimize alterations and/or impacts to OHARNG proceedings. The RD will identify access routes to the AOC for heavy equipment and steps to minimize potential hazards to on-site personnel. Developing the RD; implementing and enforcing LUCs; and coordinating with local, state, and federal agencies will increase the implementation difficulty of Alternative 3.

7.2.3.7 Cost

The present value cost to complete Alternative 3 is approximately $1,649,093 (in base year 2016 dollars) and based on use of VEG© technology. The total estimated costs for Alternative 3 at each load line are summarized in Table 7-2. See Appendix J for a detailed description of Alternative 3 costs.

Table 7-2. Alternative 3 Cost Summary for Load Lines 1 Through 4 and 12

Alternative 3 Commercial/Industrial Land Use - Ex-situ Thermal Treatment and Excavation/Off-site Disposal of Soil and Administrative LUCs					
Cost by Phase	**Non discounted Cost**				
	Load Line 1	**Load Line 2**	**Load Line 3**	**Load Line 4**	**Load Line 12**
Remedial Design	$24,168	$18,335	$27,608	$21,492	$20,944
Remedial Action	$257,964	$33,377	$286,771	$100,938	$74,185
Completion Report	$32,054	$34,726	$30,719	$33,390	$34,726
Contingency	$44,460	$12,232	$48,835	$22,050	$18,376
Total Capital Costs:	**$358,647**	**$98,669**	**$393,933**	**$177,870**	**$148,230**
Operations and Maintenance (O&M)	$79,373	$79,373	$79,373	$79,373	$79,373
Contingency	$14,976	$14,976	$14,976	$14,976	$14,976
Total O&M Costs:	**$94,349**	**$94,349**	**$94,349**	**$94,349**	**$94,349**
Total Alternative Cost	**$452,996**	**$193,018**	**$488,281**	**$272,219**	**$242,579**

This cost assumes an existing thermal treatment system is on site and ready for mobilization, incurring an estimated cost of $1,000. If no treatment system is on-site and readily available, the mobilization cost may increase to an estimated $25,000, increasing the estimated cost of Alternative 3 to $1,674,093 (in base year 2016 dollars).

7.2.4 Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment

Alternative 4 will achieve Unrestricted (Residential) Land Use by implementing excavation and off-site disposal of contaminated soil from each load line. The excavated soil will be transported to an off-site permitted disposal facility. Upon removing the contaminated soil, no LUCs will be required for any receptor.

7.2.4.1 Overall Protection of Human Health and the Environment

This alternative would provide adequate protection of human health and the environment through the removal of soil and sediment contaminated with COCs above Residential RGOs. Following implementation of this alternative, the human health risks associated with residential receptors would be eliminated. Removing contamination within these AOCs, as described in the remedial alternative, results in the AOC being protective of human health for Unrestricted (Residential) Land Use.

7.2.4.2 Compliance with ARARs

There are no identified chemical- or location-specific ARARs for Alternative 4. However, there are action-specific ARARs for this alternative. Those requirements identified as ARARs deal primarily with characterizing, managing, and disposing of contaminated soil generated from excavation. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially erosion control measures. Action-specific ARARs only apply if the action is taken. Potential ARARs for excavating soil are presented in Section 4.0.

7.2.4.3 Long-term Effectiveness and Permanence

Alternative 4 would provide a high degree of long-term effectiveness and permanence. Soil from each AOC and sediment from Kelly's Pond (Load Line 2) will be excavated and transported to an off-site disposal facility to result in Unrestricted (Residential) Land Use, thereby mitigating risks to human health and the environment. Consequently, LUCs are not required after removal activities are complete. No CERCLA 5-year reviews or O&M sampling are required.

7.2.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative includes removing contaminated material from the site, thereby reducing toxicity, mobility, and volume of contaminants at the site. However, in the absence of treatment, the toxicity and volume of excavated material will not be reduced. The mobility of contaminants will be reduced by placing the excavated material in an engineered disposal facility.

7.2.4.5 Short-term Effectiveness

There will be potential short-term worker and community exposures associated with Alternative 4. Workers may be exposed during excavation activities. A HASP that identifies appropriate PPE for workers will minimize and/or eliminate exposures.

