Draft
Remedial Investigation Report
CC RVAAP-73 Facility-Wide Coal Storage
Revision 0

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

August 18, 2015

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This Remedial Investigation Report presents the investigation activities completed at CC RVAAP-73 Facility-Wide Coal Storage at the former Ravenna Army Ammunition Plant in Portage and Trumbull counties, Ohio. This report presents the field activities completed to characterize the nature and extent of contamination, a risk assessment, and an evaluation of the results in a pathway analysis. No further investigation (e.g., Level III Baseline ERA) or removal action is considered necessary for environmental media in CC RVAAP-73 Facility-Wide Coal Storage for the protection of ecological receptors.

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CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Environmental Chemical Corporation has completed the *Draft Remedial Investigation Report for CC RVAAP-73 Facility-Wide Coal Storage at the Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*. 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 project data quality objectives, technical assumptions, methods, procedures, and materials used. The appropriateness of the data used, level of data obtained, and reasonableness of the results, including whether the product meets the customer's needs, are consistent with law and existing United States Army Corps of Engineers' policy.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degree Celsius
°F	Degree Fahrenheit
µg/kg	Microgram(s) per kilogram
µg/L	Microgram(s) per liter
θw	Water-filled soil porosity
alpha-BHC	Alpha-hexachlorocyclohexane
AMEC	AMEC Environment & Infrastructure, Inc.
amsl	Above mean sea level
AOC	Area of concern
atm-m^3/mol	Atmosphere relative to cubic meter per mol
bgs	Below ground surface
BSV	Background Screening Value
C	Carbon or composite sample
CAS	Chemical Abstract Service
CC	Army Environmental Compliance-Related Cleanup Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	Centimeter
cm^2/sec	Square centimeter per second
CMCOPC	Contaminant migration chemical of potential concern
COC	Chemical of concern
COPC	Chemical of potential concern
COPEC	Chemical of potential ecological concern
CPG	Certified Professional Geologist
CR	Compliance Restoration
CSM	Conceptual site model
Cw	Target groundwater concentration
D	Discrete sample
DAF	Dilution attenuation factor
DERR	Division of Environmental Response and Revitalization
DNAP	Division of Natural Areas and Preserves
DQO	Data quality objective
DSB	Deep soil boring
DU	Decision unit

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

ECC	Environmental Chemical Corporation
EcoSSL	Ecological Soil Screening Level
ELCR	Excess lifetime cancer risk
EPC	Exposure point concentration
EQM	Environmental Quality Management, Inc.
ERA	Ecological Risk Assessment
ESV	Ecological Screening Value
FD	Field duplicate
FGDC	Federal Geographic Data Committee
ft	Feet (foot)
ft^2	Square feet (foot)
FWCUG	Facility-Wide Cleanup Goal
FWSAP	Facility-Wide Sampling and Analysis Plan
gpm	Gallon per minute
HELP	Hydrologic Evaluations of Landfill Performance
HHRA	Human Health Risk Assessment
HLC	Henry’s Law Constant
HQ	Hazard Quotient
HRR	Historical Records Review
i	Hydraulic gradient
ID	Identification
IDW	Investigation-derived waste
in.	Inch(es)
INRMP	Integrated Natural Resources Management Plan
IS	Incremental sample
ISM	Incremental sampling methodology
J	Estimated
K	Hydraulic conductivity
K_d	Distribution coefficient
km	Kilometer(s)
km^2	Square kilometer(s)
K_{oc}	Water/organic carbon partition coefficient
K_{ow}	Octanol-water partition coefficient
LANL	Los Alamos National Laboratory
L/kg	Liter per kilogram
LOQ	Limit of Quantitation
Lz	Leaching zone

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

m	Meter
MCL	Maximum Contaminant Level
MDC	Maximum detected concentration
mg/kg	Milligram(s) per kilogram
mg/L	Milligram(s) per liter
mi	Mile(s)
mi^2	Square mile(s)
N&E	Nature and extent
NA	Not applicable
NB	No background
NC	Not calculated
ND	Not detected
NGT	National Guard Trainee
NLCT	North Line Road Coal Tipple
No.	Number
NOAEL	No Observed Adverse Effect Level
NR	Not reported
NSL	No screening level
ODNR	Ohio Division of Natural Resources
OGE	O'Brien and Gere Engineers, Inc.
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
ORNL	Oak Ridge National Laboratory
PAH	Polycyclic aromatic hydrocarbon
PBT	Persistent, bioaccumulative, and toxic
PCB	Polychlorinated biphenyl
P.E.	Professional Engineer
Ph.D.	Doctor of Philosophy
PID	Photoionization detector
PRG	Preliminary Remediation Goal
QA	Quality assurance
QC	Quality control
R	Retardation factor or Risk Assessment Information System
RA	Risk assessment
RfD	Reference dose
RI	Remedial investigation
RR	Residential Receptor

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

RR AC	Residential Receptor Adult-Cancer
RR CN	Residential Receptor Adult-Non-Cancer
RRSL	Residential Regional Screening Level
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SB	Soil boring
SCCT	Sand Creek Coal Tipple
SD	Wet sediment
SI	Site Inspection
SOR	Sum of ratio
SRC	Site-related chemical
SS	Surface soil
SSL	Soil Screening Level
SVOC	Semivolatile organic compound
SW	Surface Water
T	Arrival time in years
TAL	Target Analyte List
TAP	Tapwater
TR	Target risk
T_{RC}	Groundwater travel time to nearest receptor
U	Non-detect
U-16	Building U-16 Boiler House
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile organic compound
Vs	Groundwater seepage velocity
X_{min}	Minimum distance to nearest downgradient surface water

EXECUTIVE SUMMARY

Environmental Chemical Corporation (ECC) was contracted by the United States Army Corps of Engineers (USACE)–Louisville District to complete a remedial investigation (RI) at the Compliance Restoration (CR) site CC (Army Environmental Compliance-Related Cleanup Program) RVAAP-68 Electric Substations (East, West, Number [No.] 3) at the former Ravenna Army Ammunition Plant (RVAAP), in Portage and Trumbull counties, Ohio. This RI was completed under Contract No. W912QR-04-D-0039, Delivery Order No. 0004.

Planning and performance of all elements of this contract are in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) Director's Final Findings and Orders for Camp Ravenna (former RVAAP, the facility), dated June 10, 2004 (Ohio EPA 2004). The Director's Final Findings and Orders requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan to complete the environmental work (i.e., RIs or activities) at the facility under the Installation Restoration Program, which began in 1989 with 32 environmental areas of concern (AOCs).

This AOC, CC RVAAP-73 Facility-Wide Coal Storage, consists of the following three former coal storage areas located throughout the facility:

- North Line Road Coal Tipple
- Sand Creek Coal Tipple
- Building U-16 Boiler House.

The Building U-16 Boiler House and North Line Road Coal Tipple are located in the northwestern portion of the facility. The Sand Creek Coal Tipple is located in the north-central portion of the facility. Coal has not been stored at these areas since at least 1979.

The Historical Records Review (HRR) completed for CC RVAAP-73 Facility-Wide Coal Storage recommended these three former coal storage areas as candidates for further investigation due to potential contamination from coal stored on the ground surface, which may represent a direct exposure pathway for human receptors under current and future land use. This report specifically addresses RI efforts for the three areas that comprise the AOC.

The results of this RI indicate that No Further Action is obtained at CC RVAAP-73 Facility-Wide Coal Storage. The horizontal and vertical extent of site-related chemicals (SRCs) related to historical coal storage has been defined as part of this RI. Fate and transport soil screening analysis indicates that most contaminant migration chemicals of potential concern (CMCOPCs) are not likely to leach from the soil to the groundwater in less than 1,000 years, and SRCs in soil were eliminated as potential risks to any downgradient receptors based on RI data. The Human Health Risk Assessment (HHRA) identified chemicals of concern (COCs) in surface soil for the North Line Road Coal Tipple. No COCs were identified in subsurface soil at any of the three former coal storage areas. However, the COCs in surface soil were eliminated based on weight-of-evidence, and therefore, No Further Action is obtained for CC RVAAP-73 Facility-Wide Coal

Storage surface soil and subsurface soil. These media at this AOC were also found to be acceptable for Unrestricted Land Use.

Remedial Investigation Objectives

The following are the CC RVAAP-73 Facility-Wide Coal Storage RI objectives:

- Conduct a field investigation to collect site-related data to delineate the nature and extent of contamination related to operations at the AOC

- Provide sufficient quality assurance (QA)/quality control (QC) sampling to evaluate the overall quality of both the field and laboratory sampling procedures

- Perform AOC-specific screening of the sample analytical results to determine if a chemical is a SRC based on applicable background screening values (BSVs)

- Perform an HHRA to determine which of the SRCs are chemicals of potential concern (COPCs) by comparing the maximum detected concentrations (MDCs) to the most stringent Facility-Wide Cleanup Goals (FWCUGs) Resident Receptor and National Guard Trainee (NGT) FWCUGs at a target cancer risk level of 10^{-6} and non-carcinogenic target HQ of 0.1.

- Determine if any of the COPCs are COCs by completing a characterization of risk using the RVAAP streamlined risk assessment approach.
- Provide recommendations as to whether remedial actions at the AOC are warranted or whether Unrestricted (Residential) Land Use is achieved and No Further Action is warranted.

Area of Concern Background

Based on the HRR, historical use of coal at the facility was consistent with conventional industrial practices at the time for steam generation supplying power houses, production facilities, and heating systems. The facility received bulk coal primarily by rail at the Sand Creek and North Line Road coal tipples. Historically, the North Line Road Coal Tipple (1.22 acres) and the Sand Creek Coal Tipple (0.65 acres) were used as bulk coal receiving, storage, and distribution areas. The Building U-16 Boiler House (0.14 acres) was used to store coal for boiler supply/steam generation. The total size of the three areas in the AOC is 2.01 acres. Bulk coal was typically stored and staged in uncovered piles on the ground surface. Coal was distributed throughout the facility by truck. Point-of-use coal storage locations included covered bins and uncovered storage piles on the ground surface. No documentation of accidental large volume spills or releases associated with the coal storage areas was found during the HRR. Based on historical aerial photographs, coal piles were removed at each storage area sometime between 1966 and 1979. Residual coal was noted at the surface at all three areas during the HRR site visit in 2004.

Remedial Investigation Activities

The media sampled as part of the RI for this AOC included surface soil and subsurface soil. Sample results were used to define the nature and extent of contamination, conduct fate and transport soil screening analyses, and support HHRAs and ecological risk assessments (ERAs). Investigative samples were collected using incremental sampling methodology (ISM), discrete, and composite methods. All samples were analyzed for Target Analyte List (TAL) metals including mercury, and semivolatile organic compounds (SVOCs). In addition, approximately 10 percent of the samples were analyzed for the full suite of analyses (i.e., TAL metals, SVOCs, polychlorinated biphenyls [PCBs], organochlorine pesticides, volatile organic compounds [VOCs], and explosives/propellants). No groundwater samples were collected as part of this RI as groundwater is being addressed under a separate facility-wide groundwater investigation (RVAAP-66 Facility-Wide Groundwater).

In accordance with the Final RI/Site Inspection Work Plan and the recommendations of the HRR, wet sediment and surface water were also sampled at two of the three former coal storage areas where Sand Creek was within a few hundred feet downgradient. Wet sediment and surface water sampling was conducted to evaluate whether SRCs in surface soil could be transported to Sand Creek in stormwater runoff.

Decision units (DUs) were designed to encompass the historical operational areas plus an additional 30 feet (ft) in all directions at each former coal storage area where storage or staging activities could have impacted surrounding media. One DU was assigned to each of the three coal areas in CC RVAAP-73 Facility-Wide Coal Storage. Sampling activities included the collection of 4 surface soil ISM samples, 24 subsurface ISM samples, and 3 subsurface vertical composite samples, including field duplicates. ISM was used to investigate each DU both vertically and horizontally to 7 ft below ground surface (bgs) to assess human health and ecological exposure risk to surface and subsurface soil at CC RVAAP-73 Facility-Wide Coal Storage. In addition, 3 vertical composite samples were collected from 7 to 13 ft bgs to supplement the HHRA and characterize the soils to that depth.

Site-Related Chemical Screening Process

After data were reviewed for QA/QC purposes, SRCs were retained for CC RVAAP-73 Facility-Wide Coal Storage if the concentrations of detected inorganic chemicals were greater than the facility BSVs or when no BSVs were established. All detected organic compounds were considered to be SRCs because BSVs are not established for organic compounds at the facility, except for those dismissed based on frequency of detection or weight-of-evidence screening.

Site-Related Chemicals Identified in Media

The datasets (consisting of investigative and field duplicates) for each media sampled are as follows:

- Surface Soil: 4 ISM samples at 0-1 ft bgs.

- Subsurface Soil: 24 ISM samples at 1-4, 4-7, and 1-7 ft bgs and 3 composite samples from 7 to 13 ft bgs.

North Line Road Coal Tipple (DU01)

The SRCs retained in surface soil are:

- Eight inorganics: arsenic, barium, beryllium, cadmium, manganese, nickel, selenium, and zinc

- Sixteen SVOCs: 2-methylnaphthalene; acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenzofuran; fluoranthene; indeno(1,2,3-c,d)pyrene; naphthalene, phenanthrene; and pyrene.

The SRCs retained in subsurface soil are:

- Three inorganics: beryllium, cadmium, and silver

- Sixteen SVOCs: 1,4-dichlorobenzene; 2-methylnaphthalene; benzo(a)anthracene, benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenzofuran; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; isophorone; naphthalene, phenanthrene; and pyrene

- One VOC: carbon disulfide

- Two explosives: 2,4-dinitrotoluene and tetryl

- One propellant: nitrocellulose.

Sand Creek Coal Tipple (DU01)

The SRCs retained in surface soil are:

- Five inorganics: cadmium, chromium, nickel, silver, and zinc

- Sixteen SVOCs: 2-methylnaphthalene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenzofuran; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; naphthalene, phenanthrene; and pyrene

- One VOC: carbon disulfide

- One explosive: tetryl.

The SRCs retained in subsurface soil are:

- Two inorganics: cadmium and silver

- Nineteen SVOCs: 1,4-dichlorobenzene; 2-methylnaphthalene; acenaphthylene; anthracene; benzo(a)anthracene, benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; benzyl alcohol; chrysene; dibenzofuran; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; isophorone; naphthalene, phenanthrene; and pyrene.

Building U-16 Boiler House (DU01)

The SRCs retained in surface soil are:

- Six inorganics: cadmium, cobalt, copper, nickel, silver, and thallium

- Two SVOCs: 2-methylnaphthalene and naphthalene.

The SRCs retained in subsurface soil are:

- Two inorganics: cadmium and silver

- Two organochlorine pesticides: alpha-hexachlorocyclohexane and p,p'-dichlorodiphenyldichloroethylene

- One propellant: nitrocellulose.

Based on the composition of coal, it is unlikely that the relatively low concentrations of many of these SRCs are due to historical coal storage at the AOC. However, these SRCs were retained to evaluate the risk to downgradient groundwater receptors as well as human and ecological receptors.

Nature and Extent of Contamination in Soil

To delineate the nature and extent of contamination at the three coal storage areas, SRCs were compared to the most stringent Resident Receptor FWCUG at a target risk of 1×10^{-6} and hazard quotient (HQ) of 0.1 or, if no FWCUG is established, the United States Environmental Protection Agency (USEPA) Residential Regional Screening Level (RSL) at a target risk of 1×10^{-6} and HQ of 0.1. The concentrations of the SRCs did not exceed their FWCUG (or RSL if no FWCUG is established), with the following few exceptions.

Surface Soil

- Arsenic and manganese at the North Line Road Coal Tipple

- Benzo(a)anthracene, benzo(b)pyrene, and benzo(b)fluoranthene at the North Line Road Coal Tipple

- Benzo(a)pyrene at the Sand Creek Coal Tipple.

Subsurface Soil

- Benzo(a)pyrene at the North Line Road Coal Tipple
- Benzo(a)pyrene at the Sand Creek Coal Tipple.

Because arsenic and manganese are not known to be coal constituents, additional sampling beyond the DUs was deemed unnecessary to define the extent of these metals in surface soil at the North Line Road Coal Tipple. Benzo(a)anthracene and benzo(a)pyrene may be present in coal, but only in trace amounts. These two polycyclic aromatic hydrocarbons (PAHs) were detected at concentrations only slightly greater than their FWCUGs, and their presence in surface soil is likely from anthropogenic sources such as asphalt and tire particles rather than historical coal storage. Benzo(b)fluoranthene is a major constituent in anthracite coal; however, if its presence was due to historical coal storage, it would be expected to be detected above the FWCUG at all three coal storage areas, but it was only detected in exceedance of the FWCUG at the North Line Road Coal Tipple. No SRCs were detected in concentrations exceeding the FWCUGs (or Residential RSLs for those SRCs without FWCUGs) at the Building U-16 Boiler House. For these reasons, additional sampling to define the extent of PAHs beyond the DUs in either surface or subsurface soil was unnecessary.

Fate and Transport Soil Screening Analysis

Soil screening analysis was performed to evaluate the potential risks to groundwater and downgradient receptors from concentrations of SRCs in surface and subsurface soils. Because the three former coal storage areas are not contiguous, this evaluation was conducted separately for each area. The downgradient receptor at each area is the nearest surface water body to which groundwater beneath the areas is likely to discharge.

Initially, the MDCs of the SRCs were compared with the generic Soil Screening Levels (SSLs) to develop the initial CMCOPCs. After the screening, the following initial CMCOPCs were retained.

North Line Road Coal Tipple

- Six metals: arsenic, barium, beryllium, cadmium, manganese, and selenium

- Nine SVOCs: 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, indeno(1,2,3-cd)pyrene, isophorone, naphthalene, and phenanthrene

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- Four SVOCs: benzo(a)anthracene, benzo(b)fluoranthene, isophorone, and naphthalene.

Building U-16 Boiler House

- Two metals: cobalt and thallium
- One organochlorine pesticide: alpha-hexachlorohexane
- One SVOC: naphthalene.

The MDCs of the initial CMCOPCs were then compared with dilution attenuation factor (DAF)-based, site-specific SSLs to further refine the initial CMCOPCs. After this screening, the following were retained as initial CMCOPCs because their reported concentrations in subsurface soil exceeded the site SSLs:

North Line Road Coal Tipple

- Five metals: arsenic, barium, cadmium, manganese, and selenium

- Six SVOCs: 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, and naphthalene

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- Three SVOCs: benzo(a)anthracene, benzo(b)fluoranthene, and naphthalene.

Building U-16 Boiler House

- One metal: cobalt
- One organochlorine pesticide: alpha-hexachlorohexane
- One SVOC: naphthalene.

The initial CMCOPCs were further refined by retaining only those that leach through the unsaturated zone to the water table in less than 1,000 years. For each area, the following initial CMCOPCs remained.

North Line Road Coal Tipple

- Three metals: arsenic, barium, and selenium
- Four SVOCs: 2-methylnaphthalene, benzo(a)pyrene, dibenzofuran, and naphthalene
- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- One SVOC: naphthalene.

Building U-16 Boiler House

- One metal: cobalt
- One organochlorine pesticide: alpha-hexachlorohexane.

The last screening was then performed to evaluate and eliminate any initial CMCOPCs from further consideration if more than 1,000 years are required for the chemical to reach the assumed downgradient receptor (i.e., nearest surface water body to which groundwater is likely to discharge). Only two initial CMCOPCs remained after this last screening.

North Line Road Coal Tipple

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- One SVOC: naphthalene.

If CMCOPCs that remain after the soil screening evaluation have concentrations greater than the most stringent Resident Receptor FWCUGs at 1×10^{-6} and HQ of 0.1 (or RSLs if no FWCUGs are established), the fate and transport evaluation would proceed to include modeling to predict the concentrations of CMCOPCs at the groundwater-surface water interface after leaching and groundwater transport. For this AOC, only 2,4-dinitrotoluene and naphthalene remained as an initial CMCOPC; however, the 2,4-dinitrotoluene MDC of 0.01 milligrams per kilogram (mg/kg) is an order of magnitude less than its FWCUG of 0.753 mg/kg, and the naphthalene MDC of 0.063 mg/kg is orders of magnitude less than its FWCUG of 122 mg/kg. Therefore, fate and transport modeling was not necessary for this AOC and was not included as part of this RI. Conclusions of the soil screening evaluation are that all of the identified SRCs at this AOC in soil were eliminated as current risks to groundwater.

Human Health Risk Assessment

As a first step of the HHRA, SRCs were screened by comparing the MDCs to the most stringent FWCUGs at a target cancer risk level of 10^{-6} and non-carcinogenic target HQ of 0.1 to identify risk-based COPCs. USEPA Residential RSLs were used for those analytes with no established FWCUGs. COPCs were then screened to identify COCs and identify the presence of those that may pose a risk to the applicable receptors at the AOC. The Ohio Army National Guard (OHARNG)-projected future land use for CC RVAAP-73 Facility-Wide Coal Storage is for military training. Unrestricted (Residential) Land Use is included to evaluate COCs at the AOC as required by the CERCLA process. The Resident Receptor is the applicable receptor for Unrestricted Land Use, and the NGT is the applicable receptor for military training. The Resident Receptor is evaluated as a first step and, if COCs are identified, the NGT is evaluated to refine potential risks. If no COCs are identified for the Resident Receptor, the NGT is not evaluated because the Resident Receptor is the most protective.

The data screening processes used for CC RVAAP-73 Facility-Wide Coal Storage follow the process identified in Facility-Wide Human Health Risk Assessor Manual (USACE 2005c) and are consistent with those established in the Final FWCUG Report (Science Applications International Corporation [SAIC] 2010) and Position Paper for Facility-Wide Human Health Cleanup Goals (USACE 2012).

Human Health Risk Assessment Results

For the Resident Receptor, COCs were identified as follows:

Surface Soil

- North Line Road Coal Tipple: arsenic and benzo(a)pyrene.
- No COCs were identified at the Sand Creek Coal Tipple or Building U-16 Boiler House.

Subsurface Soil

- No COCs were identified at any of the three former coal storage areas.

For the NGT, COCs were identified as follows:

Surface Soil

- North Line Road Coal Tipple: manganese.

- No COCs were identified at the Sand Creek Coal Tipple or the Building U-16 Boiler House.

Subsurface Soil

- No COCs were identified at any of the three former coal storage areas.

North Line Road Coal Tipple

Arsenic, benzo(a)pyrene, and manganese were identified as COCs for surface soil. The total excess lifetime cancer risk (ELCR) for the Resident Receptor (9×10^{-5}) exceeded the Ohio EPA risk criterion of 10^{-5}, but was within the USEPA acceptable risk range of from 10^{-4} to 10^{-6}, and the hazard index for Resident Receptor is below the USEPA threshold value of 1. Furthermore, the weight-of-evidence shows that all COCs can be eliminated from further evaluation for Resident Receptor and NGT. Therefore, No Further Action is achieved for North Line Road Coal Tipple surface soil.

No COCs were identified in subsurface soil for the Resident Receptor for the North Line Road Coal Tipple. Therefore, No Further Action is obtained for North Line Road Coal Tipple subsurface soil.

Sand Creek Coal Tipple

No COCs were identified in surface soil or subsurface soil for the Resident Receptor in this exposure area. Therefore, No Further Action is obtained for Sand Creek Coal Tipple surface soil and subsurface soil.

Building U-16 Boiler House

No COCs were identified for surface or subsurface soil for the Resident Receptor in this exposure area. Therefore, No Further Action is obtained for Building U-16 Boiler House surface and subsurface soil.

Ecological Risk Assessment Results

The ERA was conducted to evaluate the potential for chemical constituents detected in surface soil to adversely affect ecological receptors. To identify chemicals of potential ecological concern (COPECs), MDCs of analytes detected in surface soil were compared to BSVs and to conservative ecological screening benchmarks for ecological receptors.

The list of COPECs was subsequently refined on a COPEC-by-COPEC basis. Considering the small individual and collective size (2.01 acres), and the low quality habitat, and taking into account uncertainties, it is unlikely that exposure to surface soil would adversely affect communities or populations of common ecological receptors or individuals of state-listed species in CC RVAAP-73 Facility-Wide Coal Storage.

No further investigation (e.g., Level III Baseline ERA) or removal action is considered necessary for environmental media in CC RVAAP-73 Facility-Wide Coal Storage for the protection of ecological receptors.

Remedial Investigation Conclusions

The results of this RI indicate that No Further Action is obtained at CC RVAAP-73 Facility-Wide Coal Storage. The RI has adequately characterized surface and subsurface soil contained within the three former coal storage areas, which comprise the operational areas of this AOC. Conclusions of the soil screening evaluation are that all SRCs in soil are currently eliminated as potential risks to groundwater, and there is no current or future exposure risk to human or ecological receptors from contact with AOC soil.

The conclusions of HHRA are as follows:

- No COCs were identified in North Line Road Coal Tipple subsurface soil for the Resident Receptor.

- COCs were identified for North Line Road Coal Tipple surface soil, but were eliminated based on weight-of-evidence.

- No COCs were identified for Sand Creek Coal Tipple surface soil or subsurface soil for the Resident Receptor.

- No COCs were identified for Building U-16 Boiler House surface soil and subsurface soil Resident Receptor.

- No further investigation (e.g., Level III Baseline ERA) or removal action is considered necessary for environmental media in CC RVAAP-73 Facility-Wide Coal Storage for the protection of ecological receptors.