The community near the excavation area and along the route to the disposal facility may be exposed during removal and transportation activities. Mitigation measures during excavation, such as erosion and dust control, will minimize/eliminate potential short-term impacts. The community will be protected during soil transport by conducting vehicles inspections before and after use, decontaminating as needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance to the disposal facility. Transportation risk associated with material leaks will increase with distance and volume of material. Transporting soil to an off-site disposal facility will comply with all applicable state and federal regulations. Pre-designated travel routes will be established, and an emergency response program will be developed to facilitate any potential accident response.

Excavating soil and restoring the AOC is estimated to be completed in less than 1 year. Upon completing the excavation activities, Load Lines 1 through 4 and 12 will be released for Unrestricted (Residential) Land Use.

7.2.4.6 Implementability

Alternative 4 will be easily implemented after the RD is developed and approved by stakeholders and all appropriate coordination with local, state, and federal agencies is completed. Excavating soil, constructing temporary roads, and conducting waste handling are conventional, straightforward construction techniques and methods. Multiple off-site disposal facilities will be available to accept generated waste. Resources (e.g., equipment, material, trained personnel) to implement this alternative will be readily available.

Excavation activities will be coordinated with Camp Ravenna and OHARNG to minimize alterations and/or impacts to OHARNG proceedings. The RD will identify access routes to the AOC for heavy equipment and provide steps to minimize potential hazards to on-site personnel. Developing the RD and coordinating with local, state, and federal agencies will increase the implementation difficulty of Alternative 4.

7.2.4.7 Cost

The present value cost to complete Alternative 4 is approximately $6,990,292 (in base year 2016 dollars). The total estimated costs for Alternative 4 at each load line are summarized in Table 7-3. See Appendix J for a detailed description of Alternative 4 costs.

Table 7-3. Alternative 4 Cost Summary for Load Lines 1 Through 4 and 12

Alternative 4 Unrestricted (Residential) Land Use - Excavation and Off-site Disposal of Soil/Sediment					
	Non discounted Cost				
Cost by Phase	**Load Line 1**	**Load Line 2**	**Load Line 3**	**Load Line 4**	**Load Line 12**
Remedial Design	$21,551	$28,325	$40,645	$26,455	$23,393
Remedial Action	$1,187,419	$1,055,088	$2,206,076	$717,172	$155,092
Completion Report	$30,185	$30,719	$29,383	$30,185	$32,054
Contingency	$292,253	$315,320	$536,817	$182,503	$49,656
Total Capital Costs:	**$1,531,408**	**$1,429,453**	**$2,812,921**	**$956,314**	**$260,196**
Operations and Maintenance (O&M)	$0	$0	$0	$0	$0
Contingency	$0	$0	$0	$0	$0
Total O&M Costs:	**$0**	**$0**	**$0**	**$0**	**$0**
Total Alternative Cost	**$1,531,408**	**$1,429,453**	**$2,812,921**	**$956,314**	**$260,196**

7.2.5 Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment

This alternative utilizes a combination of ex-situ thermal treatment for soil and sediment and excavation with off-site disposal of soil to achieve Unrestricted (Residential) l Land Use. Upon removing and treating the contaminated soil and sediment, no additional controls will be required for any receptor.

7.2.5.1 Overall Protection of Human Health and the Environment

This alternative would be protective of human health and the environment. Ex situ treatment of soil and sediment in conjunction with excavation and off-site disposal would reduce the COC concentrations below the Residential RGOs. These remedial activities will result in the AOCs being protective of human health for the Resident Receptor.

7.2.5.2 Compliance with ARARs

There are no identified chemical- or location-specific ARARs for Alternative 5. However, there are action-specific ARARs for this alternative. Those requirements identified as ARARs deal primarily with characterizing, managing, and treating contaminated soil generated from excavation, as well as obtaining a PBR exemption for low-emitting air pollution sources prior to operating the thermal treatment system. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially may trigger ARARs for erosion-control measures. Action-specific ARARs only apply if the action is taken. Potential ARARs for excavating soil are presented in Section 4.0.

7.2.5.3 Long-term Effectiveness and Permanence

Ex-situ thermal treatment would reduce contaminant concentrations in soil at each AOC and in sediment at Load Line 2 (Kelly's Pond) to below RGOs. Limited areas with metals contaminated soil would be addressed by removing the soil and disposing of it at a licensed facility off site. The implementation of these combined technologies would eliminate risks to the Resident Receptor at Load Lines 1 through 4 and 12. Therefore, this alternative would be effective in the long term because COCs would be permanently removed from the soil and/or the AOCs. Consequently, LUCs will not be required when removal activities are complete. No CERCLA 5-year reviews or O&M sampling will be required.