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1. INTRODUCTION

Environmental Chemical Corporation (ECC) was contracted by the United States Army Corps of Engineers (USACE)–Louisville District to complete a remedial investigation (RI) at the Camp Ravenna Compliance Restoration (CR) site CC (Army Environmental Compliance-Related Cleanup Program) RVAAP-73 Facility-Wide Coal Storage at the former Ravenna Army Ammunition Plant (RVAAP), in Portage and Trumbull counties, Ohio. This document was prepared under Multiple Award Remediation Contract Number (No.) W912QR-04-D-0039, Delivery Order No. 0004, Modification No. 1.

The facility, previously known as the RVAAP, consists of 21,683 acres and is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (km) (3 miles [mi]) east/northeast of the city of Ravenna and approximately 1.6 km (1 mi) northwest of the city of Newton Falls. The facility 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 United States Property and Fiscal Office 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 the former 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. This document replaces former or use-specific terms, such as former RVAAP or Camp Ravenna, with “facility” when referring to the entire property.

This RI was conducted at one area of concern (AOC), CC RVAAP-73 Facility-Wide Coal Storage. This AOC consists of three separate coal storage areas at the facility:

- North Line Road Coal Tipple
- Sand Creek Coal Tipple
- Building U-16 Boiler House.

Planning and performance of all elements of this contract are in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) Director’s Final Findings and Orders for the facility, dated June 10, 2004 (Ohio EPA 2004). The Director’s Final Findings and Orders require conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan to complete the RI for multiple AOCs, including CC RVAAP-73 Facility-Wide Coal Storage. The work described in this RI Report was conducted in accordance with the *Final Site Inspection and Remedial Investigation Work Plan at Compliance Restoration Sites (Revision 0), Ravenna Army Ammunition Plant, Ravenna, Ohio* (Final Site Inspection [SI]/RI Work Plan) (ECC 2012).

1.1 PURPOSE

ECC submitted this RI to the USACE–Louisville District in accordance with the Performance Work Statement, Contract No. W912QR-04-D-0039, Delivery Order No. 0004 under a firm-fixed price Performance-Based Acquisition to provide environmental investigation and remediation services at 14 CR sites at the facility (Figures 1-1 and 1-2). The Delivery Order was issued by the USACE–Louisville District on August 15, 2011.

Environmental investigations at the facility began under the Installation Restoration Program in 1989, at 32 AOCs. The United States Army Center for Health Promotion and Preventive Medicine (now the United States Army Public Health Command) collected samples at each of the AOCs and performed a Relative Risk Site Evaluation, which prioritized each AOC into three groups: low, medium, and high priorities. Restoration work has proceeded primarily by addressing the highest priority sites first. In 1998, the number of AOCs was increased from 32 to 51. The relative risk rankings were performed to prioritize those additional AOCs. CR sites were added in 2010. This RI discusses one of these AOCs, CC RVAAP-73 Facility-Wide Coal Storage (Figure 1-3).

The following are the CC RVAAP-73 Facility-Wide Coal Storage RI objectives:

– Conduct a field investigation to collect site-related data to characterize the nature and extent of chemicals at the AOC

– Provide sufficient quality assurance (QA)/quality control (QC) sampling to evaluate the overall quality of both the field and laboratory sampling procedures

– Perform AOC-specific screening of the sample analytical results to determine if a chemical is a site-related chemical (SRC) based on applicable background screening values (BSVs)

– Perform a risk-based screening of the identified SRCs by comparing the maximum detected concentrations (MDCs) to the Facility-Wide Cleanup Goals (FWCUGs) to identify chemicals of potential concern (COPCs)

– Perform a human health risk assessment (HHRA) to identify chemicals of concern (COCs) and identify the presence of any COCs that may pose a risk to the applicable receptors (i.e., Resident Receptor and National Guard Trainee [NGT]) at the AOC

– Determine if additional remedial actions are warranted or if Unrestricted (Residential) Land Use is achieved and no further actions are warranted.

1.2 SCOPE

The RI conducted for this AOC was based on findings of the Historical Records Review (HRR). The HRR is presented in the *Historical Records Review Report for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern) Revision 0*, dated December 22, 2011 (Science Applications International Corporation [SAIC] 2011a). The HRR identified the three coal storage areas that require further evaluation, which comprise the CC RVAAP-73 Facility-Wide Coal Storage AOC:

- North Line Road Coal Tipple
- Sand Creek Coal Tipple
- Building U-16 Boiler House.

The RI was conducted in accordance with the *Final Site Inspection and Remedial Investigation Work Plan* (Final RI/SI Work Plan) *at Compliance Restoration Sites, Revision 0*, dated October 3, 2012 (ECC 2012). This RI consisted of intrusive soil sampling using incremental sampling methods (ISM) and, where appropriate, soil, sediment, and surface water sampling using discrete sampling methods. Following data validation and QA/QC, the dataset was further refined and aggregated to identify SRCs and COPCs. The COPCs were then screened for identification of COCs for fate and transport and risk assessment purposes.

1.3 REPORT ORGANIZATION

This RI report is organized into the following nine chapters:

- ***Chapter 1 (Introduction)***—Provides an overview of the purpose and scope of this RI.

- ***Chapter 2 (Background)***—Describes the installation's location, operational history, demography, land use, as well as the AOC site description, operational history, and previous investigations.

- ***Chapter 3 (CC RVAAP-73 Facility-Wide Coal Storage Settings)***—Describes the environmental setting at the facility including geology, hydrogeology, climate, potential human and ecological receptors, and conceptual site model (CSM).

- ***Chapter 4 (RI Activities)***—Describes the scope of work completed and the procedures followed during this RI, including a discussion of the sampling rationale for placement of environmental media sampling locations, field activity procedures, laboratory methods, and protocols. Included in this chapter are the pre-mobilization activities and the field sampling methodologies for the surface and subsurface soil ISM sampling, discrete soil sampling, and sediment and surface water sampling. Any deviations from the work plan are outlined in this chapter. In addition, this chapter details site surveying and the collection and characterization of the investigation-derived waste (IDW) generation and management.

- ***Chapter 5 (Nature and Extent of Contamination)***—Describes the data generated during this RI and discusses the occurrence and distribution of chemicals at CC RVAAP-73 Facility-Wide Coal Storage.

- ***Chapter 6 (Contaminant Fate and Transport)***—Describes the media and fate and transport mechanisms associated with the contaminants present.

- ***Chapter 7 (Risk Assessment)***—Presents a qualitative assessment of the appropriate analytical data collected to evaluate the potential risks to human health and ecological receptors.

- ***Chapter 8 (RI Conclusions and Recommendations)***—Presents the summary, conclusions, and recommendations for CC RVAAP-73 Facility-Wide Coal Storage based on the results of this RI.

- ***Chapter 9 (References)***—Lists references used to prepare this document.

The appendices to this document contain the summarized investigation data, including:

- Appendix A – Boring Logs

- Appendix B – Data Verification Report

- Appendix C – Field Activity Forms

- Appendix D – Site Photographs

- Appendix E – Survey Data

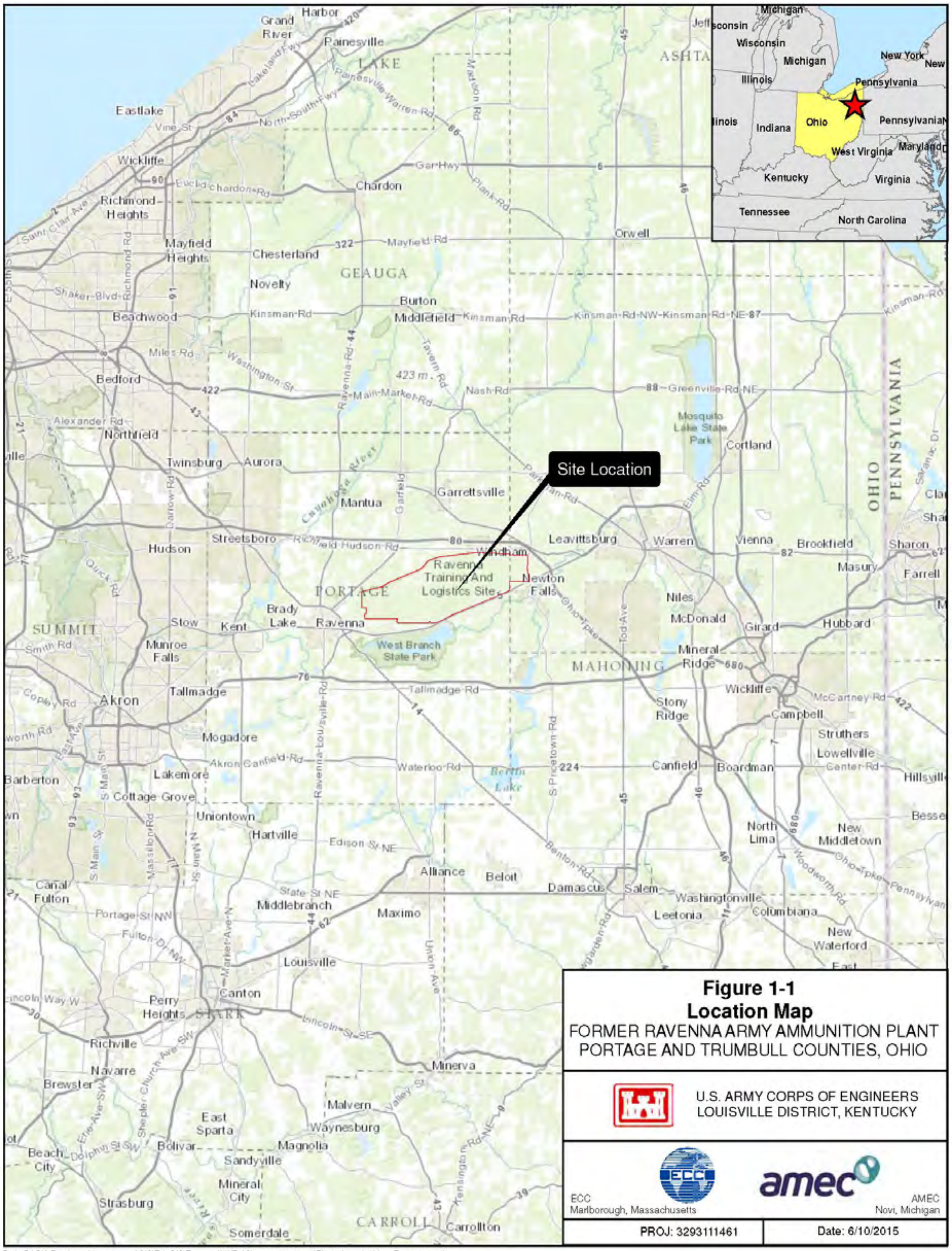
- Appendix F – IDW Disposal Letter Reports

- Appendix G – Laboratory Analytical Results, Laboratory Data, and Chain of Custody Forms

- Appendix H – Data Validation Report

- Appendix I – Human Health Risk Assessment Tables

- Appendix J – Regulatory Correspondence and Comment Response Table.



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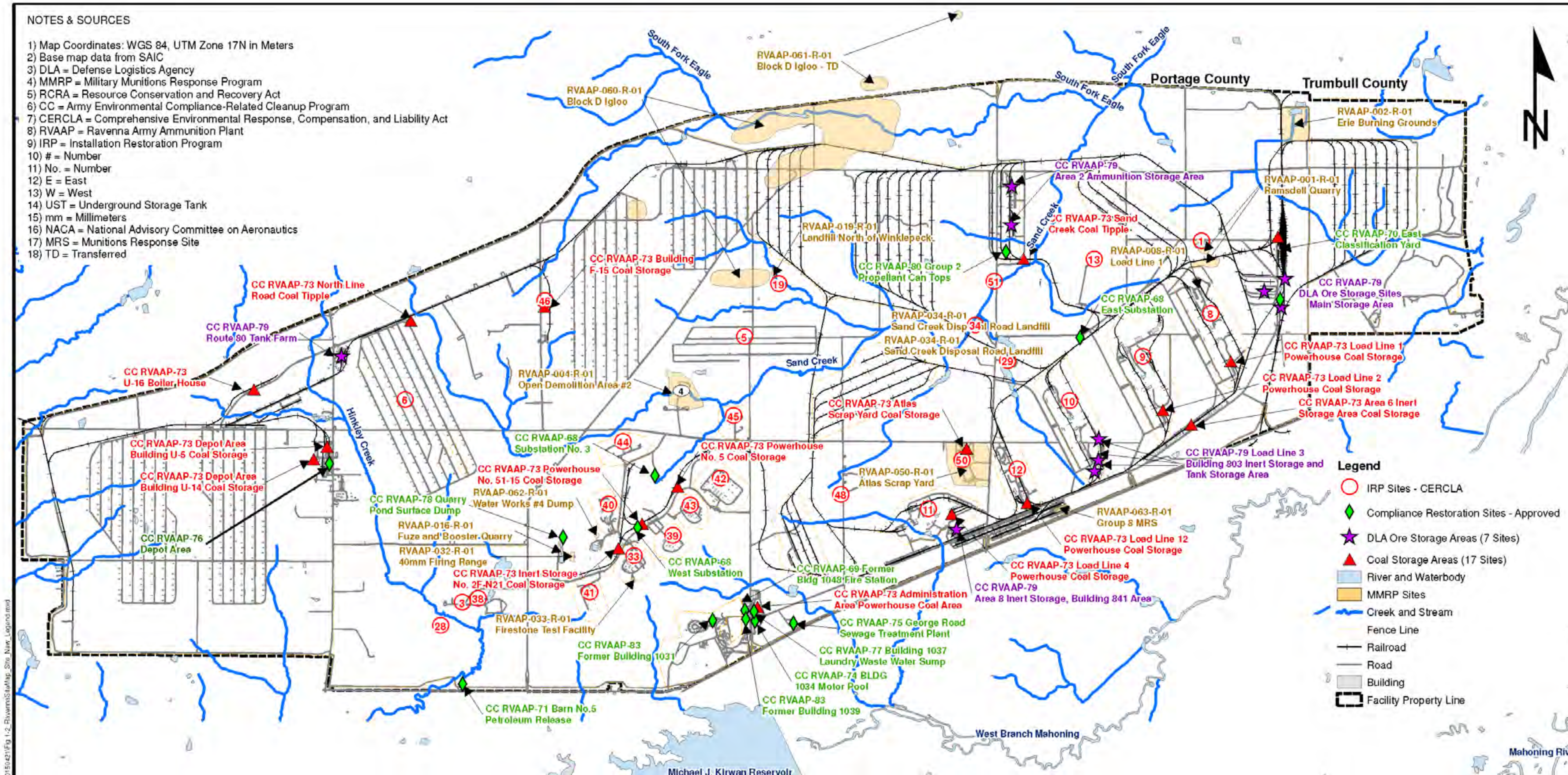

IRP SITES - CERCLA		
1	RVAAP-1	Ramsdell Quarry Landfill
3	RVAAP-3	Open Demolition Area #1
5	RVAAP-5	Winklepeck Burning Grounds
6	RVAAP-6	C Block Quarry
8	RVAAP-8	Load Line 1
9	RVAAP-9	Load Line 2
10	RVAAP-10	Load Line 3
11	RVAAP-11	Load Line 4
12	RVAAP-12	Load Line 12
13	RVAAP-13	Building 1200 - Dilution Settling Pond
19	RVAAP-19	Landfill North of Winklepeck Burning Grounds
28	RVAAP-28	Mustard Agent Burial Site
29	RVAAP-29	Upper and Lower Cobbs Ponds
33	RVAAP-33	Load Line 6
34	RVAAP-34	Sand Creek Disposal Road Landfill
38	RVAAP-38	NACA Test Area
39	RVAAP-39	Load Line 5
40	RVAAP-40	Load Line 7
41	RVAAP-41	Load Line 8
42	RVAAP-42	Load Line 9
43	RVAAP-43	Load Line 10
44	RVAAP-44	Load Line 11
45	RVAAP-45	Wet Storage Area
46	RVAAP-46	Building F-15 and F-16
48	RVAAP-48	Anchor Test Area
50	RVAAP-50	Atlas Scrap Yard
51	RVAAP-51	Dump Along Paris Windham Rd.
	RVAAP-66	Facility-Wide Groundwater
	RVAAP-67	Facility-Wide Sewer

COMPLIANCE RESTORATION SITES (14 SITES)	
CC RVAAP-68	Electric Substations (E, W, No. 3)
CC RVAAP-69	Former Building 1048 Fire Station
CC RVAAP-70	East Classfication Yard
CC RVAAP-71	Barn No. 5 Petroleum Release
CC RVAAP-72	Facility-Wide USTs (45 Sites)
CC RVAAP-73	Facility-Wide Coal Storage
CC RVAAP-74	Building 1034 Motor Pool Hydraulic Lift
CC RVAAP-75	George Road Sewage Treatment Plant
CC RVAAP-76	Depot Area
CC RVAAP-77	Building 1037 - Laundry Waste Water Sump
CC RVAAP-78	Quarry Pond Surface Dump
CC RVAAP-79	DLA Ore Storage Sites
CC RVAAP-80	Group 2 Propellant Can Tops
CC RVAAP-83	Former Building 1031 and 1039

MMRP SITES (14 SITES)	
RVAAP-001-R-01	Ramsdell Quarry
RVAAP-002-R-01	Erie Burning Grounds MRS
RVAAP-004-R-01	Open Demolition Area #2 MRS
RVAAP-008-R-01	Load Line 1 MRS
RVAAP-016-R-01	Fuze and Booster Quarry MRS
RVAAP-019-R-01	Landfill North of Winklepeck MRS
RVAAP-032-R-01	40 mm Firing Range MRS
RVAAP-033-R-01	Firestone Test Facility MRS
RVAAP-034-R-01	Sand Creek Dump MRS
RVAAP-050-R-01	Atlas Scrap Yard MRS
RVAAP-060-R-01	Block D Igloo MRS
RVAAP-061-R-01	Block D Igloo - TD MRS
RVAAP-062-R-01	Water Works #4 Dump MRS
RVAAP-063-R-01	Group 8

OTHER REGULATORY - RCRA	
CC RVAAP-04	Open Demolition Area #2

0 2,000 4,000 Feet

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT, KENTUCKY

Figure 1-2
Location of Compliance Restoration Sites
FORMER RAVENNA ARMY AMMUNITION PLANT PORTAGE AND TRUMBULL COUNTIES, OHIO

1361

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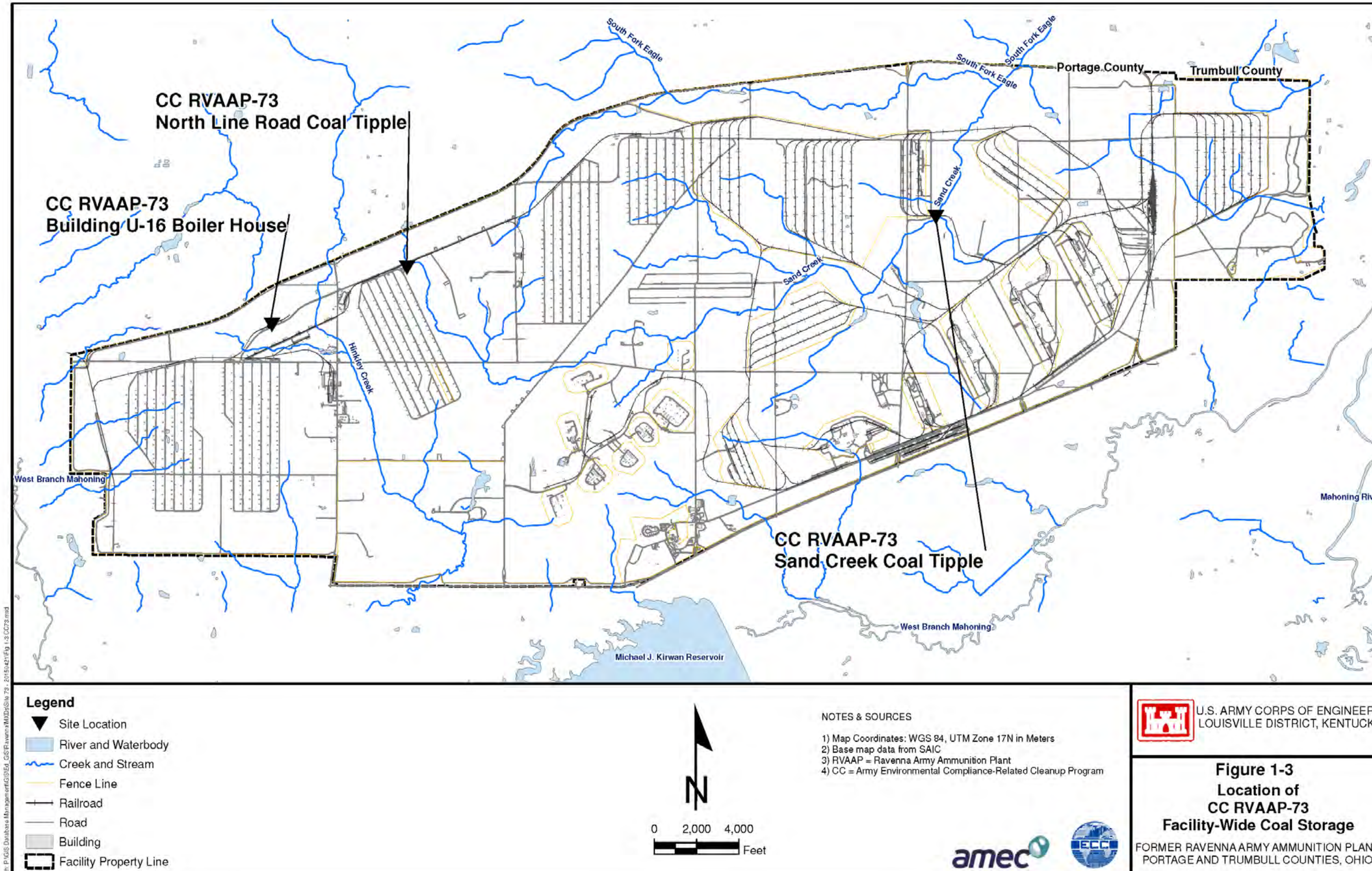

Figure 1-3
Location of
CC RVAAP-73
Facility-Wide Coal Storage

1373

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2. BACKGROUND

2.1 FACILITY-WIDE BACKGROUND

2.1.1 Facility Description

The facility, previously known as the RVAAP, consists of 21,683 acres and is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 km (3 mi) east/northeast of the city of Ravenna and approximately 1.6 km (1 mi) west of the city of Newton Falls.

2.1.2 Demography and Land Use

The 2010 Census reports that the populations of Portage and Trumbull counties are 161,419 and 210,312, respectively. Population centers closest to the facility 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 percent of Portage County, in which the majority of the facility 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 south of the facility.

As of September 2013, administrative accountability for the entire 21,683-acre facility has been transferred to the United States Property and Fiscal Office for Ohio, and the property was subsequently licensed to the OHARNG for use as a military training site (Camp Ravenna). Training and related activities at the facility include field operations and bivouac training, convoy training, equipment maintenance, C-130 aircraft drop zone operations, helicopter operations, and storage of heavy equipment.

2.1.3 Environmental Setting

This section describes the physical features, topography, geology, hydrogeology, and environmental characteristics of the facility. The environmental setting specific to CC RVAAP-73 Facility-Wide Coal Storage is included in Chapter 3.

2.1.3.1 Physiographic Setting

The facility is located within the Southern New York Section of the Appalachian Plateaus physiographic province (United States Geological Survey [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.

2.1.3.2 Surface Features and Topography

The topography of the facility is gently undulating with an overall decrease in ground elevation from a topographic high of approximately 1,220 feet (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 (60.1-centimeter [cm]) contour interval with an accuracy of 0.02 ft (0.61 cm). USACE based the topographic information on aerial photographs taken during Spring 1997. The USACE survey is the basis for the topographical information illustrated in figures included in this report.

2.1.3.3 Geology and Soil

The regional geology at the facility 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 the facility is presented in the following subsections and shown on Figures 2-1 and 2-2, respectively.

2.1.3.3.1 Bedrock Geology

The bedrock geology has been inferred from the data presented in the Environmental Quality Management, Inc. (EQM) Facility-Wide Groundwater Monitoring Annual Report for 2012 (EQM 2013) and shown on Figure 2-1. Additional bedrock monitoring wells have been installed at the site since the January 2010 data by SAIC that served as the previous interpretation of site bedrock (SAIC 2011a). Areas that differ significantly are noted on Figure 2-1.

The Sharon Sandstone Member of the Pennsylvanian Pottsville Formation is the primary bedrock beneath the facility (Figure 2-1). The lower portion of the Sharon Sandstone Member is informally referred to as the Sharon Conglomerate. In the western portion of the facility, the upper members of the Pottsville Formation, including the Sharon Shale, 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 the facility is between 5 and 11.5 ft per mi (1.5-3.5 meter [m] per 1.6 km) to the south. The Sharon Sandstone Member, the lowest unit of the Pottsville Formation, is a highly porous, loosely cemented, permeable, cross-bedded, frequently fractured and weathered, orthoquartzite sandstone, which is locally conglomeratic. Thin shale lenses occur in the upper portion of the unit. The Sharon Shale is a gray to black sandy to micaceous shale containing thin coal, underclay, and sandstone lenses. The Mercer Member of the Pottsville Formation consists of silty to carbonaceous shale with abundant thin, discontinuous sandstone lenses in the upper portion. Regionally, the Mercer Member also has been noted to contain interbeds of coal. The Homewood Sandstone Member is the uppermost unit of the Pottsville Formation. It typically occurs as a caprock on bedrock highs in the subsurface, and ranges from well-sorted, coarse-grained, white quartzose sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. Thin shale layers are prevalent in the Homewood Member as indicated by a darker gray shade of color (Winslow and White 1966).