In addition, the VEG© technology thermal treatment is a green and highly sustainable alternative for on-site treatment and unrestricted reuse of soil. This technology converts contaminants into a renewable source of fuel to run treatment operations, and reduces or eliminates air emissions, including carbon dioxide, which may normally result if vehicles are used to transport contaminated soil to a disposal facility.

7.2.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 5 will involve excavating contaminated soil and on-site treatment of soil and sediment. Although a small quantity of soil will be placed in an engineered, lined disposal cell at the landfill, a majority of the soil will be thermally treated on site. This alternative will reduce the toxicity, mobility, and volume of COCs through treatment.

7.2.5.5 Short-term Effectiveness

Workers may be exposed during excavation activities, stockpiling soil and sediment, and loading soil and sediment into the treatment system with Alternative 5. A HASP that identifies appropriate PPE for workers will minimize and/or eliminate exposures.

Mitigation measures during excavation, such as erosion and dust control, will minimize/eliminate potential short-term impacts. Soil treatment will occur in a fully enclosed chamber, thus minimizing worker exposure to heat from the treatment process or resulting vapors. Treating the soil and restoring each AOC is estimated to be completed in less than 1 year. Upon completing the excavation and site restoration activities, Load Lines 1 through 4 and 12 will be released for Unrestricted (Residential) Land Use.

7.2.5.6 Implementability

The ease of implementability of Alternative 5 is predicated on commercial availability of the mobile thermal treatment system, given the limited number of systems in operation. Once on site, the treatment system can efficiently mobilize from within the former RVAAP.

Alternative 5 will be implementable after using historical bench-scale tests to establish optimal treatment temperature and residence times; developing an RD that is approved by stakeholders; and completing all appropriate coordination with local, state, and federal agencies. Excavating soil and sediment, constructing temporary roads, and waste handling are conventional, straightforward construction techniques and methods.

Soil treatment activities will be coordinated with Camp Ravenna and OHARNG to minimize alterations and/or impacts to OHARNG proceedings. The RD will identify access routes to the AOC for heavy equipment and steps to minimize potential hazards to on-site personnel. Developing the RD and coordinating with local, state, and federal agencies will increase the implementation difficulty of Alternative 5.

7.2.5.7 Cost

The present value cost to complete Alternative 5 is approximately $4,702,011 (in base year 2016 dollars) and based on use of VEG© technology. This alternative does not include an O&M period subsequent to the soil treatment, as Unrestricted (Residential) Land Use is achieved. The total estimated costs for Alternative 5 at each load line are summarized in Table 7-4. See Appendix J for a detailed description of Alternative 5 costs.

Table 7-4. Alternative 5 Cost Summary for Load Lines 1 Through 4 and 12

Alternative 5 Unrestricted (Residential) Land Use - Ex-situ Thermal Treatment and Excavation/Off-site Disposal of Soil/Sediment					
Cost by Phase	**Non discounted Cost**				
	Load Line 1	**Load Line 2**	**Load Line 3**	**Load Line 4**	**Load Line 12**
Remedial Design	$34,515	$34,218	$59,191	$31,563	$25,021
Remedial Action	$747,700	$786,887	$1,305,382	$485,626	$125,433
Completion Report	$32,341	$34,344	$32,341	$32,913	$37,206
Contingency	$192,112	$201,757	$329,461	$129,741	$44,260
Total Capital Costs:	**$1,006,668**	**$1,057,205**	**$1,726,374**	**$679,844**	**$231,920**
Operations and Maintenance (O&M)	$0	$0	$0	$0	$0
Contingency	$0	$0	$0	$0	$0
Total O&M Costs:	**$0**	**$0**	**$0**	**$0**	**$0**
Total Alternative Cost	**$1,006,668**	**$1,057,205**	**$1,726,374**	**$679,844**	**$231,920**

This cost assumes an existing thermal treatment system is on site and ready for mobilization, incurring an estimated cost of $1,000. If no treatment system is on-site and readily available, the mobilization cost may increase to an estimated $25,000, increasing the estimated cost of Alternative 5 to $4,727,011 (in base year 2016 dollars).

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8.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The comparative analysis provides a means by which remedial alternatives can be directly compared to one another with respect to common criteria. Table 8-1 provides a comparative analysis of the alternatives evaluated.

Overall protection and compliance with ARARs are threshold criteria that must be met by any alternative to be eligible for selection. If any alternative is considered “not protective” for overall protectiveness of human health and the environment or “not compliant” for compliance with ARARs, it is not eligible for selection as the recommended alternative. Alternative 1 is not protective of human health and is not compliant with ARARs. In addition, Alternative 1 does not meet the RAO. Therefore, Alternative 1 is not eligible for selection.

For the remaining alternatives, the balancing criteria (short- and long-term effectiveness; reduction of contaminant toxicity, mobility, or volume through treatment; ease of implementation; and cost) are used to select a recommended alternative among the alternatives that satisfies the threshold criteria. The remaining alternatives are ranked amongst one another for each of the balancing criteria and a total score is generated.

Alternatives 2 and 3 provide adequate long-term protection of human health provided proper enforcement of the administrative controls. Comparatively, Alternatives 4 and 5 provide a higher degree of long-term effectiveness and permanence because the contaminated soil/sediment would either be excavated and removed from the AOCs or thermally treated to reduce COCs to below RGOs. Therefore, Alternatives 2 and 3 score lower due to the remaining residual risk for the Resident Receptor and the necessity of LUCs.

Alternatives 3 and 5 will reduce the toxicity, mobility, and volume of contamination through treatment. Alternative 5 received the higher score because a larger volume of soil would be treated. Alternatives 2 and 4 reduce the mobility of contaminants by placing contamination in an engineered landfill, however, receive a lower score because no treatment is included in waste management.

Short-term effectiveness is achieved for all alternatives with implementation of expedited remediation efforts posing minimal impacts to the environment. Excavation and off-site disposal poses a modest risk to the community due to the transportation of contaminated soil and sediment on public roads. Proper soil handling techniques would be implemented to prevent or minimize adverse environmental impacts during the implementation of this alternative. Risks to site workers during soil excavation and loading would be mitigated through appropriate health and safety practices addressed in the HASP. With the thermal treatment alternatives (Alternatives 3 and 5), workers may be exposed during excavation activities, stockpiling soil, and loading soil into the treatment system. The higher score was given to Alternatives 2 and 3 because smaller quantities of soil are being actively remediated.

Alternatives 2 and 4 are easily implementable, since excavation and off-site disposal alternatives have been employed multiple times at the former RVAAP. Alternatives 3 and 5 are also easily implementable assuming the on-site availability of the thermal treatment system. Alternatives 4 and 5 score lower due to the increased difficulties associated with implementing the sediment removal from Kelly’s Pond at Load Line 2.

Alternative 3 scores the highest and is the recommended alternative. Alternative 3 is effective in the long term, easily implementable, and has the lowest cost. In addition, Alternative 3 is a green and highly sustainable alternative for on-site treatment and implements a treatment alternative to reduce the toxicity, mobility, and volume of contamination.

Excavation and off-site disposal alternatives have been implemented multiple times during restoration efforts at the former RVAAP. As with Alternative 3, Alternative 2 is effective in the long term and reduces the mobility of contaminants by placing contamination in an engineered landfill.

Table 8-1. Summary of Comparative Analysis of Remedial Alternatives for Load Lines 1 Through 4 and 12

NCP Evaluation Criteria	Alternative 1: No Action	Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs	Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs	Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment	Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment
Threshold Criteria	***Result***	***Result***	***Result***	***Result***	***Result***
1. Overall Protectiveness of Human Health and the Environment	Not protective	Protective	Protective	Protective	Protective
2. Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant	Compliant
Balancing Criteria	***Score***	***Score***	***Score***	***Score***	***Score***
3. Long-term Effectiveness and Permanence	Not applicable	2	2	3	3
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Not applicable	1	2	1	3
5. Short-term Effectiveness	Not applicable	2	3	1	2
6. Implementability	Not applicable	3	3	2	2
7. Cost	Not applicable ($0)	3 $2,011,655	3 $1,649,093	1 $6,990,292	1 $4,702,011
Balancing Criteria Score	*Not applicable*	*11*	*13*	*8*	*11*

Any alternative considered "not protective" for overall protectiveness of human health and the environment or "not compliant" for compliance with ARARs, it is not eligible for selection as the recommended alternative. Therefore, that alternative is not ranked as part of the balancing criteria evaluation.
Scoring for the balancing criteria is as follows: Most favorable = 3, favorable = 2, least favorable = 1. The alternative with the highest total balancing criteria score is considered the most feasible.