As shown on Figure 2-1, two small areas of Berea Sandstone were identified as the uppermost bedrock present. The Berea sandstone is a medium- to fine-grained clay-bonded quartz sandstone. The upper 20-30 ft of the Berea is thinly-bedded; however, the beds of the lower Berea are more massive with distinctive cross-bedding (USGS 1954).

2.1.3.3.2 Soil and Glacial Deposits

Bedrock at the facility 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 (Figure 2-2). Unconsolidated glacial deposits vary considerably in their character and thickness across the facility, from 0 in some of the eastern portions of the facility to an estimated 150 ft (46 m) 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 (USACE 2001a). 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 2001a).

Soil at the facility 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 (United States Department of Agriculture [USDA] 1978, 2010). Much of the native soil at the facility was disturbed during construction activities in former production and operational areas of the facility. Several soil types are present at the facility, as shown on Figures 2-3a and 2-3b.

2.1.3.4 Hydrogeology

2.1.3.4.1 Regional Hydrogeology

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 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 comes from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at the facility have not been delineated.

The potentiometric surfaces at the facility for unconsolidated deposits and bedrock are based on the facility-wide July 2012 groundwater monitoring event (EQM 2013). The groundwater elevations of the unconsolidated deposits are shown on Figure 2-4. The potentiometric surface of the Homewood Sandstone Member (uppermost aquifer of the Pottsville Formation) is presented on Figure 2-5, the potentiometric surface of the upper Sharon Sandstone Member (intermediate aquifer of the Pottsville Formation) is presented on Figure 2-6, and the potentiometric surface of the lower Sharon Sandstone Member (referred to in this RI as the Sharon Conglomerate; the deepest aquifer of the Pottsville Formation) is presented on Figure 2-7.

The groundwater table occurs within the unconsolidated zone in many areas of the facility. The thickness of the unconsolidated interval at the facility ranges from thin to absent in the eastern and northeastern portions of the facility to an estimated 150 ft (46 m) in the central portion 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 shallow 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.

As shown on Figure 2-4, groundwater in the unconsolidated aquifer predominantly flows in an eastward direction; however, the unconsolidated zone shows numerous local flow variations influenced by topography and drainage patterns. The local variations in flow direction suggest: (1) groundwater in the unconsolidated deposits is generally in direct hydraulic communication with surface water, and (2) surface water drainage ways may also act as groundwater discharge locations. In addition, topographic ridges between surface water drainage features act as groundwater divides in the unconsolidated deposits, as inferred near the western facility boundary.

Within bedrock units at the facility, the principal water-bearing aquifer is the Sharon Conglomerate of the Pottsville Formation. Depending on the existence and depth of overburden, the Sharon Conglomerate ranges from an unconfined to a leaky artesian aquifer. Water yields from onsite water supply wells completed in the Sharon Conglomerate ranged from 30 to 400 gallons per minute (gpm) (United States Army Toxic and Hazardous Materials Agency 1978). Well yields of 5-200 gpm were reported for onsite bedrock wells completed in the Sharon Conglomerate (Kammer 1982). At the facility, the upper portion of the Sharon Conglomerate (Sharon Sandstone Member) is apparently hydraulically separate from the lower Sharon Conglomerate (EQM 2013).

The Sharon bedrock potentiometric gradient is a more uniform and regional eastward flow direction than the unconsolidated zone and is not as affected by local surface topography. As shown on Figure 2-6, the regional groundwater flow direction of the upper Sharon Sandstone is to the east; however, there is a notable mounding of groundwater in the southeastern portion of the facility where groundwater within this aquifer is radial. As shown on Figure 2-7, the groundwater flow direction in the lower Sharon Conglomerate is also to the east.

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 Conglomerate due to lower permeabilities. None of the monitoring wells at the facility are identified as screened in the Connoquenessing (EQM 2013). As shown on Figure 2-5, the groundwater flow within the Homewood Sandstone at the facility is radial due to the sandstone's presence as a localized cap rock.

For much of the eastern half of the facility, 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. However, in the far eastern area, the two potentiometric surfaces are at approximately the same elevation, suggesting that hydraulic communication between the two aquifers is occurring. Due to the lack of well data in the western portion of the facility, generalized hydraulic gradients and flow patterns are difficult to discern.

2.1.3.4.2 Groundwater Usage and Domestic Water Supply

The facility historically used groundwater for both domestic and industrial supplies. Groundwater utilized at the facility during past operations was obtained from production wells located throughout the facility, with the majority of wells screened in the Sharon Conglomerate. The Army discontinued use of most of the groundwater production wells prior to 1993, when the facility was placed in modified caretaker status. Currently, one of the four remaining original groundwater production wells remains in use by the Army. This well, located in the Administration Area, is not used as a potable water source of supply, but supplies sanitary water for actively used buildings in that area.

In addition, in 2010, OHARNG installed two bedrock aquifer production wells for use as a groundwater supply. These two OHARNG groundwater supply wells are installed in the Sharon Conglomerate aquifer and are located near Buildings 1067 and 1068 within the Administration Area. There is also one groundwater supply well just south of Winklepeck Burning Grounds along the west side of George Road, which was formerly used to supply water for environmental restoration activities. This groundwater supply well is used solely for onsite activities and is not used for public distribution, livestock, or commercial groundwater potable supply.

The closest population center to the facility, the city of Newton Falls, obtains municipal water supplies from the east branch of the Mahoning River. Currently, the majority of residential groundwater use in the area surrounding the facility is primarily for domestic and livestock supply, with the Sharon Conglomerate acting as the major producing aquifer in the area. The Connoquenessing and Homewood sandstones also provide limited groundwater resources, primarily surrounding the western half of the facility. Unconsolidated deposits can also be an important source of groundwater, as many of the domestic wells and small public water supplies located near the facility obtain sustainable quantities of water from wells completed in unconsolidated deposits. Local groundwater within and surrounding the facility contains proportionately high levels of iron, manganese, and carbonate compounds.

2.1.3.4.3 Regional Surface Water

The facility 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, which is located to the south of State Route 5 (Figure 1-1). The West Branch flows out of the reservoir and parallels the southern the facility boundary before joining the Mahoning River east of the facility. The western and northern portions of the facility 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.

As shown on Figure 1-2, the three primary watercourses that drain the facility are:

- South fork of Eagle Creek
- Sand Creek
- Hinkley Creek.

All of these watercourses have many associated tributaries. Sand Creek, with a drainage area of 13.9 square mi (mi^2) (36 square km [km^2]), flows generally 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 mi (4.3 km) to its confluence with Eagle Creek. The drainage area of the south fork of Eagle Creek is 26.2 mi^2 (67.8 km^2), 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 11.0 mi^2 (28.5 km^2), flows in a southerly direction through the facility, and converges with the west branch of the Mahoning River south of the facility (USACE 2001a).

Approximately one-third of the facility meets the regulatory definition of a wetland, with the majority of the wetland areas located in the eastern portion of the facility. Wetland areas 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 50 ponds are scattered throughout the facility. 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. Water bodies at the facility could support aquatic vegetation and biota. Stormwater 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. Additionally, the storm sewer system was one of the primary drainage mechanisms for process effluent during the period that production facilities were in operation.

2.1.3.5 Climate

The general climate of the facility 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. Climate data for the facility area presented below were obtained from National Weather Service records for the 16-year period of record from 1996 to 2012 at the Youngstown Regional Airport, Ohio (http://www.nws.noaa.gov/climate/xmacis.php?wfo=cle). Wind speed data for Youngstown, Ohio, are from the National Climatic Data Center (http://www.ncdc.noaa.gov/data-access/quick-linksa#wind) for the available 53-year period of record from 1950 through 2002.

Average annual rainfall in the facility area is 41.2 inches (in.) (104.65 cm), with the highest monthly average occurring in May (4.35 in. or 11.05 cm) and the lowest monthly average occurring in February (2.50 in. or 6.35 cm). For the period of 1971-2000, the average annual snowfall for the Youngstown Area totals approximately 55.0 in. (139.7 cm), with the highest monthly average occurring in January (14.3 in. or 36.32 cm). Due to the influence of lake effect snowfall events associated with Lake Erie (located approximately 35 mi [56.3 km] northwest of the facility), snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the facility area is 49.6 degrees Fahrenheit (ºF), with an average daily high temperature of 70.7ºF and an average daily low temperature of 26.5ºF. The record high temperature of 103ºF occurred in July 1936, and the record low temperature of -22ºF occurred in January 1994. The prevailing wind direction at the facility is from the west-southwest, with the highest average wind speed occurring in January (12.0 mi [19.31 km] per hour) and the lowest average wind speed occurring in August (7.04 mi [11.27 km] per hour). Thunderstorms occur on approximately 35 days per year and are most abundant from April through August. The facility area is susceptible to tornadoes; minor structural damage to several buildings on facility property occurred as the result of a tornado in 1985.

2.2 AREA OF CONCERN DESCRIPTION

Figures 1-2 and 1-3 depict the location of this AOC. The Building U-16 Boiler House and North Line Road Coal Tipple are located in the northwestern portion of the former RVAAP. Building U-16 Boiler House is located north of Bundling/North Line Road, west of Route 80 (also known as Freedom Road), and north of Newton Falls Road. North Line Road Coal Tipple is located just south of Bundling/North Line Road; east of Road 7C, and north of Newton Falls Road. Sand Creek Coal Tipple is located in the north-central portion of the facility, just east of Paris-Windham Road and west of Building 1200.

2.2.1 Operational History

Based on the HRR, historical use of coal at the facility was consistent with conventional industrial practices at the time for steam generation supplying power houses, production facilities, and heating systems. The facility received bulk coal primarily by rail at the Sand Creek and North Line Road coal tipples. Bulk coal was typically stored and staged in uncovered piles on the ground surface. Coal was distributed throughout the facility by truck. Coal storage locations included covered bins and uncovered storage piles on the ground surface. No documentation of accidental large volume spills or releases associated with the coal storage areas was found during the HRR. Historical aerial photographs of the former coal storage areas from 1952, 1959, 1966, 1979, 1985, 1994, 1997, 2000, 2003, 2006, 2009, and 2012 were reviewed to estimate the timeframe of property use for coal storage. There are no aboveground storage tanks or underground storage tanks associated specifically with the former coal storage areas.

- ***North Line Road Coal Tipple*—**Historically, this area was used as a bulk coal receiving, storage, and distribution area. Based on historical aerial photographs of this area, probable coal storage piles appear in the 1952 through 1966 photos. Most of the coal appears to have been removed by 1979. By 1985, there is no evidence of coal storage in this area; however, during a 2004 visit to this area, very small particles of coal were noted as remaining scattered over the area (SAIC 2011a).

- ***Sand Creek Coal Tipple*—**Historically, this area was used as a bulk coal receiving, storage, and distribution area. Based on historical aerial photographs of this area, there is no clear evidence of coal storage in this area. Residual coal was observed in this area during the 2004 area visit (SAIC 2011a).

- ***Building U-16 Boiler House*—**Historically, this area was used to store coal for boiler supply/steam generation. Based on historical aerial photographs of this area, probable coal storage piles appear in the 1952 through 1966 photos. Most of the coal appears to have been removed by 1979. By 1985, there is no evidence of coal storage in this area; however, during a 2004 visit to this area, residual coal was observed in the area (SAIC 2011a).

2.2.2 Land Use and Ownership History

CC RVAAP-73 Facility-Wide Coal Storage is on property located within the boundaries of the facility. The facility is federally owned; however, administrative accountability for the entire 21,683-acre facility has been transferred to the United States Property and Fiscal Office for Ohio, and the property was subsequently licensed to the OHARNG for use as a military training site.

2.2.3 Physical Property Characteristics

***North Line Road Coal Tipple*—**The North Line Road Coal Tipple is located in the northwestern portion of the facility, just south of North Line Road and just northeast of C Block Quarry (CC RVAAP-06). The area is approximately 53,347 square ft (ft^2) (1.22 acres). No building is associated with this location, and the area is generally flat, unpaved, and partially vegetated with low shrubs. The surrounding area is wooded. According to the HRR, residual coal was observed at the surface.

***Sand Creek Coal Tipple*—**The Sand Creek Coal Tipple area is located in the east-central portion of the facility, just southeast of Paris Windham Road and Area 2 Ammunition Storage Area (CC RVAAP-79 DLA Ore Storage Sites AOC). The area is approximately 28,196 ft^2 (0.65 acres). The tipple is at the base of the former rail spur and, based on aerial photographs, it appears to be covered by woody/shrub-type vegetation. According to the HRR, residual coal was observed at the surface. Sand Creek runs adjacent to the area to the south and east.

Building U-16 Boiler House**—**The Building U-16 Boiler House on the north side of Bundling Road in the northwestern portion of the facility. The area comprises approximately 6,050 ft^2 (0.138 acres). The boiler house has been demolished, and the area has been graded. According to the HRR, residual coal was observed, and the surface of the area is covered mainly with grasses and small shrubs. A rail line exists just north of the area. According to the HRR, residual coal was observed at the surface.

2.2.4 Chronological Property Summary

The areas included in CC RVAAP-73 Facility-Wide Coal Storage were constructed as part of the former original RVAAP facility. No specific documentation was found during the HRR to define the years of operation of each specific former coal storage area. Historical aerial photographs indicate coal storage ceased sometime between 1966 and 1979.

2.2.5 Military Operations

No documented evidence of historical military operations being performed in the immediate vicinity of coal storage areas was found during the HRR.

2.2.6 Previous Investigations

No documentation of investigations specific to the former coal storage areas was found during the HRR. Coal is not a CERCLA-release contaminant. However, multiple investigations have been conducted, or are in progress, throughout the facility to investigate former coal storage locations that are not included in this RI, specifically Load Lines 1, 2, 3, 4, and 12; Atlas Scrap Yard; and Buildings F-15 and F-16. Various environmental data for soil, surface water, sediment, and groundwater have been collected at these AOCs and facility-wide, which are presented in respective RI reports or characterization reports that provide a comprehensive characterization of contamination. These investigations included sample locations in the vicinity of the former coal storage locations. For example, Sand Creek surface water and sediment were sampled during a historical water quality study conducted at the facility from 1998 to 2003 (USACE 2005a). Sand Creek is adjacent to the North Line Road Coal Tipple and the Sand Creek Coal Tipple. One collocated surface water and sediment sampling location was approximately 1,400 ft upgradient (north) of the North Line Road Coal Tipple and another was located approximately 300 ft downgradient (north) of the Sand Creek Coal Tipple. Results indicate that the water quality in Sand Creek is “good to exceptional” for aquatic habitats.

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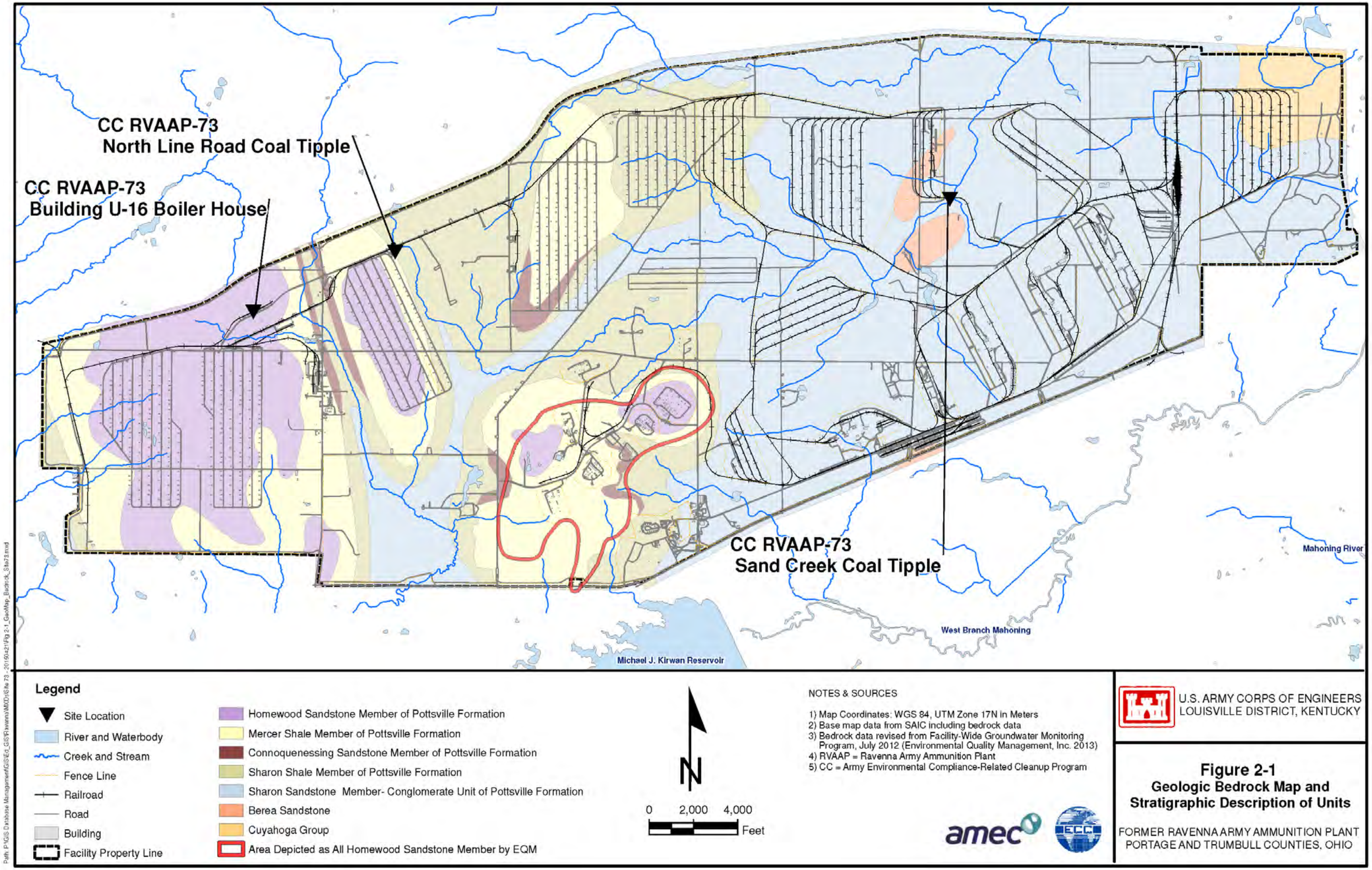
CC RVAAP-73
North Line Road Coal Tipple
CC RVAAP-73
Building U-16 Boiler House
CC RVAAP-73
Sand Creek Coal Tipple
Mahoning River
West Branch Mahoning
Michael J. Kirwan Reservoir
Legend
Site Location
River and Waterbody
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
Homewood Sandstone Member of Pottsville Formation
Mercer Shale Member of Pottsville Formation
Connoquenessing Sandstone Member of Pottsville Formation
Sharon Shale Member of Pottsville Formation
Sharon Sandstone Member- Conglomerate Unit of Pottsville Formation
Berea Sandstone
Cuyahoga Group
Area Depicted as All Homewood Sandstone Member by EQM
N
0 2,000 4,000
Feet
NOTES & SOURCES
1) Map Coordinates: WGS 84, UTM Zone 17N in Meters
2) Base map data from SAIC including bedrock data
3) Bedrock data revised from Facility-Wide Groundwater Monitoring Program, July 2012 (Environmental Quality Management, Inc. 2013)
4) RVAAP = Ravenna Army Ammunition Plant
5) CC = Army Environmental Compliance-Related Cleanup Program
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U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT, KENTUCKY
Figure 2-1
Geologic Bedrock Map and
Stratigraphic Description of Units
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

1801

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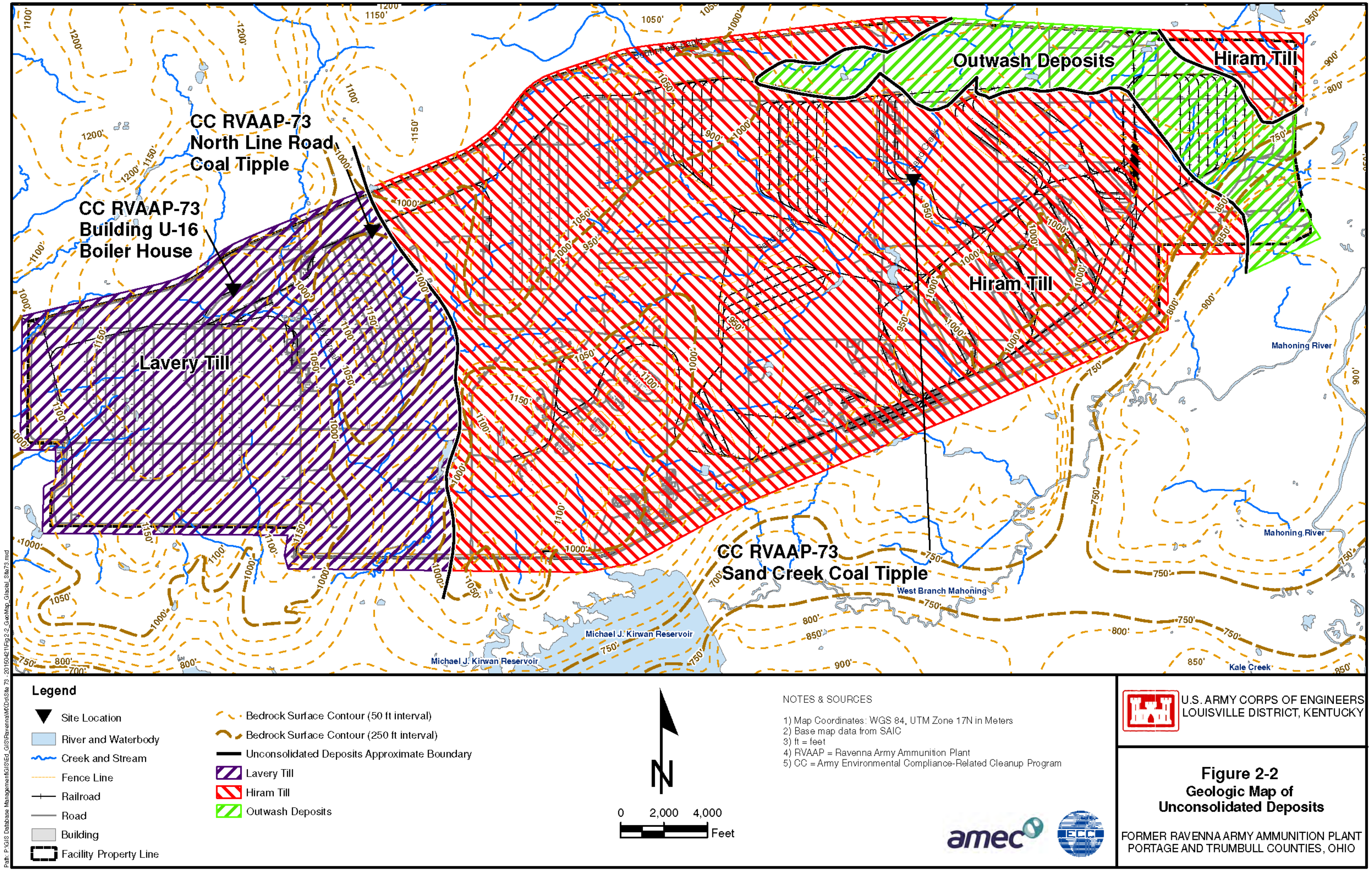

Figure 2-2
Geologic Map of
Unconsolidated Deposits

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

1813

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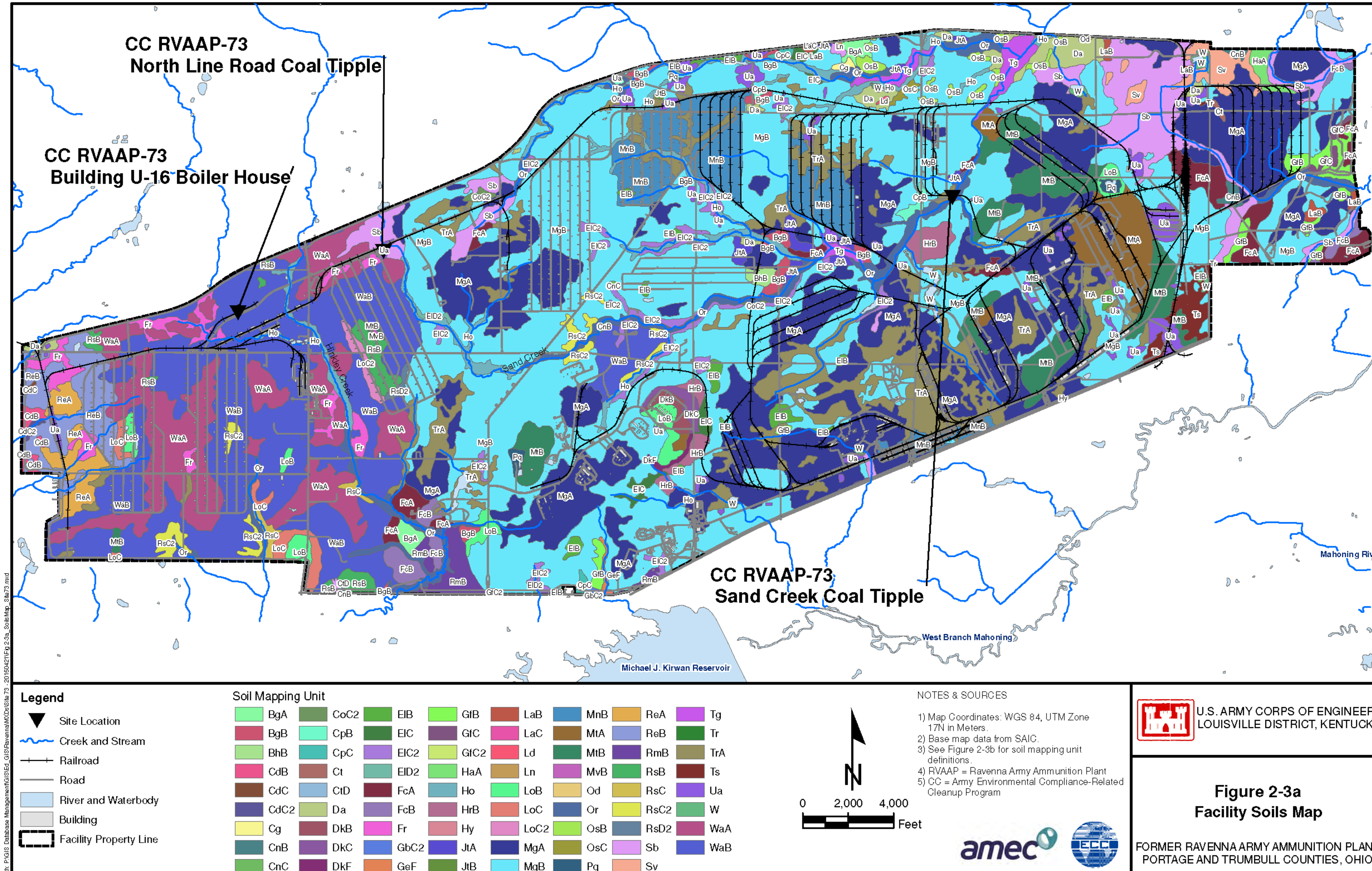
CC RVAAP-73
North Line Road Coal Tipple
CC RVAAP-73
Building U-16 Boiler House
CC RVAAP-73
Sand Creek Coal Tipple
Sand Creek
Hinkley Creek
Mahoning River
West Branch Mahoning
Michael J. Kirwan Reservoir
Legend
Site Location
Creek and Stream
Railroad
Road
River and Waterbody
Building
Facility Property Line
Soil Mapping Unit
BgA BgB BhB CdB CdC CdC2 Cg CnB CnC
CoC2 CpB CpC Ct CtD Da DkB DkC DkF
EIB EIC EIC2 EID2 FcA FcB Fr GbC2 GeF
GfB GfC GfC2 HaA Ho HrB Hy JtA JtB
LaB LaC Ld Ln LoB LoC LoC2 MgA MgB
MnB MtA MtB MvB Od Or OsB OsC Pq
ReA ReB RmB RsB RsC RsC2 RsD2 Sb Sv
Tg Tr TrA Ts Ua W WaA WaB
N
0 2,000 4,000
Feet
NOTES & SOURCES
1) Map Coordinates: WGS 84, UTM Zone 17N in Meters.
2) Base map data from SAIC.
3) See Figure 2-3b for soil mapping unit definitions.
4) RVAAP = Ravenna Army Ammunition Plant
5) CC = Army Environmental Compliance-Related Cleanup Program
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ECC
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT, KENTUCKY
Figure 2-3a
Facility Soils Map
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

1825

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Legend

Soil Mapping Unit

- BgA, Bogart silt loam, 0 - 2% slopes
- BgB, Bogart silt loam, 2 - 6% slopes
- BhB, Bogart-Haskins complex, 2 - 6% slopes
- CdB, Canfield silt loam, 2 - 6% slopes
- CdC, Canfield silt loam, 6 - 12% slopes
- CdC2, Canfield silt loam, 6 - 12% slopes, moderately eroded
- Cg, Carlisle muck
- CnB, Chili loam, 2 - 6% slopes
- CnC, Chili loam, 6 - 12% slopes
- CoC2, Chili gravelly loam, 6 - 12% slopes, moderately eroded
- CpB, Chili silt loam, 2 - 6% slopes
- CpC, Chili silt loam, 6 - 12% slopes
- Ct, Chili-Oshtemo complex
- CtD, Chili-Oshtemo complex, 12 - 18% slopes
- Da, Damascus loam
- DkB, Dekalb channery loam, 2 - 6% slopes
- DkC, Dekalb channery loam, 6 - 12% slopes
- DkF, Dekalb channery loam, 25 - 70% slopes
- ElB, Ellsworth silt loam, 2 - 6% slopes
- ElC, Ellsworth silt loam, 6 - 12% slopes
- ElC2, Ellsworth silt loam, 6 - 12% slopes, moderately eroded
- ElD2, Ellsworth silt loam, 12 - 18% slopes, moderately eroded
- FcA, Fitchville silt loam, 0 - 2% slopes
- FcB, Fitchville silt loam, 2 - 6% slopes
- Fr, Frenchtown silt loam
- GbC2, Geeburg silt loam, 6 - 12% slopes, moderately eroded
- GeF, Geeburg and Glenford silt loams, steep
- GfB, Glenford silt loam, 2 - 6% slopes
- GfC, Glenford silt loam, 6 - 12% slopes
- GfC2, Glenford silt loam, 6 - 12% slopes, moderately eroded
- HaA, Haskins loam, 0 - 2% slopes
- Ho, Holly silt loam
- HrB, Hornell silt loam, 3 - 8% slopes
- Hy, Holly silt loam, frequently flooded
- JtA, Jimtown loam, 0 - 2% slopes
- JtB, Jimtown loam, 2 - 6% slopes
- LaB, Lakin loamy sand, 2 - 6% slopes
- LaC, Lakin loamy sand, 6 - 12% slopes
- Ld, Linwood muck
- Ln, Lorain silty clay loam
- LoB, Loudonville silt loam, 2 - 6% slopes
- LoC, Loudonville silt loam, 6 - 12% slopes
- LoC2, Loudonville silt loam, 6 - 12% slopes, moderately eroded
- MgA, Mahoning silt loam, 0 - 2% slopes
- MgB, Mahoning silt loam, 2 - 6% slopes
- MnB, Mahoning-Urban land complex, undulating
- MtA, Mitiwanga silt loam, 0 - 2% slopes
- MtB, Mitiwanga silt loam, 2 - 6% slopes
- MvB, Mitiwanga silt loam, 2 - 6% slopes, moderately well drained variant
- Od, Olmsted loam
- Or, Orrville silt loam
- OsB, Oshtemo sandy loam, 2 - 6% slopes
- OsC, Oshtemo sandy loam, 6 - 12% slopes
- Pq, Pits, quarries
- ReA, Ravenna silt loam, 0 - 2% slopes
- ReB, Ravenna silt loam, 2 - 6% slopes
- RmB, Remsen silt loam, 2 - 6% slopes
- RsB, Rittman silt loam, 2 - 6% slopes
- RsC, Rittman silt loam, 6 - 12% slopes
- RsC2, Rittman silt loam, 6 - 12% slopes, moderately eroded
- RsD2, Rittman silt loam, 12 - 18% slopes, moderately eroded
- Sb, Sebring silt loam
- Sv, Sebring silt loam, dark surface variant
- Tg, Tioga loam
- Tr, Trumbull silt loam
- TrA, Trumbull silt loam, 0 - 2% slopes
- Ts, Trumbull silty clay loam
- Ua, Udorthents
- W, Water
- WaA, Wadsworth silt loam, 0 - 2% slopes
- WaB, Wadsworth silt loam, 2 - 6% slopes

NOTES & SOURCES

1) Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed 12/28/2012.
2) See Figure 2-3a for soils map.
3) RVAAP = Ravenna Army Ammunition Plant
4) CC = Army Environmental Compliance-Related Cleanup Program

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Figure 2-3b
Description of Soil Mapping Units

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

1837

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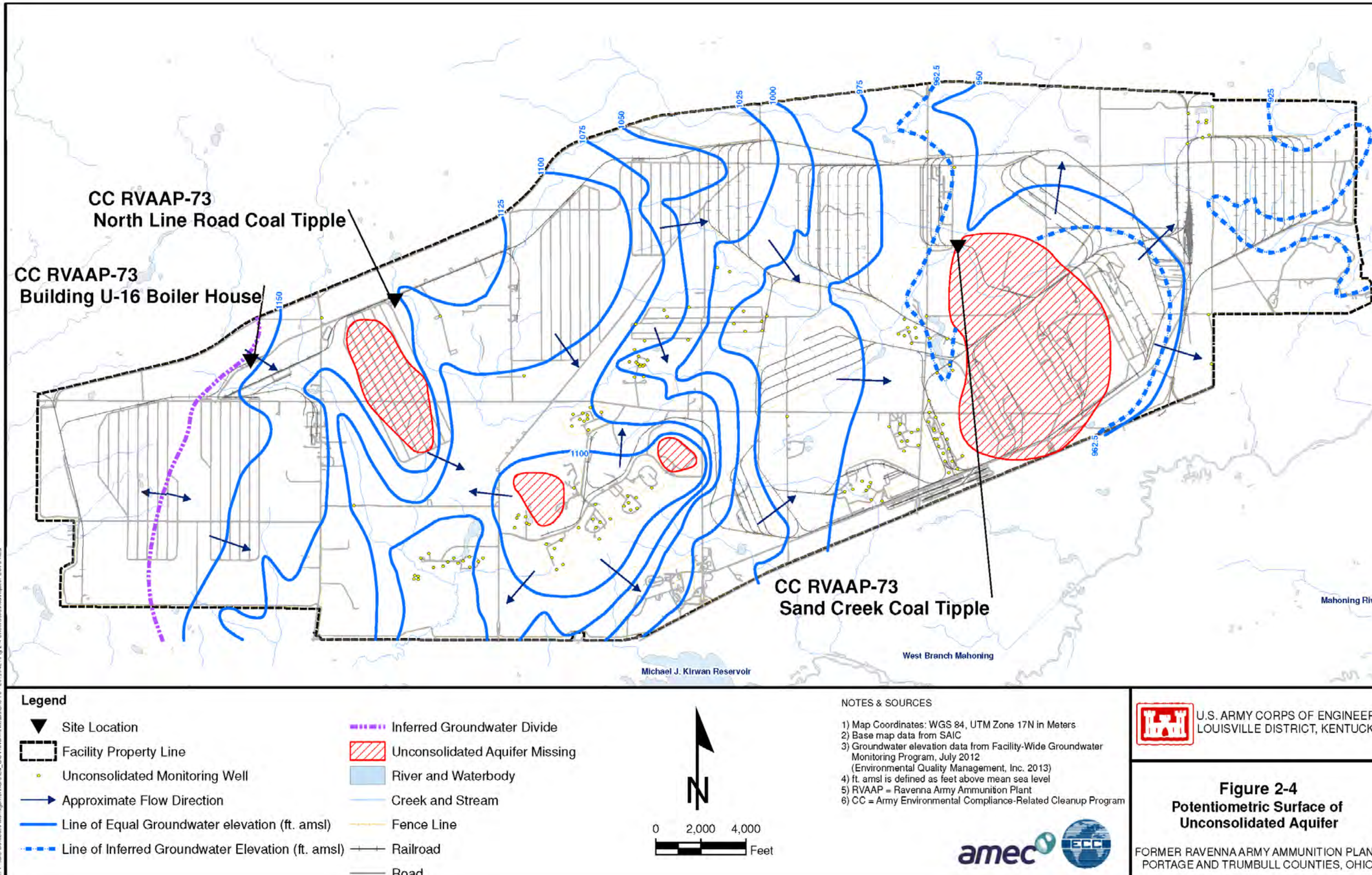
CC RVAAP-73
North Line Road Coal Tipple
CC RVAAP-73
Building U-16 Boiler House
CC RVAAP-73
Sand Creek Coal Tipple
1150
1125
1100
1075
1050
1025
1000
975
962.5
950
925
Mahoning River
West Branch Mahoning
Michael J. Kirwan Reservoir
Legend
Site Location
Facility Property Line
Unconsolidated Monitoring Well
Approximate Flow Direction
Line of Equal Groundwater elevation (ft. amsl)
Line of Inferred Groundwater Elevation (ft. amsl)
Inferred Groundwater Divide
Unconsolidated Aquifer Missing
River and Waterbody
Creek and Stream
Fence Line
Railroad
Road
N
0 2,000 4,000
Feet
NOTES & SOURCES
1) Map Coordinates: WGS 84, UTM Zone 17N in Meters
2) Base map data from SAIC
3) Groundwater elevation data from Facility-Wide Groundwater Monitoring Program, July 2012 (Environmental Quality Management, Inc. 2013)
4) ft. amsl is defined as feet above mean sea level
5) RVAAP = Ravenna Army Ammunition Plant
6) CC = Army Environmental Compliance-Related Cleanup Program
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Figure 2-4
Potentiometric Surface of
Unconsolidated Aquifer
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

1849

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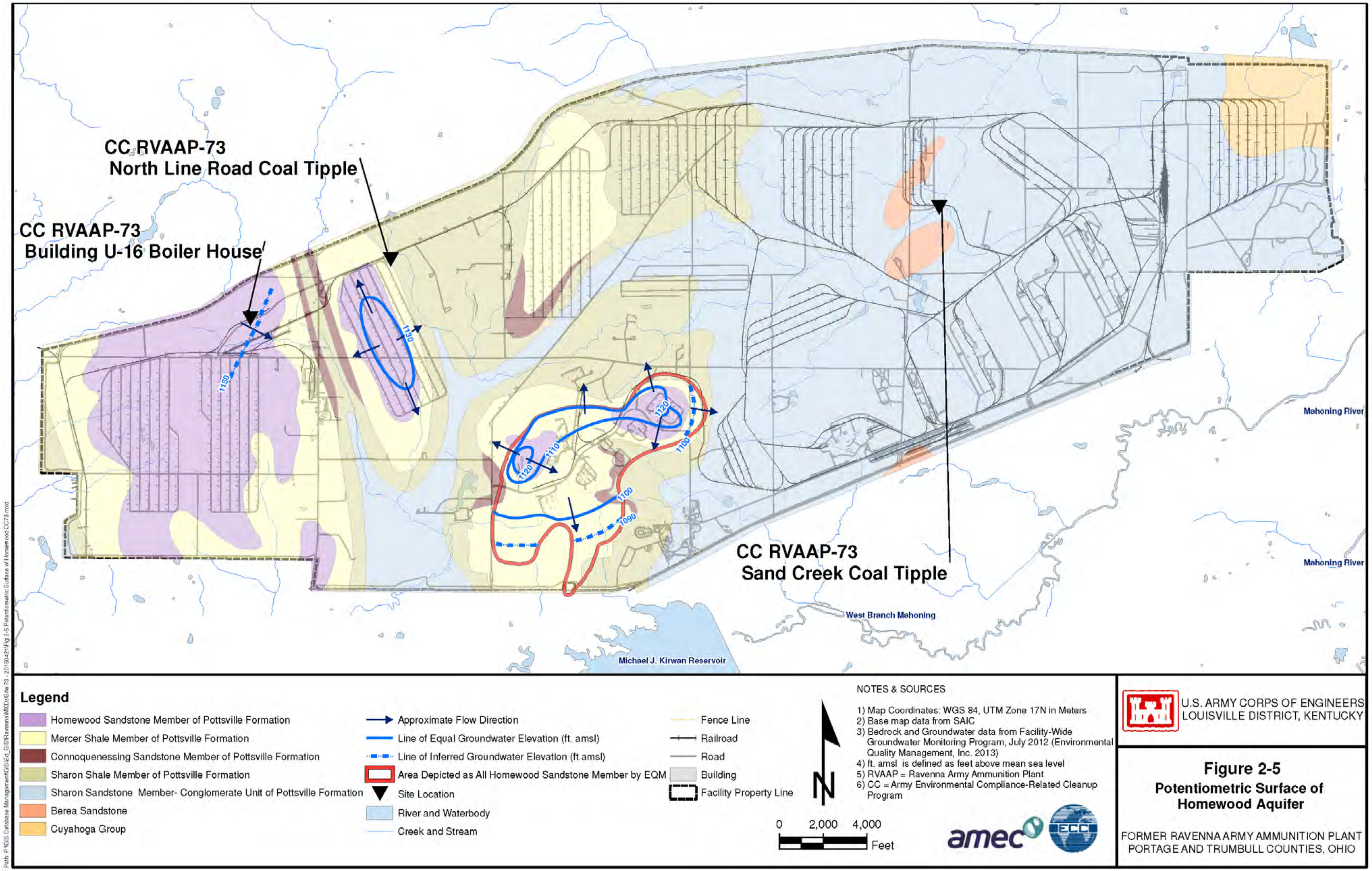
CC RVAAP-73
North Line Road Coal Tipple
CC RVAAP-73
Building U-16 Boiler House
CC RVAAP-73
Sand Creek Coal Tipple
Mahoning River
Mahoning River
West Branch Mahoning
Michael J. Kirwan Reservoir
1150
1130
1120
1110
1120
1100
1100
1090
Legend
Homewood Sandstone Member of Pottsville Formation
Mercer Shale Member of Pottsville Formation
Connoquenessing Sandstone Member of Pottsville Formation
Sharon Shale Member of Pottsville Formation
Sharon Sandstone Member- Conglomerate Unit of Pottsville Formation
Berea Sandstone
Cuyahoga Group
Approximate Flow Direction
Line of Equal Groundwater Elevation (ft. amsl)
Line of Inferred Groundwater Elevation (ft.amsl)
Area Depicted as All Homewood Sandstone Member by EQM
Site Location
River and Waterbody
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
NOTES & SOURCES
1) Map Coordinates: WGS 84, UTM Zone 17N in Meters
2) Base map data from SAIC
3) Bedrock and Groundwater data from Facility-Wide Groundwater Monitoring Program, July 2012 (Environmental Quality Management, Inc. 2013)
4) ft. amsl is defined as feet above mean sea level
5) RVAAP = Ravenna Army Ammunition Plant
6) CC = Army Environmental Compliance-Related Cleanup Program
N
0 2,000 4,000
Feet
amec
ECC
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT, KENTUCKY
Figure 2-5
Potentiometric Surface of Homewood Aquifer
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

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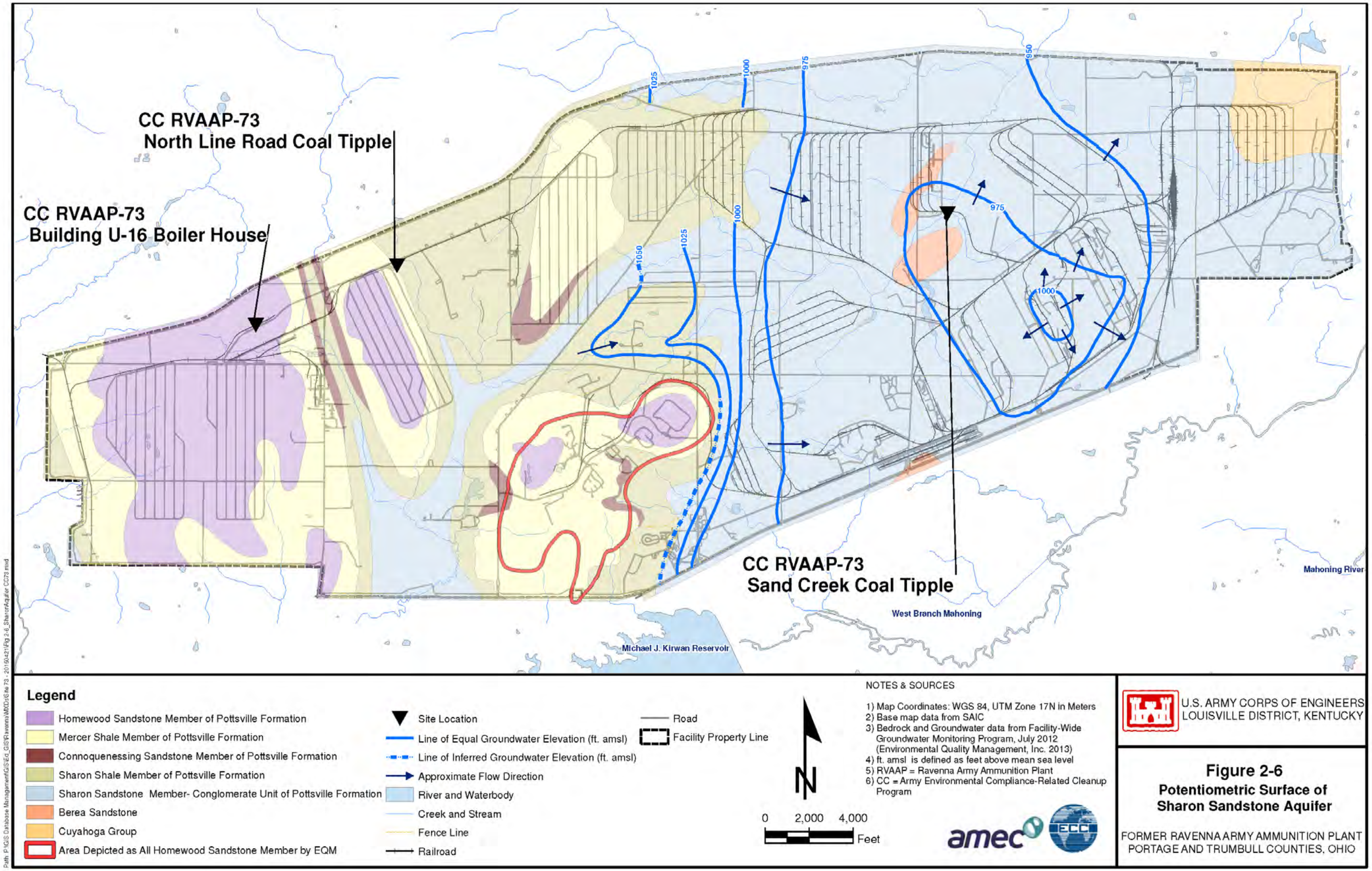
CC RVAAP-73
North Line Road Coal Tipple
CC RVAAP-73
Building U-16 Boiler House
CC RVAAP-73
Sand Creek Coal Tipple
1025
1000
975
950
1050
1025
1000
975
1000
Mahoning River
West Branch Mahoning
Michael J. Kirwan Reservoir
Legend
Homewood Sandstone Member of Pottsville Formation
Mercer Shale Member of Pottsville Formation
Connoquenessing Sandstone Member of Pottsville Formation
Sharon Shale Member of Pottsville Formation
Sharon Sandstone Member- Conglomerate Unit of Pottsville Formation
Berea Sandstone
Cuyahoga Group
Area Depicted as All Homewood Sandstone Member by EQM
Site Location
Line of Equal Groundwater Elevation (ft. amsl)
Line of Inferred Groundwater Elevation (ft. amsl)
Approximate Flow Direction
River and Waterbody
Creek and Stream
Fence Line
Railroad
Road
Facility Property Line
N
0 2,000 4,000
Feet
NOTES & SOURCES
1) Map Coordinates: WGS 84, UTM Zone 17N in Meters
2) Base map data from SAIC
3) Bedrock and Groundwater data from Facility-Wide Groundwater Monitoring Program, July 2012 (Environmental Quality Management, Inc. 2013)
4) ft. amsl is defined as feet above mean sea level
5) RVAAP = Ravenna Army Ammunition Plant
6) CC = Army Environmental Compliance-Related Cleanup Program
amec
ECC
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Figure 2-6
Potentiometric Surface of
Sharon Sandstone Aquifer
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

1873

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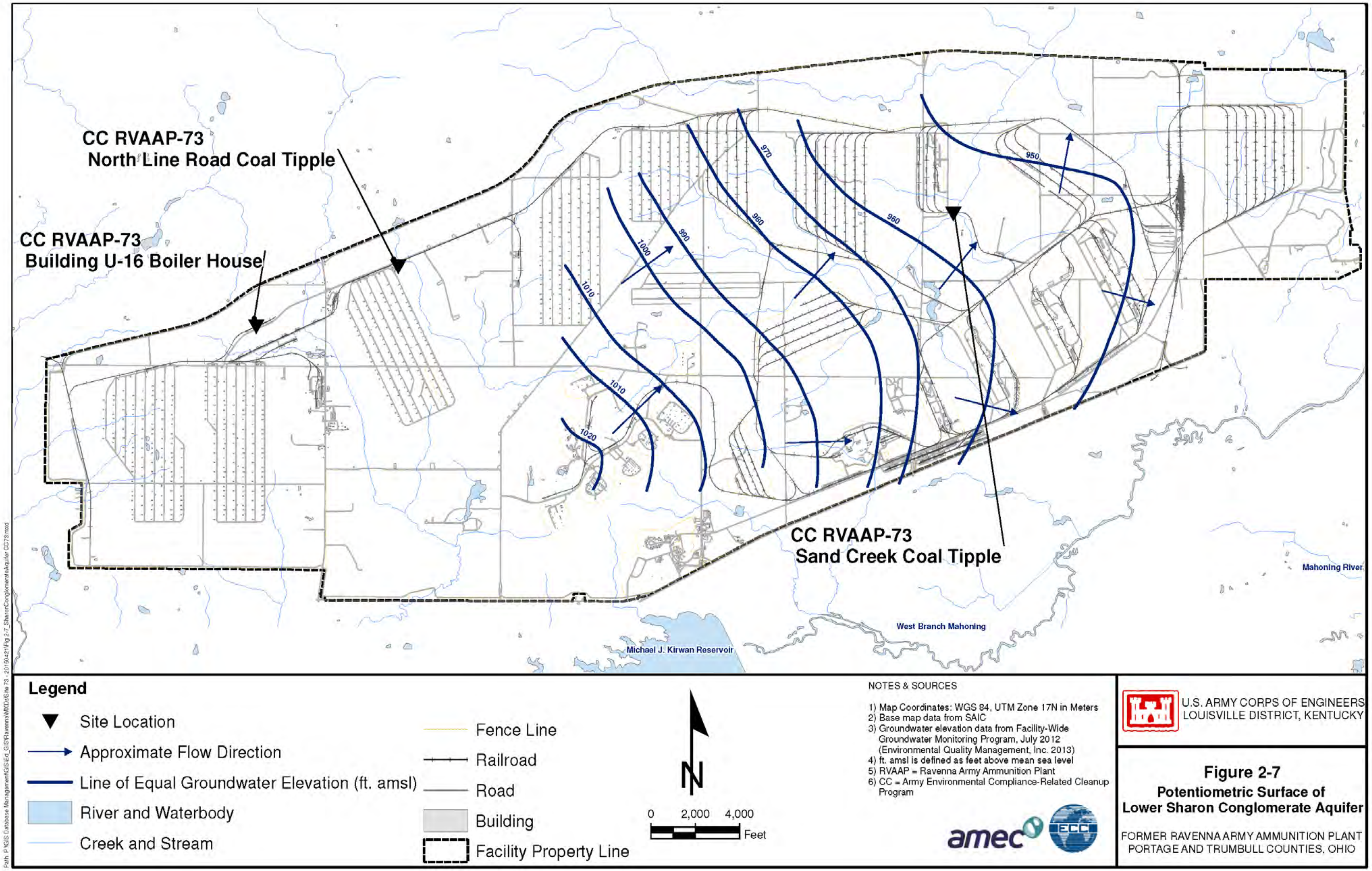

Figure 2-7
Potentiometric Surface of Lower Sharon Conglomerate Aquifer

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3. CC RVAAP-73 FACILITY-WIDE COAL STORAGE SETTINGS

This chapter describes the physical features of the three former coal storage areas of CC RVAAP-73 Facility-Wide Coal Storage including surface features and topography, soil and geology, hydrogeology, and surface water. Potential receptors are also discussed based on environmental setting factors.