ARAR = Applicable or Relevant and Appropriate Requirement.
LUC = Land Use Control.
NCP = National Contingency Plan.

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9.0 CONCLUSIONS AND RECOMMENDED ALTERNATIVE

9.1 CONCLUSIONS

The primary purposes of this FS Addendum Report are to review the history of Load Lines 1 through 4 and 12, summarize RI activities, evaluate results of the RI, develop RAOs and remedial alternatives, and present a recommended alternative to address soil and sediment at the AOCs.

An assessment of data collected at Load Lines 1 through 4 and 12 concluded remediation was not necessary for surface water for any receptor. Conclusions of the ERA at Load Lines 1 through 4 indicate remedial actions are not needed to protect ecological receptors. An ERA was not conducted for Load Line 12 in this FS Addendum. As concluded in the Final ROD at Load Line 12, remediation to meet human health cleanup goals would reduce overall contaminant concentrations and ecological risk (USACE 2009a). As a result, ecological cleanup goals were not required. Anticipated remedial activities to protect the human receptor will benefit ecological resources and reduce the potential for contaminant migration to groundwater. Fate and transport modeling indicates soil remediation for RDX at Load Line 1 will be necessary for protection of groundwater. Remedial actions specific to groundwater media at Load Lines 1 through 4 and 12 will be evaluated as an individual AOC for the entire facility and addressed in a separate RI/FS report.

Investigations of each load line concluded that substantial areas of each load line do not require further action to attain Commercial/Industrial Land Use. Limited areas of surface and subsurface soil at each load line were identified as posing unacceptable risk to the Industrial Receptor. Unrestricted (Residential) Land Use was evaluated in this FS in accordance with DERP Manual 4715.20 (DoD 2012) in order to make appropriate risk management decisions. Consequently, alternatives were developed and evaluated to determine the most feasible remedial alternative at Load Lines 1 through 4 and 12.

After COCs were identified and RGOs were established, remedial technologies were screened and the following viable remedial alternatives were developed:

- Alternative 1: No Action,
- Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs,
- Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs,
- Alternative 4: Unrestricted (Residential) Land Use – Excavation and Off-site Disposal of Soil/Sediment, and
- Alternative 5: Unrestricted (Residential) Land Use – Ex-situ Thermal Treatment of Soil/Sediment.

Except Alternative 1, all other alternatives were determined to be protective and compliant with the NCP threshold criteria. Thus, Alternatives 2 through 5 were compared against one another to provide information of sufficient quality and quantity to justify the selection of a remedy. The following section provides the recommended alternative for Load Lines 1 through 4 and 12.

9.2 RECOMMENDED ALTERNATIVE

The recommended alternative for Load Lines 1 through 4 and 12 is Alternative 3: Commercial/Industrial Land Use – Ex-situ Thermal Treatment of Soil and Administrative LUCs, if an on-site thermal treatment system is available at the former RVAAP. Alternative 3 meets the threshold and primary balancing criteria and is protective of the likely future land user (Industrial Receptor). The total cost of Alternative 3 at all five load lines is $1,649,093, making it the most cost effective alternative. In addition, Alternative 3 is a green and highly sustainable alternative for on-site treatment and implements a treatment alternative to reduce the toxicity, mobility, and volume of contamination.

The selection of Alternative 3 as a recommended alternative is predicated on the commercial availability of the thermal treatment system. In the event that a thermal treatment system is not on site at the former RVAAP, Alternative 2: Commercial/Industrial Land Use – Excavation and Off-site Disposal of Soil and Administrative LUCs would be readily available and may be implemented. Excavation and off-site disposal alternatives have been implemented multiple times during restoration efforts at the former RVAAP. As with Alternative 3, Alternative 2 is effective in the long term and is protective of the likely future land user. Alternative 3 reduces the mobility of contaminants by placing contamination in an engineered landfill.

The next step in the CERCLA process is to prepare a PP to solicit public input on the remedial alternatives. The PP will present these alternatives with the preferred remedial alternative for Load Lines 1 through 4 and 12. Comments on the PP provided by state and federal agencies and the public will be presented in the Responsive Summary section of the ROD for Load Lines 1 through 4 and 12. The ROD will provide a brief summary of the history, characteristics, and risks of the AOC and will document the selected remedy.

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