3.1 SURFACE FEATURES AND TOPOGRAPHY

The surface features present at CC RVAAP-73 Facility-Wide Coal Storage are generally similar to the rest of the facility, with mildly undulating topography. Figures 3-1a through 3-1c illustrate the area features and topography of the three coal storage areas. These areas are mostly void of large or tall vegetation, with the exception of Sand Creek Coal Tipple, and are surrounded by wooded areas. Railroad spurs and/or roads are located immediately adjacent to each area.

North Line Road Coal Tipple—The topography at North Line Road Coal Tipple is generally flat with a slight grade to the east-southeast toward Sand Creek (Figure 3-1a). The approximate surface elevation of the area is 1,128 ft amsl. The area comprises approximately 1.22 acres, and the surface of the area is an open field. No building is associated with this location. A ditch exists to the north of the area along the south side of North Line Road. The ditch flows east-northeast into Sand Creek.

Sand Creek Coal Tipple—The topography of the immediate area of the Sand Creek Coal Tipple is generally flat, but the larger vicinity slopes toward Sand Creek to the east and south (Figure 3-1b). The approximate surface elevation of the area is 945 ft amsl. The tipple area is approximately 0.65 acres and, based on aerial photographs, the area appears to be covered by woody/shrub type species.

Building U-16 Boiler House—The topography at the Building U-16 Boiler House area is generally flat, with a slight grade to the southeast (Figure 3-1c). The approximate surface elevation of the area is 1,187 ft amsl. The area comprises approximately 0.14 acres, and the surface of the area is covered mainly with grasses and small shrubs. There is no structure within the investigated area.

3.2 SOIL AND GEOLOGY

While Figures 3-2a through 3-2c show original soil types at the former coal storage areas, it is likely that the native soil types have been disturbed to a degree that the original soil type at these locations can no longer be definitively identified. Soils were observed and documented during the RI conducted in the three CC RVAAP-73 Facility-Wide Coal Storage areas and typically matched those descriptions provided by USDA for the upper portion at each boring location. Boring logs are presented in Appendix A.

The borings at the CC RVAAP-73 Facility-Wide Coal Storage areas have not been advanced to bedrock. The bedrock geology has been inferred from the data shown on Figure 2-1.

***North Line Road Coal Tipple*—**As shown on Figure 3-2a, the native soil at North Line Road Coal Tipple was mapped by the USDA as Udorthents. Boring logs from the area indicate dark brown to gray silty clays, which are assumed to be Lavery Till glacial deposits (Figure 2-2) or fill material. One boring location indicated slag and coal from 8 to 10 in. below ground surface (bgs).

Although borings in this area have not been advanced to the top of bedrock, the bedrock beneath this coal tipple is assumed to be shale; likely either Mercer Shale or Sharon Shale (Figure 2-1). Based on approximate surface elevation (Figure 3-1a) and the top of bedrock elevation (Figure 2-1), the depth to bedrock in this area is estimated to be approximately 125 ft bgs (1,000 ft amsl).

***Sand Creek Coal Tipple*—**As shown on Figure 3-2b, the native soil at North Line Road Coal Tipple was mapped by the USDA as Trumbull silt loam (0-2 percent slopes). Boring logs from the area indicate dark brown to gray silty clays at the surface, grading to silty sand. These soils are assumed to be Hiram Till glacial deposits (Figure 2-2) or fill material.

Although borings at the site have not been advanced to the top of bedrock, the bedrock beneath the area is assumed to be the lower portion of the Pennsylvanian Pottsville Formation (Sharon Conglomerate) (Figure 2-1). Based on approximate surface elevation (Figure 3-1b) and the top of bedrock elevation (Figure 2-1), the depth to bedrock in this area is estimated to be approximately 20 ft bgs (925 ft amsl).

***Building U-16 Boiler House*—**The native soil at the Building U-16 Boiler House was mapped by the USDA as Wadsworth silt loam (2-6 percent slopes) (Figure 3-2c). Boring logs from the area indicate predominantly brown silty clays, which are assumed to be Lavery Till glacial deposits (Figure 2-2) or fill material from site construction. One boring location included coal and gravel from 0 to 6 in. bgs.

Although borings in this area have not been advanced to the top of bedrock, the bedrock beneath the area is assumed to be the Homewood Sandstone Member of Pottsville formation (Figure 2-1). Based on approximate surface elevation (Figure 3-1c) and the top of bedrock elevation (Figure 2-1), the depth to bedrock in this area is estimated to be approximately 27 ft bgs (1,160 ft amsl).

3.3 HYDROGEOLOGY

The hydrogeology for each of the three CC RVAAP-73 Facility-Wide Coal Storage areas is based on data presented in the Facility-Wide Groundwater Monitoring Program 2012 Annual Report (EQM 2013).

***North Line Road Coal Tipple*—**No groundwater monitoring wells are located within the North Line Road Coal Tipple. The nearest groundwater monitoring well in the vicinity is FWGmw-003 is located approximately 50 ft east and is screened in the unconsolidated sediments from 8.5 and 18.5 ft bgs. The depth to water in this well was approximately 4.5 ft bgs during the July 2012 groundwater monitoring event, with a potentiometric elevation of 1,124.98 ft amsl. Based on the potentiometric surface of the unconsolidated aquifer (Figure 2-4) and the estimated ground surface elevation (Figure 3-1a), the depth to groundwater is likely within a few feet of the ground surface (i.e., <5 ft bgs). The groundwater flow direction in the unconsolidated aquifer beneath the area is to the east-southeast toward Sand Creek, as shown on Figure 2-4. As shown on Figure 2-1, Mercer shale and/or Sharon shale likely exist below the unconsolidated aquifer at the North Line Road Coal Tipple.

Sand Creek Coal Tipple—No groundwater monitoring wells are located within the Sand Creek Coal Tipple area. As shown on Figure 2-4, this area is located on the northwestern boundary of an area where the unconsolidated aquifer is missing. The generalized groundwater flow directions within the unconsolidated aquifer east of this area are strongly influenced by Sand Creek, located just to the south and east of the Sand Creek Coal Tipple. Groundwater that may perch on top of the very shallow bedrock likely flows east to Sand Creek, which is located approximately 50 ft from the eastern boundary of the coal tipple area.

Monitoring wells B12mw-013 and BKGmw-012 are located approximately 2,130 ft east and 3,300 ft west of the area, respectively, and monitor the Sharon Sandstone bedrock aquifer. B12mw-013 is screened 11.5-21.5 ft bgs and had a potentiometric elevation of 985.56 ft amsl in July 2012. BKGmw-012 is screened 38.6-59.6 ft bgs and had a potentiometric elevation of 988.59 ft amsl in July 2012. The estimated depth to groundwater in the Sharon aquifer is approximately 35 ft bgs. As shown on Figure 2-6, the generalized groundwater flow direction within the Sharon aquifer beneath this area is to the east-northeast.

Building U-16 Boiler House—No groundwater monitoring wells are located within the Building U-16 Boiler House area. The nearest facility-wide groundwater monitoring well is FWGmw-0014, which is located approximately 0.5 mi to the east and is screened in unconsolidated sediments from 8.25 to 18.25 ft bgs. The depth to water in this well was approximately 4 ft bgs during the July 2012 groundwater monitoring event, with a potentiometric elevation of 1,131.39 ft amsl. A background monitoring well, BKGmw-005, is located approximately 0.5 mi to the northeast of the former boiler house and is screened in the unconsolidated aquifer from 8.2 to 18.2 ft bgs. The depth to water in this well was approximately 12 ft bgs during the July 2012 groundwater monitoring event, with a potentiometric elevation of 1,137.27 ft amsl.

The estimated groundwater elevation of the unconsolidated aquifer beneath the area is 1,165 ft amsl (approximately 22 ft bgs), and the direction of groundwater flow is presumed to be to the southeast toward a tributary of Hinkley Creek (Figure 2-4). Based on the 2012 groundwater monitoring report and the topography of the area, a groundwater divide likely exists just north and west of the area.

The closest bedrock monitoring well, FWGmw-005, is located approximately 2,300 ft to the south and is screened in the uppermost Homewood Sandstone aquifer with a potentiometric elevation of 1,147.75 ft amsl. There are no monitoring wells west of the area. Groundwater in the Homewood bedrock beneath the area is presumed to be 1,150 ft amsl, and the direction of groundwater flow is presumed to the east-southeast (Figure 2-5).

3.4 SURFACE WATER

Surface water bodies are not present within any of the three areas of CC RVAAP-73 Facility-Wide Coal Storage. During storm events, surface water at these areas either runs off the land following topography toward surrounding drainage or infiltrates into the subsurface. Infiltration is likely limited by the presence of silty and clayey soils at each area. Surface water runoff is a primary migration pathway for any potential contamination at the three CC RVAAP-73 Facility-Wide Coal Storage areas toward downgradient creeks and tributaries. Figures 3-3a through 3-3c show surface water features and locations of surveyed wetlands in each of the three areas of CC RVAAP-73 Facility-Wide Coal Storage.

North Line Road Coal Tipple—As shown on Figure 3-3a, there are no wetlands, creeks, streams, or other water bodies within the North Line Road Coal Tipple area. Based on the topography map of this area (Figure 3-1a), the ground surface is relatively flat, with a gentle downward slope to the east toward Sand Creek, located approximately 400 ft east. Light precipitation likely infiltrates or pools on the surface. However, during periods of sustained precipitation, surface water may flow toward Sand Creek. Sand Creek flows southeast away from the site.

As shown on Figure 3-3a, several wetlands are present along and near Sand Creek and its tributaries north and east of the North Line Road Coal Tipple. The closest downgradient wetland is located approximately 1,100 ft southeast of the North Line Road Coal Tipple area.

Sand Creek Coal Tipple—As shown on Figure 3-3b, there are no wetlands, creeks, streams, or other water bodies within the Sand Creek Coal Tipple area. However, Sand Creek is located within 50 ft of the southeast corner of the area. Sand Creek flows to the east paralleling the area's southern boundary where a tributary enters the creek approximately 50 ft east of the northeast corner of the area. Sand Creek then flows northeast away from the Sand Creek Coal Tipple area. Based on the topography map of the Sand Creek Coal Tipple area (Figure 3-1b), the ground surface at the coal tipple is relatively flat with a gentle downward slope to the east. Light precipitation likely infiltrates or pools on the surface. However, during periods of sustained precipitation, the area likely drains east/northeast toward Sand Creek. As shown on Figure 3-3b, wetlands line both sides of Sand Creek.

Building U-16 Boiler House—As shown on Figure 3-3c, there are no wetlands, creeks, streams, or other water bodies within the Building U-16 Boiler House area. Based on the topography map of this area (Figure 3-1c), the ground surface is relatively flat. Light precipitation likely infiltrates or pools on the surface. However, during periods of sustained precipitation, surface water would flow in a generally south-southeastern direction. The nearest downgradient surface water body is a tributary (and associated wetlands) of Hinckley Creek, located approximately 1,100 ft south of the Building U-16 Boiler House area.

3.5 POTENTIAL RECEPTORS AT CC RVAAP-73 FACILITY-WIDE COAL STORAGE

Human and ecological receptors are discussed in the following sections. An HHRA and ecological risk assessment (ERA) were conducted as part of this RI, and the results are presented in Chapter 7.

3.5.1 Human Receptors

The CC RVAAP-73 Facility-Wide Coal Storage AOC consists of three separate storage areas and was used historically for the storage of coal. Coal stockpiles are no longer present at the three areas of the AOC. The future land use is military training. The representative receptor for the areas is the NGT. The Unrestricted Land Use is evaluated using the Resident Receptor scenario. This land use and receptor scenario is used to evaluate an "unrestricted land use" option; Unrestricted (Residential) Land Use is included to evaluate COCs for unrestricted land use at the AOC to determine current risks and as outlined in the Facility-Wide Human Health Risk Assessor Manual (USACE 2005c).

No groundwater receptors have been identified for this AOC. Groundwater beneath the AOC is not currently used for potable purposes, although groundwater may be used for drinking water in the future. The nearest groundwater supply wells utilized by the Army and OHARNG within the facility are located in the former Administration Area, which is approximately 3.5 mi southeast of the North Line Road Coal Tipple (the closest of the three areas of the AOC). Groundwater is being evaluated on a facility-wide basis as a separate AOC (RVAAP-66).

3.5.2 Biological Resources

The facility has a diverse range of vegetation and habitat resources. Habitats present within the facility include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open-water ponds and lakes, and semi-improved administration areas (OHARNG 2008).

Vegetation at the facility can be grouped into three categories: herb-dominated, shrub-dominated, and tree-dominated. Approximately 60 percent of the facility is covered by forest or tree-dominated vegetation. The facility has seven forest formations, four shrub formations, eight herbaceous formations, and one non-vegetated formation (OHARNG 2008).

Surface water features within the facility include a variety of streams, ponds, floodplains, and wetlands. Numerous streams drain the facility, including approximately 19 mi of perennial streams. Approximately 153 acres of ponds are found on the facility. These ponds provide valuable habitat and support to wood ducks, hooded mergansers, mallards, Canada geese, and other birds and wildlife species. Some ponds have been stocked with fish and are used for fishing and hunting (OHARNG 2008). Wetlands are abundant and prevalent throughout the facility. These wetland areas include seasonal wetlands, wet fields, and forested wetlands. Most of the wetland areas on the facility are the result of natural drainage and beaver activity;

however, some wetland areas are associated with anthropogenic settling ponds and drainage areas.

An abundance of wildlife is present on the facility; 35 species of land mammals, 214 species of birds, 41 species of fish, and 34 species of amphibians and reptiles have been identified. No federally-listed species are known to reside at the facility and no critical habitat occurs (OHARNG 2008). Ohio state-listed plant and animal species have been identified through confirmed sightings and/or biological inventories at the facility. Information regarding candidate, threatened, or endangered species at the facility was obtained from the Facility Rare Species List and is presented as Table 3-1 containing the state-listed species that have been identified to be on the facility by biological inventories and confirmed sightings.

No detailed ecological study has been performed within or surrounding CC RVAAP-73 Facility-Wide Coal Storage. Wildlife inhabiting this AOC would be potential receptors to contamination in soil, sediment, and/or surface water. The North Line Road Coal Tipple and the Sand Creek Coal Tipple are located in wooded areas of the facility. The Building U-16 Boiler House is located on a thin strip of land between a road and rail line.

Wildlife studies have not been conducted specifically for CC RVAAP-73 Facility-Wide Coal Storage. However, the herbaceous fields, forests, and shrubs at the AOC provide habitat for a variety of wildlife species. CC RVAAP-73 Facility-Wide Coal Storage provides foraging habitat for birds as well as habitat for small mammals including, mice and voles, shrews, and moles that would typically occur in these habitats. Larger mammals occurring on the facility including white-tailed deer, raccoons, woodchucks, and eastern fox squirrels may also use AOC habitats, but only transiently.

Terrestrial portions of CC RVAAP-73 Facility-Wide Coal Storage have not been surveyed for federal or state-listed species nor have there been any reported sightings of listed species. On the facility, there are no known occurrences of federally-listed rare, threatened, and endangered species (AMEC Environment & Infrastructure, Inc. [AMEC] 2008). Occurrences of state-listed species that have been identified at the facility are listed on Table 3-1.

3.6 CONCEPTUAL SITE MODEL

The CSM summarized below describes primary and secondary contaminant sources at the three CC RVAAP-73 Facility-Wide Coal Storage areas. Primary sources are point sources that can be traced back to an operation, discharge point, or other specific location (coal). Secondary sources are contaminated media, such as soil, surface water, and/or sediment.

3.6.1 Contaminant Sources

The piles of coal have been removed from the three areas of CC RVAAP-73 Facility-Wide Coal Storage. Although small amounts of remnant coal have been noted on the ground surface at the Building U-16 Boiler House, North Line Road Coal Tipple, and Sand Creek Coal Tipple, coal in itself is not a regulated CERCLA substance. For purposes of this investigation, the areas around where the piles of coal were located are being investigated to identify if there are sources of contaminants. Secondary sources (contaminated media) are evaluated as part of this RI effort and are described in the following sections.

3.6.2 Soils

The HRR indicates that soil at the three areas of the AOC may have been impacted by former transfer and storage of coal. Surface and subsurface soil sampling was conducted to define the nature and extent of any potential contamination at each of the three AOC areas.

3.6.3 Sediment/Surface Water

No sediment or surface water bodies are present in the former coal storage areas of CC RVAAP-73 Facility-Wide Coal Storage AOC. However, Sand Creek is located within 50 ft of the Sand Creek Coal Tipple, and Sand Creek is 150 ft from North Line Road Coal Tipple at its nearest point. During this RI, surface water and sediment samples were obtained from Sand Creek upgradient and downgradient of the two tipples to evaluate the whether SRCs in surface soil within these areas may be transported to Sand Creek in stormwater runoff during heavy precipitation events.

3.6.4 Groundwater

Groundwater is evaluated on a facility-wide basis, sampled under the Facility-Wide Groundwater Monitoring Program as a separate AOC (RVAAP-66). Potential leaching of soil contaminants to groundwater is evaluated in this report through fate and transport screening and is presented in Chapter 6. For this AOC, no groundwater receptors have been identified.

3.6.5 Migration Pathways

Contaminants in soil may migrate to surface water as particulates in stormwater runoff following a storm event. Based on topographical elevations as shown on Figures 3-1a through 3-1c, Sand Creek may receive a portion of the stormwater runoff from Sand Creek Coal Tipple and North Line Road Coal Tipple. Calculations of contaminant leaching from soil and transport via groundwater are included in this report; however, a full evaluation of facility-wide groundwater will be provided in the separate RVAAP-66 report.

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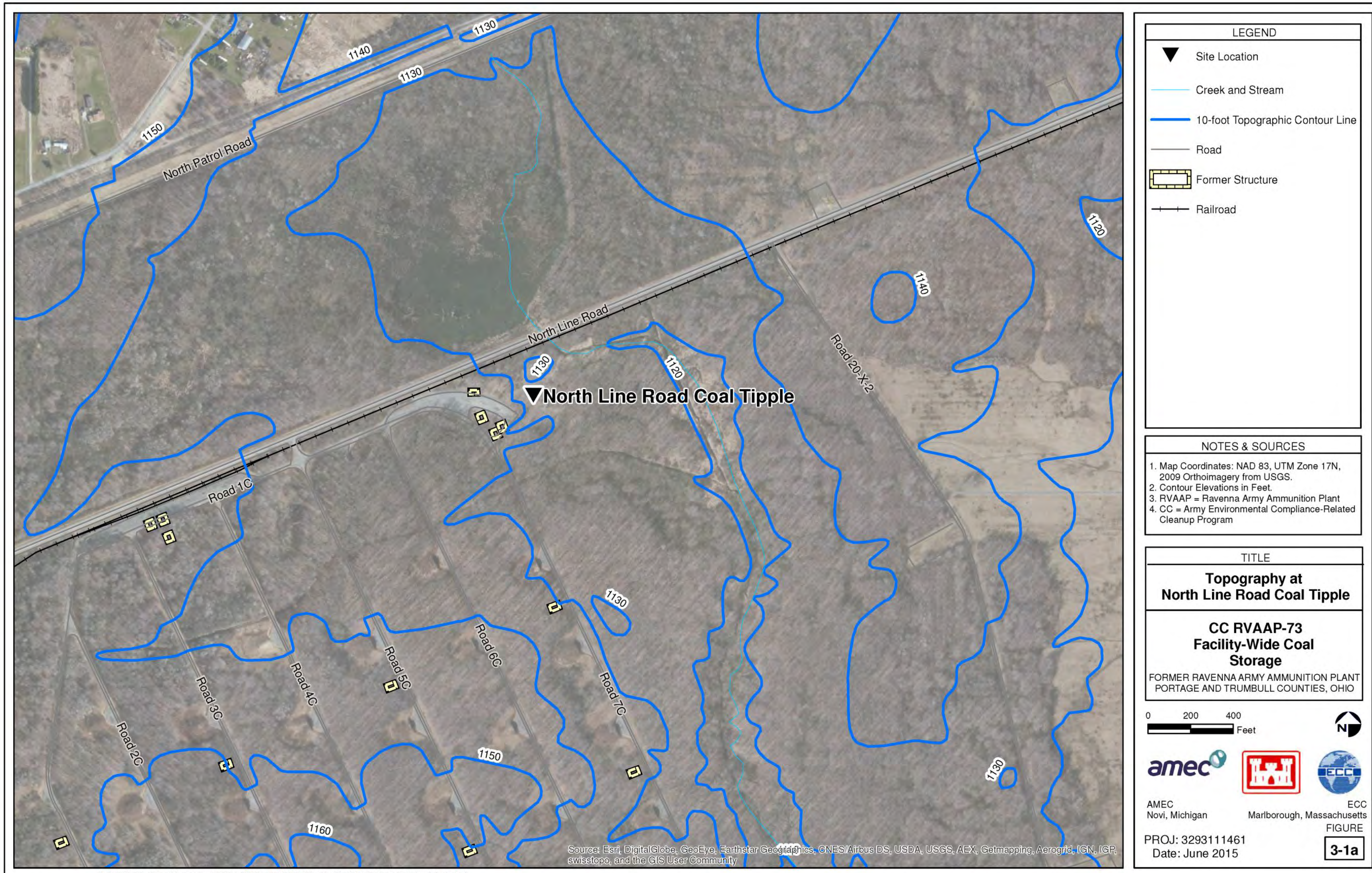
Table 3-1: Facility Federal and State-Listed Species (February 28, 2014)

Status	Common Name	Scientific Name
Federal Endangered	None	None
State Endangered	American bittern	*Botaurus lentiginosus*
	Black Bear	*Ursus americanus*
	Brush-tipped emerald	*Somatochlora walshii*
	Graceful underwing	*Catocala gracilis*
	Handsome sedge	*Carex formosa*
	Mountain brook lamprey	*Ichthyomyzon greeleyi*
	Narrow-necked Pohl's moss	*Pohlia elongata* var. *elongata*
	Northern harrier	*Circus cyaneus*
	Philadelphia panic-grass	*Panicum philadelphicum*
	Sandhill crane	*Grus canadensis*
	Tufted Moisture-loving moss	*Philonotis fontana* var. *caespitosa*
	Variegated scouring-rush	*Equisetum variegatum*
State Threatened	Barn owl	*Tyto alba*
	Bobcat	*Felis rufus*
	Caddisfly	*Psilotreta indecisa*
	Hobble-bush	*Viburnum alnifolium*
	Least bittern	*Ixobrychus exilis*
	Lurking leskea	*Plagiothecium latebricola*
	Simple willow-herb	*Epilobium strictum*
	Trumpeter swan	*Cygnus buccinator*
	Strict blue-eyed grass	*Sisyrinchium montanum*
State Potentially Threatened	Arborvitae*	*Thuja occidentalis*
	False hop sedge	*Carex lupuliformis*
	Greenwhite sedge	*Carex albolutescens*
	Long beech fern	*Phegopteris connectilis*
	Pale sedge	*Carex pallescens*
	Sharp-glumed manna-grass	*Glyceria acutifolia*
	Shinning ladies-tresses	*Spiranthes lucida*
	Straw sedge	*Carex straminea*
	Water avens	*Geum rivale*
	Woodland horsetail	*Equisetum sylvaticum*
Federal Species of Concern	Bald eagle	*Haliaetus leucocephalus*
	Butternut	*Juglans cinerea*
	Handsome sedge	*Carex formosa*
State Species of Concern	Big brown bat	*Eptesicus fuscus*
	Bobolink	*Dolichonyx oryzivorus*
	Cerulean warbler	*Dendroica cerulea*
	Common moorhen	*Gallinula chloropus*
	Creek heelsplitter	*Lasmigona compressa*
	Deer mouse	*Peromyscus maniculatus*
	Eastern box turtle	*Terrapene carolina*
	Eastern garter snake	*Thamnophis sirtalis*
	Eastern red bat	*Lasiurus borealis*
	Eastern sand darter	*Ammocrypta pellucida*
	Four-toed salamander	*Hemidactylium scutatum*
	Great egret	*Ardea alba*
	Henslow's sparrow	*Ammodramus henslowii*
	Hoary bat	*Lasiurus cinereus*
	Little brown bat	*Myotis lucifugus*
	Marsh wren	*Cistothorus palustris*
	Mayfly	*Stenonema ithica*
	Moth	*Apamea mixta*
	Moth	*Brachylomia algens*

Table 3-1: Facility Federal and State Listed-Species (February 28, 2014) (continued)

Status	Common Name	Scientific Name
	Northern bobwhite	*Colinus virginianus*
	Northern long-eared bat	*Myotis septentrionalis*
	Prothonotary warbler	*Protonotaria citrea*
	Pygmy shrew	*Sorex hovi*
	Scurfy quaker	*Homorthodes furfurata*
	Sedge wren	*Cistothorus platensis*
	Sharp-shinned hawk	*Accipiter striatus*
	Smooth green snake	*Opheodrys vernalis*
	Sora rail	*Porzana carolina*
	Southern Bog Lemming	*Synaptomys cooperi*
	Star-nosed mole	*Condylura cristata*
	Tri-colored bat	*Perimyotis subflavus*
	Virginia rail	*Rallus limicola*
	Woodland jumping mouse	*Napaeozapus insignis*
	Yellow-bellied sapsucker	*Sphyrapicus varius*
State Species of Interest	American Black Duck	*Anas rubripes*
	Blackburnian warbler	*Dendroica fusca*
	Black-throated blue warbler	*Dendroica caerulescens*
	Brown creeper	*Certhia americana*
	Canada warbler	*Wilsonia canadensis*
	Dark-eyed junco	*Junco hyemalis*
	Gadwall	*Anas strepera*
	Golden-crowned kinglet	*Regulus satrapa*
	Green-winged teal	*Anas crecca*
	Hermit thrush	*Catharus guttatus*
	Least flycatcher	*Empidonax minimus*
	Magnolia warbler	*Dendroica magnolia*
	Mourning warbler	*Oporornis philadelphia*
	Northern shoveler	*Anas clypeata*
	Northern waterthrush	*Seiurus noveboracensis*
	Pine siskit	*Carduelis pinus*
	Purple finch	*Carpodacus purpureus*
	Red-breasted nuthatch	*Sitta canadensis*
	Redhead duck	*Aythya americana*
	Ruddy duck	*Oxyura jamaicensis*
	Subflava sedge borer moth	*Archanara subflava*
	Wilson’s Snipe	*Gallinago delicata*
	Winter wren	*Troglodytes troglodytes*
State Extirpated	Golden-winged warbler	*Vermivora chrysoptera*
Federal Endangered	Indiana Bat	*Myotis sodalist*
	Mitchell’s satyr	*Neonympha mitchellii*
	Clubshell mussel	*Pleurobena clava*
Federal Threatened	Northern Monkshood	*Aconitum noveboracense*
Federal Candidate Species	Eastern Massasauga	*Sistrurus catenatus*
State Endangered	Northern Monkshood	*Aconitum noveboracense*
	Indiana Bat	*Myotis sodalist*
	Upland Sandpiper	*Bartamia longicauda*
State Threatened	Flat-Stem Pondweed	*Potomogeton zosteriformis*
State Potentially Threatened	Virginia Meadow-beauty	*Rhexia virginica*
	White Beak-rush	*Rhynchospora alba*
Rare Plant Communities	Floodplain Forest	Not applicable


North Line Road Coal Tipple
North Patrol Road
North Line Road
Road 1C
Road 2C
Road 3C
Road 4C
Road 5C
Road 6C
Road 7C
Road 20-X-2
1120
1130
1140
1150
1160
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
LEGEND
Site Location
Creek and Stream
10-foot Topographic Contour Line
Road
Former Structure
Railroad
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. Contour Elevations in Feet.
3. RVAAP = Ravenna Army Ammunition Plant
4. CC = Army Environmental Compliance-Related Cleanup Program
TITLE
Topography at North Line Road Coal Tipple
CC RVAAP-73 Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO
0 200 400
Feet
N
AMEC
Novi, Michigan
ECC
Marlborough, Massachusetts
FIGURE
3-1a
PROJ: 3293111461
Date: June 2015
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2221

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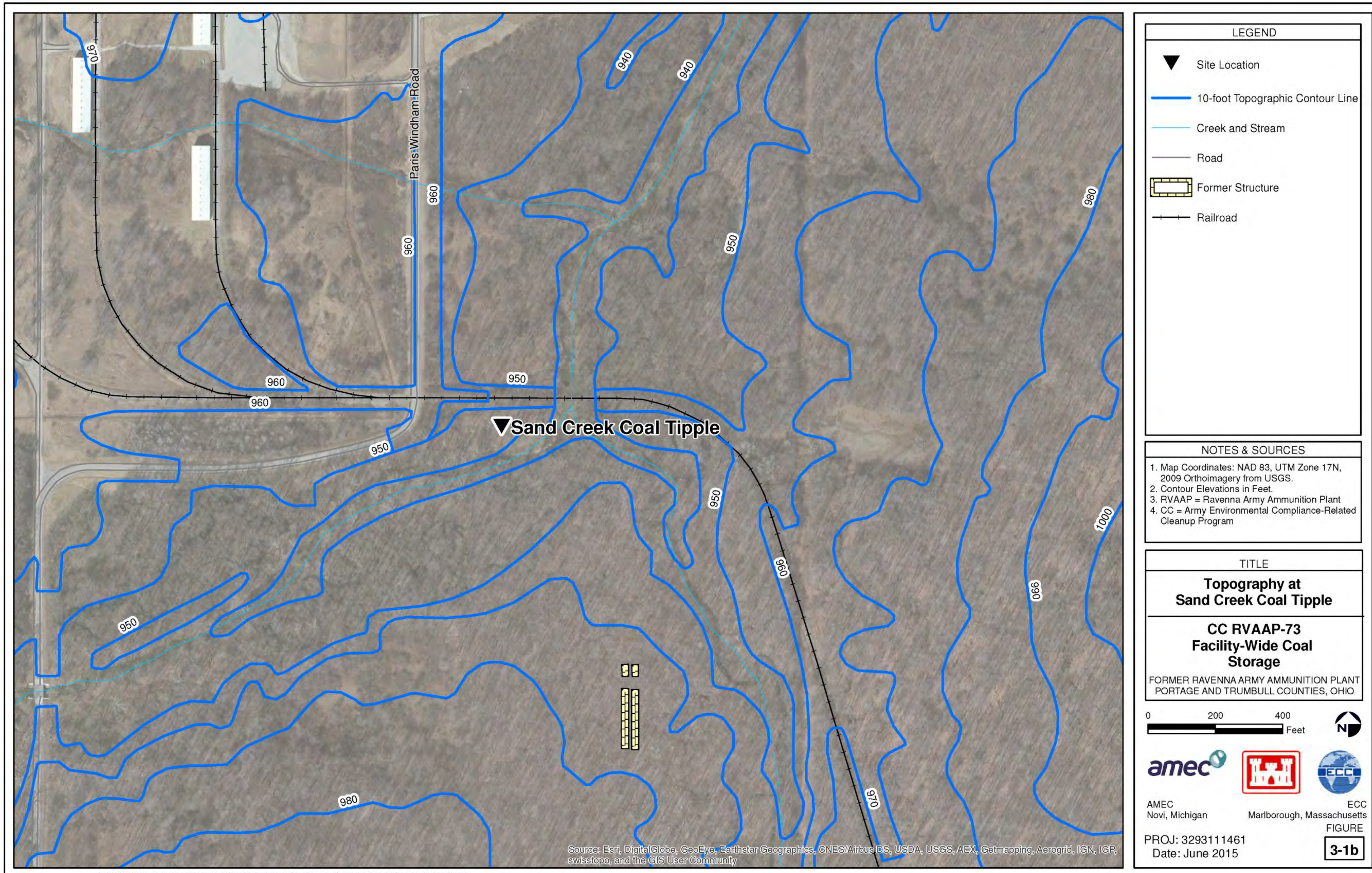
LEGEND
Site Location
10-foot Topographic Contour Line
Creek and Stream
Road
Former Structure
Railroad
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. Contour Elevations in Feet.
3. RVAAP = Ravenna Army Ammunition Plant
4. CC = Army Environmental Compliance-Related Cleanup Program
TITLE
Topography at Sand Creek Coal Tipple
CC RVAAP-73 Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO
0
200
400
Feet
N
AMEC
Novi, Michigan
ECC
Marlborough, Massachusetts
FIGURE
PROJ: 3293111461
Date: June 2015
3-1b
Sand Creek Coal Tipple
Paris-Windham Road
940
950
960
970
980
990
1000
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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2233

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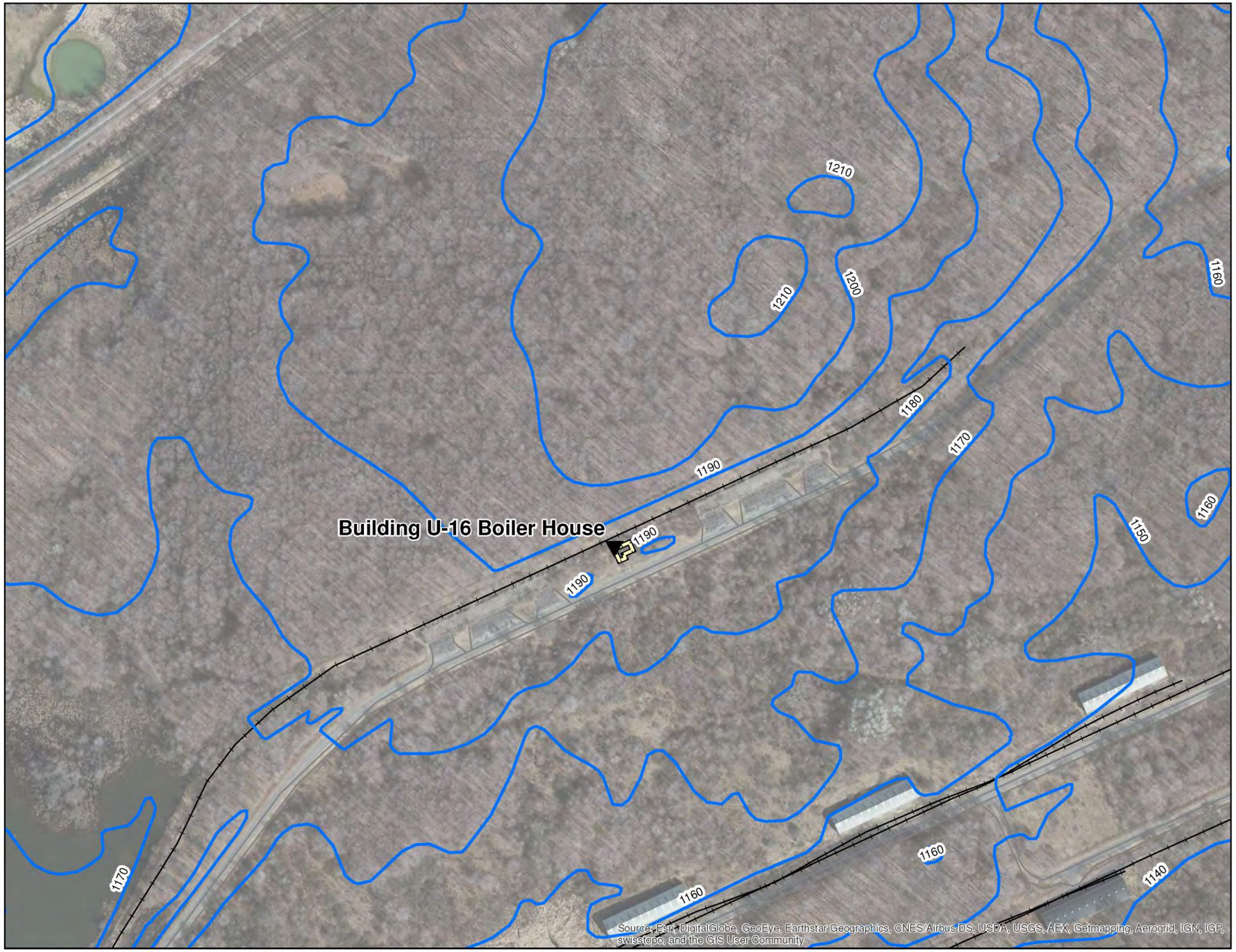

LEGEND

- Site Location
- 10-foot Topographic Contour Line
- Road
- Former Structure
- Railroad

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. Contour Elevation in Feet.
3. RVAAP = Ravenna Army Ammunition Plant
4. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Topography at Building U-16 Boiler House

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 200 400 Feet

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE
3-1c

2245

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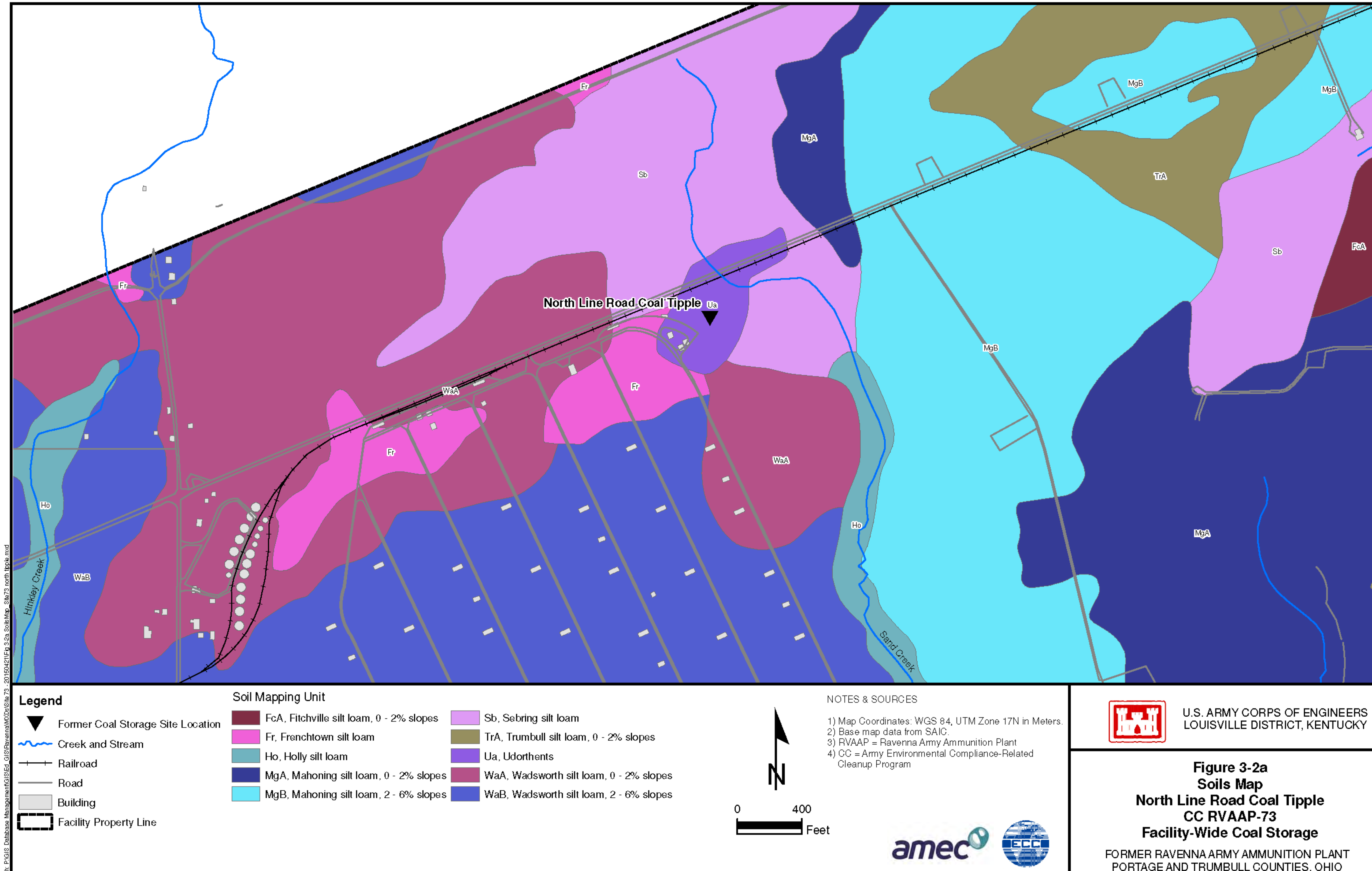

Figure 3-2a
Soils Map
North Line Road Coal Tipple
CC RVAAP-73
Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

2257

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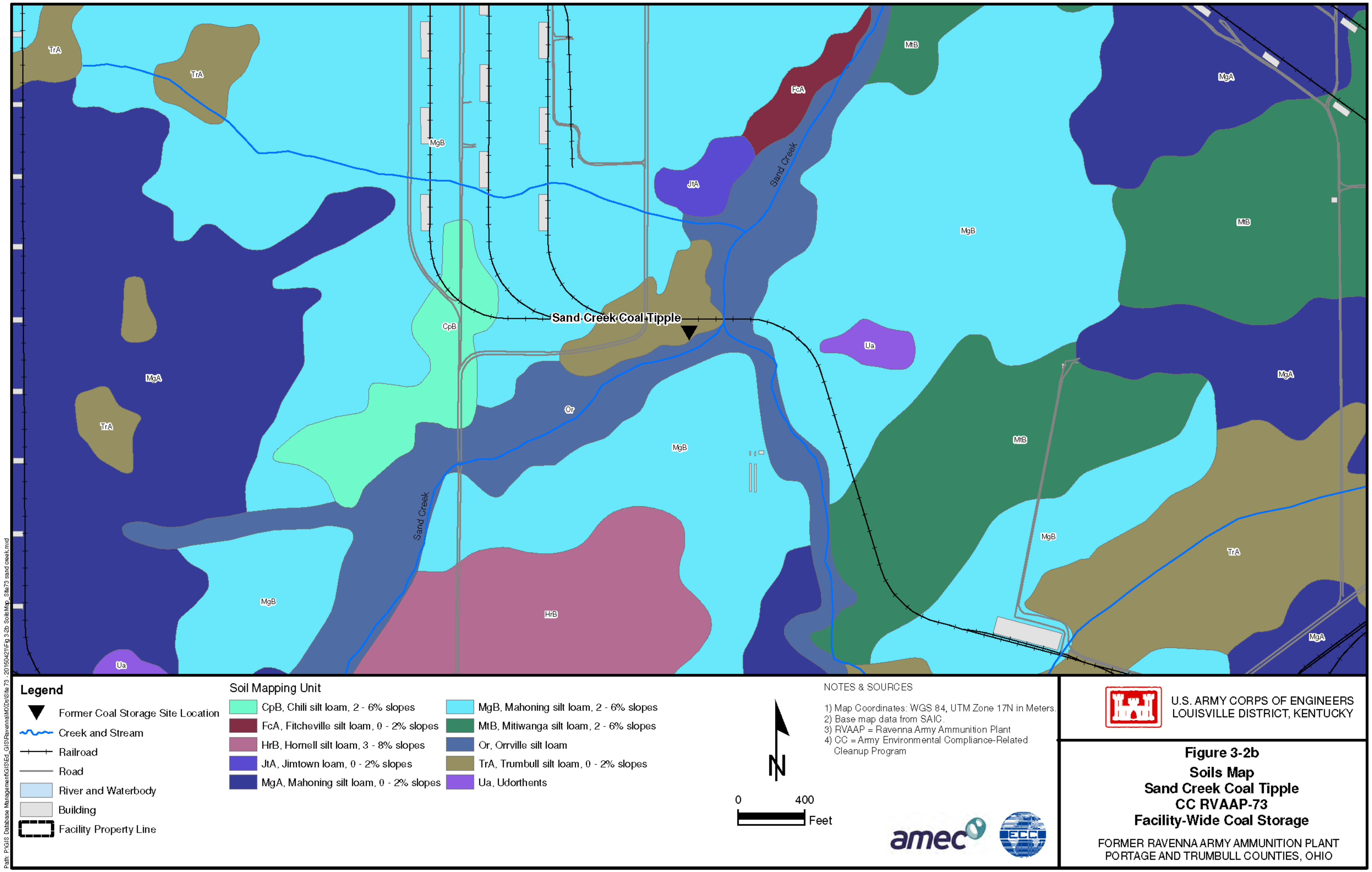

Figure 3-2b
Soils Map
Sand Creek Coal Tipple
CC RVAAP-73
Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

2269

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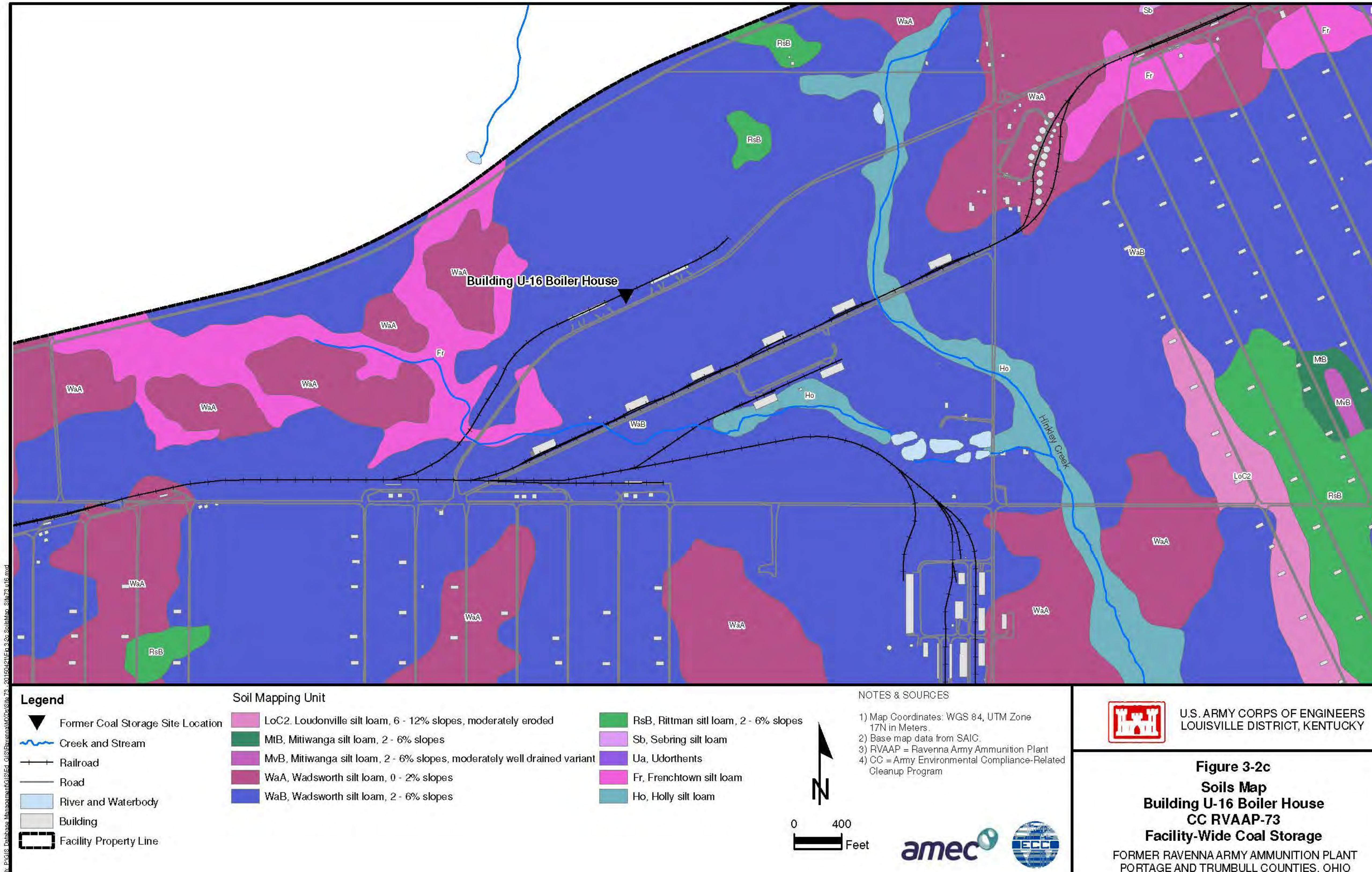
Building U-16 Boiler House
Hinkley Creek
WaA
WaB
Fr
RsB
Ho
LoC2
MtB
MvB
Sb
Ua
Legend
Former Coal Storage Site Location
Creek and Stream
Railroad
Road
River and Waterbody
Building
Facility Property Line
Soil Mapping Unit
LoC2, Loudonville silt loam, 6 - 12% slopes, moderately eroded
MtB, Mitiwanga silt loam, 2 - 6% slopes
MvB, Mitiwanga silt loam, 2 - 6% slopes, moderately well drained variant
WaA, Wadsworth silt loam, 0 - 2% slopes
WaB, Wadsworth silt loam, 2 - 6% slopes
RsB, Rittman silt loam, 2 - 6% slopes
Sb, Sebring silt loam
Ua, Udorthents
Fr, Frenchtown silt loam
Ho, Holly silt loam
N
0
400
Feet
NOTES & SOURCES
1) Map Coordinates: WGS 84, UTM Zone 17N in Meters.
2) Base map data from SAIC.
3) RVAAP = Ravenna Army Ammunition Plant
4) CC = Army Environmental Compliance-Related Cleanup Program
amec
ECC
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT, KENTUCKY
Figure 3-2c
Soils Map
Building U-16 Boiler House
CC RVAAP-73
Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

2281

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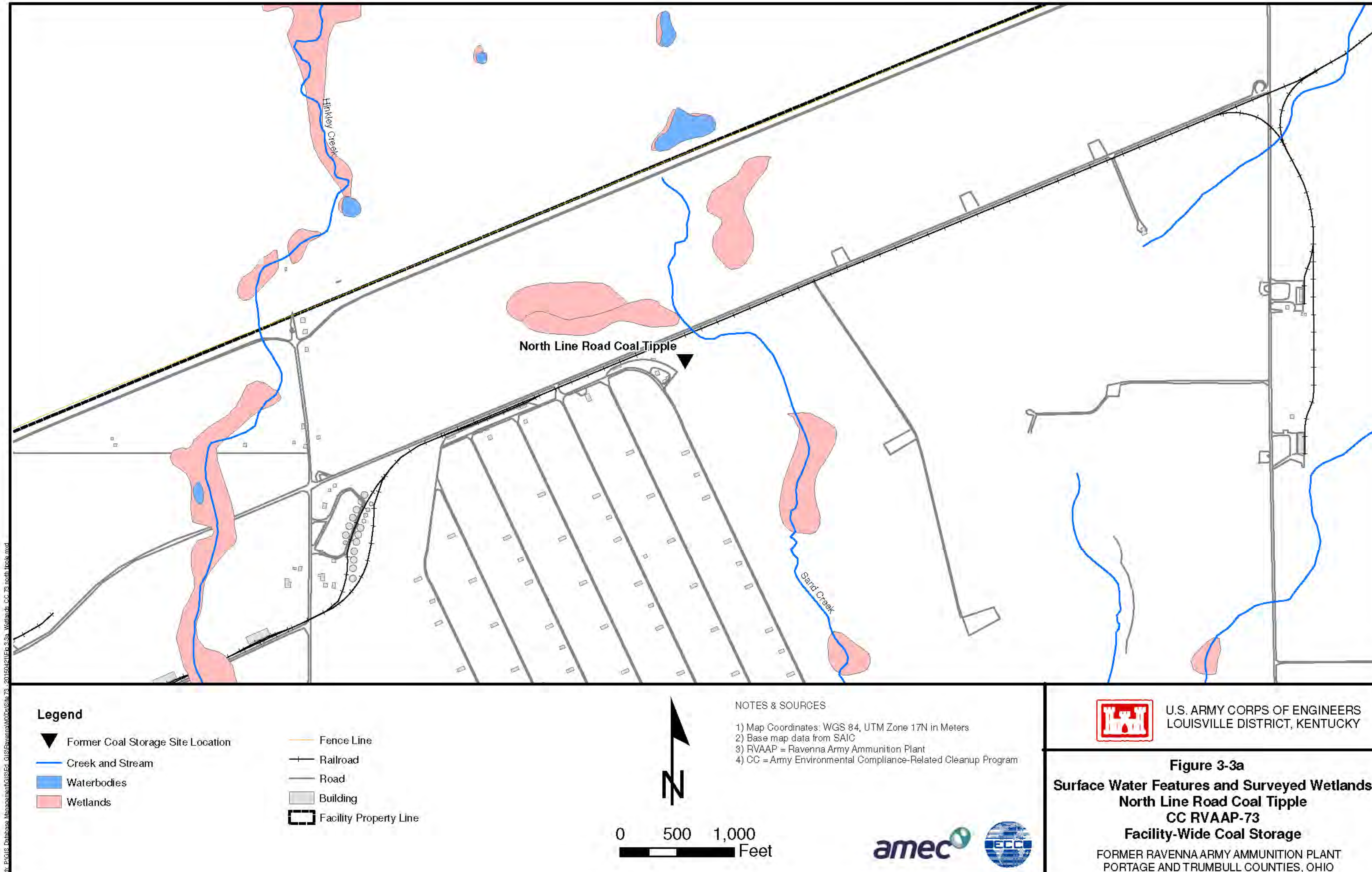

Figure 3-3a
Surface Water Features and Surveyed Wetlands
North Line Road Coal Tipple
CC RVAAP-73
Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

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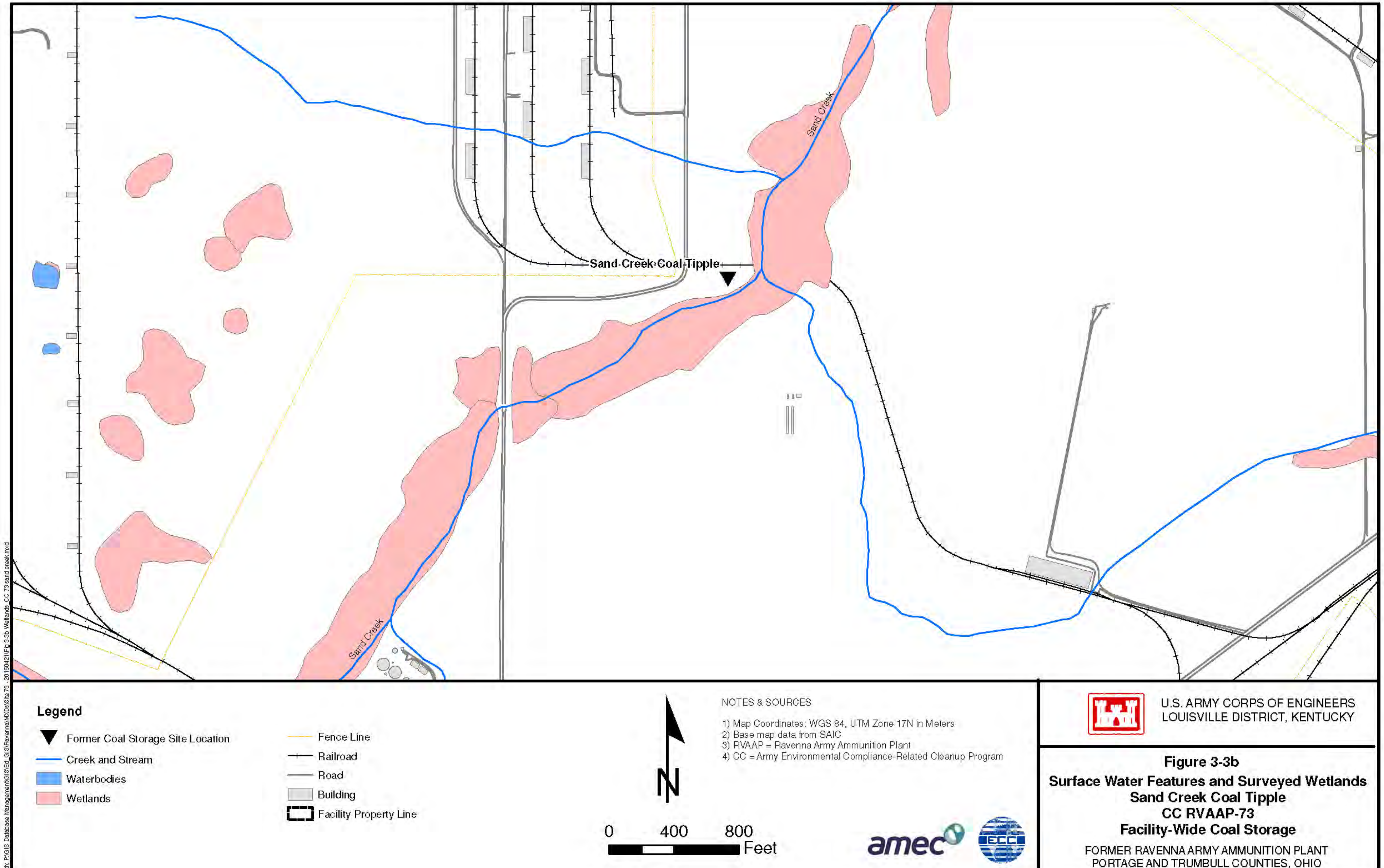

Figure 3-3b
Surface Water Features and Surveyed Wetlands
Sand Creek Coal Tipple
CC RVAAP-73
Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

2305

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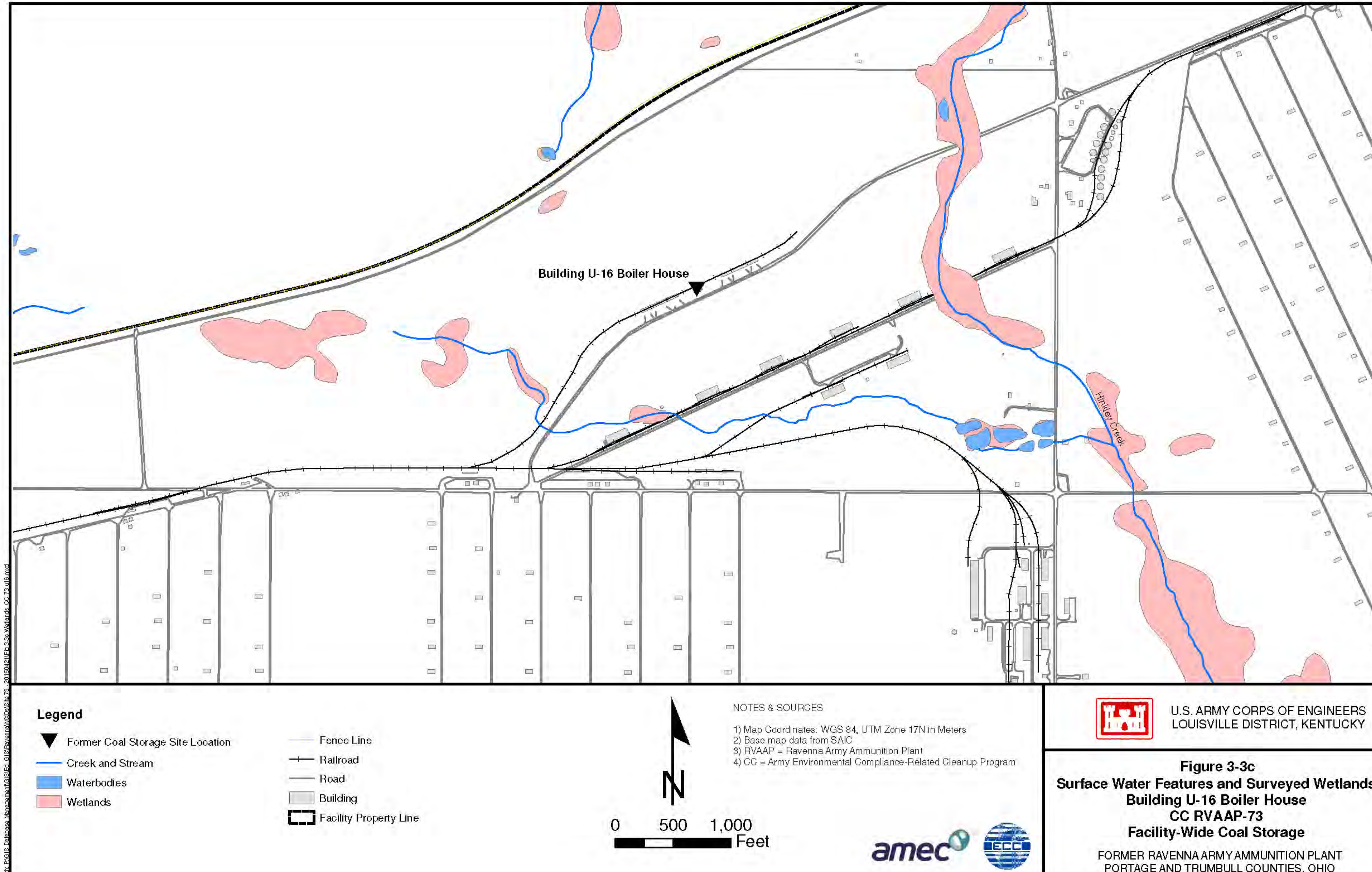

Figure 3-3c
Surface Water Features and Surveyed Wetlands
Building U-16 Boiler House
CC RVAAP-73
Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

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4. REMEDIAL INVESTIGATION ACTIVITIES

Work conducted for this RI was performed as specified in the Final SI/RI Work Plan (ECC 2012) and the Facility-Wide Sampling and Analysis Plan (FWSAP) for Environmental Investigations, dated February 24, 2011 (SAIC 2011b), unless specifically noted, herein (Section 4.5).

4.1 DATA QUALITY OBJECTIVES

The overall project data quality objective (DQO) is to provide representative, repeatable, high quality data to address the primary project objectives identified in Section 4.2 of the FWSAP. Samples were collected and analyzed according to the FWSAP and the SI/RI Work Plan. The FWSAP and SI/RI Work Plan provide the organization, objectives, intended data uses, and QA/QC activities to perform in order to achieve the desired DQOs for maintaining the defensibility of the data. Project DQOs were established in accordance with the United States Environmental Protection Agency (USEPA) Region 5 guidance. Requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data verification criteria for the RI are consistent with USEPA and United States Department of Defense requirements. DQOs for this project include analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data. Appendix B presents the data verification performed in accordance with the project-specific DQOs.

Problem Definition

The RI conducted for this AOC was based on findings of the HRR. The background historical review presented in the HRR identified the following areas of CC RVAAP-73 Facility-Wide Coal Storage AOC that require further evaluation:

- North Line Road Coal Tipple
- Sand Creek Coal Tipple
- Building U-16 Boiler House.

The HRR recommended surface soil, subsurface soil, sediment, and surface water sampling at the North Line Road Coal Tipple and the Sand Creek Coal Tipple and surface soil and subsurface soil at the Building U-16 Boiler House. This RI was conducted to define the nature and extent of contaminants in soil at each of these three areas. In addition, this RI was conducted to evaluate whether additional remedial actions are warranted or if No Further Action is obtained.

4.2 SAMPLING RATIONALE

At the CC RVAAP-73 Facility-Wide Coal Storage AOC, ISM and composite sampling methods were employed to investigate surface and subsurface soils to identify SRCs and delineate the nature and extent of those SRCs. In addition to soils, the HRR recommended discrete sampling to investigate sediment and surface water in Sand Creek, which flows within a few hundred feet of the North Line Road Coal Tipple and within 50 ft of the Sand Creek Coal Tipple. Sediment and surface water sampling was conducted to evaluate whether the stormwater runoff exposure pathway from surface soil at the two former coal areas to Sand Creek is complete. Sampling locations were chosen to represent at least one upgradient sample, a location where surface water runoff may enter the creek, and a downgradient sample. Sediment and surface water were not investigated downgradient of the Building U-16 Boiler House because sediment and surface water are present at a considerable distance downgradient (i.e., approximately 1,100 ft).

Decision units (DUs) were designed to represent the operational areas at each former coal storage area where storage or staging activities could have caused residual contamination in the surrounding media plus an additional 30 ft in all directions (Figures 4-1a through 4-1c). The location and size of each DU were based on historical usage, planned use of the AOC, and physical features of the AOC. A detailed description of the sampling activities conducted at CC RVAAP-73 Facility-Wide Coal Storage is provided in the following section and is summarized in Tables 4-1 and 4-2.

Soil sample depth intervals were selected based on exposure units to humans as defined in the Facility-Wide Human Health Cleanup Goals for the RVAAP (SAIC 2010). The exposure unit for the Resident Receptor is defined as 0-1 ft bgs for surface soil and as 1-13 ft bgs for subsurface soil. For the NGT, the exposure units are defined as 0-4 ft bgs for surface soil and 4-7 ft bgs for subsurface soil. Within each DU, surface soil samples were collected using ISM from 0 to 1 ft bgs. Five soil borings were then drilled to 7 ft bgs using direct push methods, and the soil was vertically profiled and logged by a field geologist. Boring logs are presented in Appendix A. Within each DU, one subsurface soil sample was collected using horizontal ISM from 1 to 4 ft bgs, and one subsurface soil sample was collected using horizontal ISM from 4 to 7 ft bgs. Five subsurface soil samples were also collected using vertical ISM from 1 to 7 ft bgs. In addition, a vertical composite soil sample was collected in each DU from one deep soil boring (DSB) (7-13 ft bgs).

Surface soil, wet sediment, subsurface soil, and surface water samples were analyzed for Target Analyte List (TAL) metals, including mercury, and semivolatile organic compounds (SVOCs) in accordance with the HRR recommendations and the Final SI/RI Work Plan. Five samples (2 subsurface soil, 1 surface soil, 1 sediment, and 1 surface water) were also analyzed for the full suite of analytes (organochlorine pesticides, TAL metals, volatile organic compounds [VOCs], SVOCs, polychlorinated biphenyls [PCBs], propellants, and explosives), in accordance with the FWSAP. Details on the sampling methods are presented in Section 4.4. Figures showing drilling and sampling locations are presented in Chapter 5.

North Line Road Coal Tipple (53,347 ft^2)—As shown on Figure 4-1a, DU01 covers the investigative area of approximately 53,347 ft^2 at this former coal storage area. ISM sampling of surface and subsurface soils was conducted in DU01; 1 ISM surface soil sample (0-1 ft bgs) 2 horizontal ISM subsurface soil samples (1 from 1 to 4 ft bgs and 1 from 4 to 7 ft bgs), and 5 vertical ISM subsurface soil samples (1-7 ft bgs). In addition, a vertical composite soil sample was collected from one DSB (7-13 ft bgs) in DU01.

In addition to soil samples, 3 collocated wet sediment and surface water samples were collected in Sand Creek, located approximately 600 ft downgradient (southeast of DU01): one upgradient, one where runoff may enter the creek, and one further downgradient. One additional collocated wet sediment and surface water sample was collected from an upgradient ditch that parallels North Line Road, approximately 70 ft north of DU01, and discharges to Sand Creek. The wet sediment and surface water samples were analyzed for TAL metals, including mercury, and SVOCs. One sediment and 1 surface water sample were also analyzed for organochlorine pesticides, PCBs, VOCs, and explosives/propellants. Sampling locations are shown on Figure 4-1a.

Sand Creek Coal Tipple (28,196 ft^2)—As shown on Figure 4-1b, DU01 covers the investigative area of approximately 28,196 ft^2 at this former coal storage area. ISM sampling of surface and subsurface soils was conducted in DU01; 1 ISM surface soil sample (0-1 ft bgs) 2 horizontal ISM subsurface soil samples (1 from 1 to 4 ft bgs and 1 from 4 to 7 ft bgs), and 5 vertical ISM subsurface soil samples (1-7 ft bgs). In addition, a vertical composite soil sample was collected from one DSB (7-13 ft bgs) in DU01.

In addition to soil samples, a total of 3 collocated wet sediment and surface water samples were collected from Sand Creek, located approximately 50 ft east of DU01: one upgradient, one where runoff may enter the creek, and one further downgradient. The wet sediment and surface water samples were analyzed for TAL metals, including mercury, and SVOCs. Sampling locations are shown on Figure 4-1b.

Building U-16 Boiler House (6,050 ft^2)—As shown on Figure 4-1c, DU01 covers the investigative area of approximately 6,050 ft^2 surrounding former Building U-16. ISM sampling of surface and subsurface soils was conducted in DU01; 1 ISM surface soil sample (0-1 ft bgs) 2 horizontal ISM subsurface soil samples (1 from 1 to 4 ft bgs and 1 from 4 to 7 ft bgs), and 5 vertical ISM subsurface soil samples (1-7 ft bgs). In addition, a vertical composite soil sample was collected from one DSB (7-13 ft bgs) in DU01.

4.3 PRE-MOBILIZATION ACTIVITIES

Prior to the field investigation, a series of pre-mobilization activities were undertaken to ensure that all applicable requirements were met. These included obtaining any necessary notifications to the Facility Manager, Ohio EPA, the operating contractor, and other stakeholders.

ECC personnel mobilized to the facility on October 22, 2012 to conduct a site walk and confirm DU locations at the three CC RVAAP-73 Facility-Wide Coal Storage areas prior to conducting surface soil sampling.

A second mobilization to the facility by ECC personnel was conducted on March 18, 2013 to mark direct-push boring locations and sediment/surface water sampling locations at CC RVAAP-73 Facility-Wide Coal Storage AOC.

4.4 FIELD SAMPLING

At CC RVAAP-73 Facility-Wide Coal Storage, soil ISM samples were collected as well as vertical composite samples at all three former coal storage areas. In addition, sediment and surface water samples were collected in the vicinity of the two coal tipple areas using discrete sampling methods. Boring logs are provided in Appendix A, field sampling activity forms are provided in Appendix C, and photographs of RI activities are provided in Appendix D. Below is a summary regarding the number and assignment of DUs to each area in CC RVAAP-73 Facility-Wide Coal Storage:

- DU01 – North Line Road Coal Tipple
- DU01 – Sand Creek Coal Tipple
- DU01 – Building U-16 Boiler House.

Figures 4-1a through 4-1c depict the location, size, and layout of each DU. Figures 4-1a and 4-1b also show the collocated surface water and wet sediment sampling locations. Boring locations for the subsurface ISM samples are shown on Chapter 5 figures. Field activities within CC RVAAP-73 Facility-Wide Coal Storage AOC were completed between November 8, 2012 and April 1, 2013.

Table 4-1 presents a summary of sample identifications, sample collection methods (type), and the rationale for the sampling activities conducted at each area of CC RVAAP-73 Facility-Wide Coal Storage AOC. Table 4-2 presents the number of samples collected per media and chemical analyses specific to each area and sample type. Matrix spike/matrix spike duplicate samples were collected at a frequency of 5 percent of samples collected, and field duplicate samples were collected at a frequency of 10 percent of samples collected. In addition to the investigative analyses shown in Table 4-2, 10 percent of samples collected were also analyzed for the full suite of analytes (TAL metals, including mercury, VOCs, SVOCs, PCBs, explosives/propellants, and organochlorine pesticides). Each ISM sample mass was at least 1 kilogram of soil. All samples were labeled and placed in a cooler with bagged ice following collection. All ISM samples were ground and sieved by the laboratory (TestAmerica Laboratories) using a No. 10 sieve (minimum 2 millimeters).

The VOC soil samples were collected as discrete soil samples using a TerraCore® sampler. A surface soil sampling location was selected at the center of each DU for VOC sample collection. For subsurface VOC samples, the sampling liner was cut open and screened with a photoionization detector (PID). The interval with the maximum PID reading was collected as the discrete VOC sample. If no PID readings were recorded, then the discrete VOC sample was collected from the mid-point of the sampling interval.

4.4.1 Surface Soil Sampling

A total of 4 surface soil ISM samples (1 from each DU in each area and 1 field duplicate) were collected from 0 to 1 ft bgs using ISM to define the extent of contamination and evaluate risk. The surface soil ISM samples were collected using the step probe and trowel/spoon method as described in Sections 5.6.2.1.1 and 5.6.2.1.2, respectively, of the FWSAP. The step probe consisted of a hollow stainless steel rod approximately 0.75 in. in diameter and 4 ft in length with a “T” handle attached to the top. A 12-in. section at the tip of the sampler was cut away to facilitate collecting the sample. The sampler had a foot peg attached 12 in. from the bottom tip, which was used to advance the sampler to 1 ft bgs. The sampler was advanced to 1 ft bgs, and

then withdrawn. The soil sample was collected from within the cut away section using a stainless steel scoopula.
Surface soil ISM samples were created by combining 30 soil aliquots collected over the surface of the DU. If refusal was encountered before 1 ft bgs, the sample location was moved within an approximate 2-ft radius of the original location and sampling was re-attempted. Surface soil sampling was planned to extend from 0 to 1 ft bgs; however, if rock or gravel was encountered at depths less than 1 ft, samples were collected from the accessible portion of the 0- to 1-ft interval.

4.4.2 Subsurface Soil Sampling

Five soil borings within each DU were advanced to collect the subsurface ISM soil samples (horizontal and vertical). Each horizontal ISM subsurface soil sample was comprised of two separate intervals, from 1 to 4 ft bgs and from 4 to 7 ft bgs. Soil aliquots were taken from the same interval (1-4 or 4-7 ft bgs) from the five borings in each DU. The aliquots were combined to create the depth-specific horizontal ISM subsurface soil samples. A vertical ISM sample was also collected at each boring location from the 1- to 7-ft interval.

Subsurface soil samples were collected using a Geoprobe® Model 6620DT direct-push drill rig. The procedures for hydraulic direct-push sampling were performed in accordance with the FWSAP. Samples were collected using 5-ft long stainless steel sampling rods lined with acetate Microcore® samplers. Each sample was collected using a dedicated liner specific for that interval. The sampler was advanced to the desired depth. The sample was then retrieved from the desired depth and the liner removed. The liner was cut open length-wise and field screened with a 10.6-electrovolt MiniRae PID. Where applicable, a VOC sample was collected using a disposable TerraCore sampler. The soil characteristics for each interval were logged on a soil boring log. All sample containers were labeled and placed in a cooler with ice following collection.

Vertical ISM samples were collected from each boring from 1 to 7 ft bgs. The 5-ft stainless steel sampler, with an acetate liner, was advanced twice at each boring location to reach the final depth of 7 ft. After acetate liners were cut open length-wise, the 30 sub-samples (aliquots) were close enough together such that they overlapped; therefore, the vertical ISM sample was collected by running a stainless steel scoopula along the length of the exposed core from 1 to 5 ft and from 5 to 7 ft. Where applicable, VOC samples were collected, as a discrete sample, immediately after the liner was opened and screened with the PID. All samples were labeled and placed in a cooler with bagged ice following collection.

At each of the three former coal storage areas, one vertical composite sample was collected from the DSB in each DU from 7 to 13 ft bgs for risk assessment purposes. To collect the composite sample, an equal quantity of soil from 7 to 13 ft bgs was collected by running a trowel or other disposable sampling device up the collected soil coring and placed into a decontaminated or dedicated stainless steel bowl. The soil placed into the bowl was initially split into quarters, and each quarter was mixed thoroughly in the center in the bowl using a stainless steel spoon. All four quarters were then mixed together until the single composite sample had a consistent physical appearance. The sample was then divided in half, and the containers were filled by scooping sample material alternately from each half.

4.4.3 Wet Sediment and Surface Water Sampling

Wet sediment and surface water sampling was conducted at two of the three areas of CC RVAAP-73 Facility-Wide Coal Storage. Three collocated surface water and wet sediment samples were collected from Sand Creek at locations upgradient, where runoff may enter the creek, and further downgradient of the North Line Road Coal Tipple DU. Sand Creek is located east of the DU and flows to the south. One additional collocated sample was collected along a drainage ditch north of the DU, which drains east to Sand Creek. At the Sand Creek Coal Tipple, 3 collocated surface water and wet sediment samples were collected from Sand Creek at locations upgradient, where runoff may enter the creek, and further downgradient of the DU. Sand Creek is located approximately 50 ft east of the DU and flows to the north.

The wet sediment samples were discrete samples collected using the trowel/spoon method as described in the FWSAP Section 5.6.2.2.1. The surface water samples were discrete grab samples collected using the Hand-Held Bottle Method described in Section 5.7.2.1.1 of the FWSAP.

4.5 DEVIATIONS FROM WORK PLAN

Work performed for the RI of CC RVAAP-73 Facility-Wide Coal Storage was conducted in accordance with the Final SI/RI Work Plan. The only deviations from the Work Plan were that 2 additional surface water/wet sediment samples were collected from Sand Creek at the North Line Road Coal Tipple area, and one additional surface water/wet sediment sample was collected from the Sand Creek Coal Tipple area. These additional samples were collected to better represent surface water and wet sediment concentrations upgradient of each area, within each area, and downgradient of each area.

4.6 SURVEYING

Campbell and Associates, Inc. of Cuyahoga Falls, Ohio was subcontracted by ECC to survey soil boring locations within the three areas of CC RVAAP-73 Facility-Wide Coal Storage AOC. Campbell and Associates, Inc. is a licensed surveyor in the state of Ohio. The corners of each DU were located using Global Positioning System methods. All of the survey data were reported in North American Datum 1983 Universal Transverse Mercator Zone 17N datum. Survey coordinates are provided in Appendix E.

4.7 INVESTIGATION-DERIVED WASTE

IDW materials generated in the field were comprised of soil cuttings from subsurface soil sampling, personal protective equipment, empty acetate liners, used TerraCore samplers, and general non-environmental trash. The soil cuttings were primarily collected in plastic garbage liners placed inside 5-gallon buckets. Additional soil materials were collected on the clear 6-mil-thick plastic sheeting placed on the ground at the end of the cutting table and below the two 5-gallon buckets used for collecting soil cuttings. A large garbage bag was used to contain the used nitrile gloves, the used TerraCore samplers, and cut up pieces of acetate liners. A long-handled steel lopper was used to cut the acetate liners into 12- to 18-in.-long pieces for ease of disposal. Finally, a large garbage bag was used to collect general non-environmental waste. The buckets for soil cuttings were brought to Building 1036 and placed in appropriately labeled 55-gallon open-headed drums.

4.7.1 Collection and Containerization

All IDW, including soil cuttings, personal protective equipment, disposable sampling equipment, and decontamination fluids, was properly handled, labeled, characterized, and managed in accordance with Section 8.0 of the FWSAP, federal and state of Ohio large-quantity generator requirements, and the facility's Installation Hazardous Waste Management Plan. IDW included soil cuttings, personal protective equipment, disposable sampling equipment, and decontamination fluids.

4.7.2 Characterization and Disposal

IDW disposal characterization samples were collected by ECC personnel on April 3, 2013. Samples were comprised of liquid IDW consisting of decontamination fluids, and solid IDW consisting of drill cuttings. IDW analyses included both liquid and solid full Toxicity Characteristic Leaching Procedure, and Reactivity, Corrosivity, and Ignitability analyses by TestAmerica Laboratories in North Canton, Ohio (IDW Letter Report in Appendix F).

On June 5, 2013, Ohio EPA approved the IDW letter report for the transport and disposal of the accumulated IDW as a result of executed RI tasks. The Ohio EPA approval letter for the IDW is provided in Appendix F. On August 5, 2013, the drummed IDW was transported under a non-hazardous waste manifest by Emerald Environmental Services, Inc. for disposal at Vexor Technology in Medina, Ohio.

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Table 4-1: Summary of Samples Collected for the Remedial Investigation

Sample Location ID	Interval (ft bgs)	Date	Type	Purpose
073SB-0016M-0001-SO	1-4	3/28/2013	IS	N&E, RA
073SB-0017M-0001-SO	1-4	3/28/2013	IS	QC FD
073SB-0019M-0001-SO	4-7	3/28/2013	IS	N&E, RA
073SB-0020M-0001-SO	1-7	3/28/2013	IS	N&E, RA
073SB-0021M-0001-SO	1-7	3/28/2013	IS	N&E, RA
073SB-0022M-0001-SO	1-7	3/28/2013	IS	N&E, RA
073SB-0023M-0001-SO	1-7	3/28/2013	IS	N&E, RA
073SB-0024M-0001-SO	1-7	3/28/2013	IS	N&E, RA
073SB-0025M-0001-SO	1-4	3/27/2013	IS	N&E, RA
073SB-0026M-0001-SO	4-7	3/27/2013	IS	N&E, RA
073SB-0027M-0001-SO	1-7	3/27/2013	IS	N&E, RA
073SB-0028M-0001-SO	1-7	3/27/2013	IS	QC FD
073SB-0029M-0001-SO	1-7	3/27/2013	IS	N&E, RA
073SB-0030M-0001-SO	1-7	3/27/2013	IS	N&E, RA
073SB-0031M-0001-SO	1-7	3/27/2013	IS	N&E, RA
073SB-0032M-0001-SO	1-7	3/27/2013	IS	N&E, RA
073SB-0033-0001-SO	7-13	3/27/2013	C	N&E, RA
073SB-0036M-0001-SO	1-4	4/1/2013	IS	N&E, RA
073SB-0037M-0001-SO	4-7	4/1/2013	IS	N&E, RA
073SB-0038M-0001-SO	1-7	4/1/2013	IS	N&E, RA
073SB-0039M-0001-SO	1-7	4/1/2013	IS	QC FD
073SB-0040M-0001-SO	1-7	4/1/2013	IS	N&E, RA
073SB-0041M-0001-SO	1-7	4/1/2013	IS	N&E, RA
073SB-0042M-0001-SO	1-7	4/1/2013	IS	N&E, RA
073SB-0043M-0001-SO	1-7	4/1/2013	IS	N&E, RA
073SB-0044-0001-SO	7-13	4/1/2013	C	N&E, RA
073SB-0067-0001-SO	7-13	3/28/2013	C	N&E, RA
073SD-0045-0001-SD	0-1	3/28/2013	D	F&T
073SD-0046-0001-SD	0-1	3/28/2013	D	F&T
073SD-0047-0001-SD	0-1	3/28/2013	D	F&T
073SD-0048-0001-SD	0-1	3/28/2013	D	QC FD
073SD-0050-0001-SD	0-1	3/28/2013	D	F&T
073SD-0052-0001-SD	0-1	3/28/2013	D	F&T
073SD-0054-0001-SD	0-1	3/28/2013	D	F&T
073SD-0055-0001-SD	0-1	3/28/2013	D	F&T

Table 4-1: Summary of Samples Collected for the Remedial Investigation (continued)

Sample Location ID	Interval (ft bgs)	Date	Type	Purpose
073SS-0002M-0001-SO	0-1	11/8/2012	IS	N&E, RA
073SS-0003M-0001-SO	0-1	11/8/2012	IS	QC FD
073SS-0005M-0001-SO	0-1	11/8/2012	IS	N&E, RA
073SS-0035M-0001-SO	0-1	4/1/2013	IS	N&E, RA
073SW-0056-0001-SW	NA	3/28/2013	D	F&T
073SW-0058-0001-SW	NA	3/28/2013	D	F&T
073SW-0059-0001-SW	NA	3/28/2013	D	QC FD
073SW-0061-0001-SW	NA	3/28/2013	D	F&T
073SW-0063-0001-SW	NA	3/28/2013	D	F&T
073SW-0064-0001-SW	NA	3/28/2013	D	F&T
073SW-0066-0001-SW	NA	3/28/2013	D	F&T
073SW-0067-0001-SW	NA	3/28/2013	D	F&T

Notes:
bgs = Below ground surface.
ft = Feet.
C = Vertical composite sample.
D = Discrete sample.
F&T = Fate and transport.
FD = Field duplicate.
ID = Identification.
IS = Incremental sample.
NA = Not applicable.
N&E = Nature and extent.
QC = Quality control.
RA = Risk assessment.

Table 4-2: Analyses Performed on Sample Types per Media

Sampling Media and Interval		Sample Type			Number of Samples Collected			Analysis					
Media	**Interval (ft bgs)**	**IS**	**D**	**C**	**NLCT**	**SCCT**	**U-16**	**VOCs**	**SVOCs**	**TAL Metals**	**PCBs**	**Explosives/ Propellants**	**Organochlorine Pesticides**
SB	1-4; 1-7; 4-7	X			7	7	7	2	21	21	2	2	2
DSB	7-13			X	1	1	1		3	3			
SS	0-1	X			1	1	1	1	3	3	1	1	1
SW	0-0		X		4	3		1	7	7	1	1	1
SD	0-1		X		4	3		1	7	7	1	1	1

Notes: Sample numbers do not include field duplicates and quality control samples.
bgs = Below ground surface.
C = Composite sample.
D = Discrete sample.
DSB = Deep soil boring.
ft = Feet (foot).
IS = Incremental sample.
NLCT = North Line Road Coal Tipple.
PCB = Polychlorinated biphenyl.
SB = Soil boring.
SCCT = Sand Creek Coal Tipple.
SD = Wet sediment sample collected for fate and transport purposes (Chapter 6).
SS = Surface soil.
SVOC = Semivolatile organic compound.
SW = Surface water collected for fate and transport purposes (Chapter 6).
TAL = Target Analyte List.
U-16 = Building U-16 Boiler House.
VOC = Volatile organic compound.

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Sand Creek
Road 20-X-2
73-NLCT-UP-SW1/UP-SD1
73-NLCT-DW-SW3/DW-SD3
73-NLCT-DW-SW4/DD-SD4
73-NLCT-MD-SW2/MD-SD2
DU01
(53,347 ft²)
North Line Road
Road 1C
Road 5C
Road 6C
Road 7C
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
LEGEND
Collocated Sediment/ Surface Water Sample Location
Decision Unit
Creek and Flow Direction
Ditch
Former Structure
Road
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. DU = Decision Unit
4. RVAAP = Ravenna Army Ammunition Plant
5. CC = Army Environmental Compliance-Related Cleanup Program
TITLE
Decision Unit and Discrete Sampling at North Line Road Coal Tipple
CC RVAAP-73 Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO
0 100 200
Feet
N
AMEC
Novi, Michigan
ECC
Marlborough, Massachusetts
PROJ: 3293111461
Date: June 2015
FIGURE
4-1a

2676

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Paris Windham Road
Sand Creek
Sand Creek
Sand Creek
73-SCCT-DW-SW3/DW-SD3
DU01
(28,196 ft²)
73-SCCT-UP-SW1/UP-SD1
73-SCCT-MD-SW2/MD-SD2
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
LEGEND
Collocated Sediment/ Surface Water Sample Location
Decision Unit
Creek and Flow Direction
Former Structure
Existing Structure
Road
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. DU = Decision Unit
4. RVAAP = Ravenna Army Ammunition Plant
5. CC = Army Environmental Compliance-Related Cleanup Program
TITLE
Decision Unit and Discrete Sampling Locations at Sand Creek Coal Tipple
CC RVAAP-73 Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO
0 100 200 Feet
N
amec
US Army Corps of Engineers
ECC
AMEC
Novi, Michigan
ECC
Marlborough, Massachusetts
PROJ: 3293111461
Date: June 2015
FIGURE
4-1b

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DU01
(6050 ft²)
U-16
Bundling Road
BB-223
BB-224
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
LEGEND
Former Structure
Existing Structure
Decision Unit
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. DU = Decision Unit
4. RVAAP = Ravenna Army Ammunition Plant
5. CC = Army Environmental Compliance-Related Cleanup Program
TITLE
Decision Unit at Building U-16 Boiler House
CC RVAAP-73 Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO
0
50
100
Feet
N
amec
US Army Corps of Engineers
ECC
AMEC
Novi, Michigan
ECC
Marlborough, Massachusetts
FIGURE
PROJ: 3293111461
Date: June 2015
4-1c

2700

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5. NATURE AND EXTENT OF CONTAMINATION

This chapter presents results of this RI data screening process to identify SRCs in soil associated with historical coal storage at CC RVAAP-73 Facility-Wide Coal Storage and to evaluate the nature and extent of those SRCs. DUs were designed to cover the known extent of the three historical storage areas and were extended an additional 30 ft in all directions (i.e., a 30-ft perimeter ring around historical operational areas). ISM was used to investigate each DU both vertically and horizontally to assess human health and ecological risk to surface and subsurface soil at the AOC. In addition, 3 vertical composite samples (one from each DU) were collected from 7 to 13 ft bgs to supplement the HHRA and characterize the soils to that depth.

Section 5.1 presents the methods used to evaluate data. Section 5.2 presents the nature and extent of SRCs in surface and subsurface soil for each of the three former coal storage areas. Summary analytical results are presented in Tables 5-1 through 5-7. Laboratory analytical results are provided in Appendix G.

5.1 DATA EVALUATION METHOD

Data evaluation methods used for CC RVAAP-73 Facility-Wide Coal Storage are consistent with those established in the Final FWCUG Report (SAIC 2010) and Position Paper for Facility-Wide Human Health Cleanup Goals (USACE 2012). These methods consist of (1) verifying data (2) data reduction and screening, and (3) presenting data. The completed Data Verification Report is included in Appendix B, and the Data Validation Report is in Appendix H. Data reporting is consistent with past data reporting practices to ensure comparability. Non-detect data are reported as not detected at the Limit of Quantitation (LOQ) in Chapter 5 tables and in Appendix B (Data Verification Report) and at the Limit of Detection in Appendix H (Data Validation Report).

5.1.1 Data Verification

Data verification was performed on 4 surface soil and 27 subsurface soil ISM samples (and QC samples) collected during the RI field activities to ensure that the precision and accuracy of the analytical data were adequate for their intended use. The review constituted comprehensive validation of 100 percent of the primary dataset.

Analytical results were reported by the laboratory in electronic format and issued to ECC on compact disc. Data verification was performed to ensure all requested data were received and complete. Data use qualifiers were assigned to each result based on the criteria provided in the Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.1 (Department of Defense 2009).

Results were qualified as follows:

- ***"U"*** – Analyte was not detected and reported less than the LOQ.

- ***"UJ"*** – Analyte was not detected and the reported limit is estimated.

- ***"J"*** – The reported result was positively identified; however, the associated numerical value is an approximate concentration of the analyte in the sample, or one or more QC criteria failed (e.g., laboratory control sample, surrogate spike recovery, or continued calibration verification). This qualifier is also used to report detections between the LOQ and the detection limit.

In addition to assigning qualifiers, the verification process was used to identify the appropriate result to use when re-analyses or dilutions were performed. Where laboratory surrogate recovery data or laboratory QC samples were outside of analytical method specifications, the verification chemist determined whether laboratory re-analysis should be used in place of an original reported result. If the laboratory reported results for both diluted and undiluted samples, diluted sample results were used for those analytes whose concentrations were greater than the calibration range of the undiluted sample. A complete presentation of the verification process results is contained in the Data Verification Report (Appendix B).

5.1.2 Data Validation

Independent, third party validation of 10 percent of the RI laboratory data was performed by North Wind Services and MECx in August 2014. The report is provided as Appendix H. For CC RVAAP-73 Facility-Wide Coal Storage, the following samples were validated:

- 073SS-0002M-0001-SO, which is the surface soil ISM sample from the Sand Creek Coal Tipple that was analyzed for the full suite of analytes. This same qualifier was applied to the field duplicate sample 073SS-0003M-0001-SO

- 073SB-0016M-0001-SO, which is a subsurface soil horizontal ISM sample from the Sand Creek Coal Tipple that was analyzed for TAL metals and SVOCs

- 073SB-0038M-0001-SO, which is a subsurface soil vertical ISM sample from the Building U-16 Boiler House that was analyzed for TAL metals and SVOCs.

The changes to the data based on validation are discussed in Appendix H. In general, the data validation performed for CC RVAAP-73 Facility-Wide Coal Storage indicates that no false negatives or false positives were identified, and the results are usable for their intended purposes, with the following notable changes:

- Because thallium was detected in the method blank, thallium was qualified as non-detect ("U") in sample 073SS-0002M-0001-SO.

- Toluene was qualified as non-detect ("U") in sample 073SS-0002M-0001-SO because of presumed contamination in the field blank or equipment rinsate.

- In sample 073SS-0002M-0001-SO, benzo(g,h,i)perylene and indeno(1,2,3-c,d)pyrene were qualified as estimated ("J") because the method reporting limit standard recoveries had a control limit greater than 30 percent.

- Cadmium in samples 073SB-0009M-0001-SO and 073SB-0016M-0001-SO was qualified as estimated ("J") with a potential positive bias due to matrix interferences.

- Bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected in one soil method blank; therefore, bis(2-ethylhexyl)phthalate was qualified as non-detected ("U") at the levels of contamination in 073SB-0016M-0001-SO and 073SD-0047M-0001-SO, and di-n-butyl phthalate was qualified as non-detect ("U") in 073SB-0016M-0001-SO.

5.1.3 Data Reduction

Summary statistics calculated for the data included the minimum, maximum, and average (mean) detected values and the proportion of detected results to the total number of samples collected. For calculation of mean detected values, non-detected results were included by using one-half of the reported method detection limit as a surrogate value during calculation of the mean result for each detected compound. In addition, data were reduced during the data screening process described below.

5.1.4 Data Screening

The surface and subsurface soil data collected for this RI were used to perform the AOC-specific screens and data evaluations. No previous data were used in the evaluation process. Groundwater is currently being investigated under a separate program under RVAAP-66 Facility-Wide Groundwater and was, therefore, not sampled as part of this RI.

Analytical results were initially evaluated to determine whether the chemical was a SRC. This was accomplished by performing the screening described below. The reported results were used to (1) compare the reported concentrations to the BSV (where established), (2) determine the frequency of detection and weight of evidence, and (3) determine whether the chemical was an essential nutrient. Analytical data collected during this RI were also compared to the media-specific (soil) and depth interval-specific (subsurface [greater than 1 ft bgs]) FWCUGs as well as to BSVs, if established.

RI analytical results comprised the dataset for screening. The dataset did not include QC samples or rejected results. Analytes having at least one detected value were included in the data screening process.

All chemicals not eliminated during the screening steps were retained as SRCs. The steps involved in the SRC screening are summarized below:

- ***Data Quality Assessment***—Data were produced, reviewed, and reported by the laboratory in accordance with specifications in the FWSAP.

- ***Background Screening***—The detected concentrations of inorganic chemicals were compared to the facility BSVs, where established. If a chemical concentration was greater than the BSVs (or detected for those inorganics with no BSVs such as cadmium and silver), the respective inorganic chemicals were retained as SRCs. All detected organic compounds were considered to be SRCs because BSVs are not established for organic compounds at the facility, except for those dismissed based on frequency of detection or weight-of-evidence screening as described below.

- ***Screening of Essential Human Nutrients***—Chemicals that are considered essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are an integral part of the human food supply and are often added to foods as supplements. USEPA recommends these chemicals not be evaluated unless they are grossly elevated relative to background concentrations or would exhibit toxicity at the observed concentrations (USEPA 1989; SAIC 2010). The chemicals included in this RI that are essential nutrients are calcium, iron, magnesium, potassium, and sodium. MDCs of essential nutrients were compared with BSVs for all the media sampled within CC RVAAP-73 Facility-Wide Coal Storage, except for potassium and sodium in sediment for which no BSVs were established. In very few circumstances, the MDCs of a few essential nutrients exceed BSVs by more than an order of magnitude; for example, potassium in surface water at the two coal tipple areas. However, these concentrations are not at levels that would exhibit toxicity; therefore, essential nutrients were not retained as SRCs.

- ***Frequency of Detection/Weight-of-Evidence Screening***—Chemicals that were not detected in a given medium were eliminated as SRCs. A weight-of-evidence approach was used to determine if chemicals with a low detection frequency (i.e., 5 percent or less where a chemical was analyzed in more than 20 samples) were AOC-related. If the detected results for a chemical showed no clustering, concentrations were not substantially elevated relative to the LOQ, and no source was evident, the results were considered spurious and the chemical was eliminated from further consideration. Frequency-of-detection screening was applied to the CC RVAAP-73 Facility-Wide Coal Storage subsurface soil dataset because the dataset is comprised of more than 20 samples, and 4 SVOCs were detected at a frequency less than 5 percent: 3, 3'-dichlorobenzidine; 4-nitrophenol; diethyl phthalate; and di-n-butyl phthalate because the results were considered spurious or laboratory contamination. Therefore, these compounds were not retained as SRCs in subsurface soil. As discussed above in Section 5.1.3, bis(2-ethylhexyl)phthalate and di-n-butyl-phthalate compounds were detected in a soil method blank and, therefore, were qualified as not detected in the samples that were validated (10 percent of data). In addition, these two compounds are recognized as being commonly attributed to sampling and analysis artifacts. Therefore, it is likely that these phthalates are artifacts of the sampling process and not site related. The Facility-Wide Human Health Risk Assessor Manual (USACE 2005c) states that common laboratory contaminants are not to be carried through the process if they are not considered to be site related. Therefore, bis(2-ethylhexyl)phthalate was not retained as an SRC in subsurface soil at the AOC.

5.1.5 Data Presentation

A summary of statistics, analytical results, and determination of SRCs in surface and subsurface soil at CC RVAAP-73 Facility-Wide Coal Storage are presented in Tables 5-1 through 5-6, respectively. The MDCs of each SRC for each medium are shown in Table 5-7 along with BSVs and most stringent Resident Receptor FWCUGs (or USEPA Residential Regional Screening Levels [RSLs] if the chemical lacked a FWCUG). On the figures, results indicate the extent and magnitude of contamination by providing MDCs of SRCs for the three former coal storage areas in red. The distribution of SRCs by location is shown on Figures 5-1 through 5-12. The complete laboratory analytical data packages are included in Appendix G as well as tables of laboratory analytical results with final qualifiers.

5.2 CONTAMINANT NATURE AND EXTENT

This section evaluates the analytical results of the RI samples collected at CC RVAAP-73 Facility-Wide Coal Storage. Figures 5-1 through 5-12 graphically present the distribution and concentrations of inorganic and organic SRCs occurring in surface and subsurface soil. The SRCs retained for each media are listed in Tables 5-1 through 5-6 for each former coal storage area. Table 5-7 presents a summary of SRCs in each media sampled at each of the three former coal storage areas. Inorganic compounds (i.e., metals) were retained as SRCs if their concentrations exceeded BSVs. Those metals without BSVs (i.e., cadmium and silver for surface and subsurface soil, and thallium for surface soil) were retained as SRCs if they were detected. All detected organic compounds were considered to be SRCs because BSVs are not established for organic compounds at the facility.

To delineate the horizontal and vertical extent of contamination, those SRCs identified in surface and subsurface soil that were considered as potential coal-related constituents were compared with the most stringent of the Resident Receptor FWCUGs at a target risk of 1×10^{-6} and a hazard quotient (HQ) of 0.1. Residential RSLs were used for comparison if FWCUGs are not established for an analyte. Only SRCs attributable to coal contamination were considered for nature and extent delineation. The analytical results are provided in Appendix G, along with complete copies of all analytical data packages.

5.2.1 Surface Soil

The dataset for surface soils consists of four (investigative and duplicate) ISM samples. Tables 5-1 through 5-3 present the results of the SRC screening for surface soil at each of the three coal storage areas. Table 5-7 presents the MDCs of SRCs in surface soil at each area. Figures 5-1, 5-2, 5-5, 5-6, 5-9, and 5-10 graphically present the distribution and concentrations of inorganic and organic SRCs occurring in the surface soil at CC RVAAP-73 Facility-Wide Coal Storage.

Surface soil ISM samples were analyzed for TAL metals, including mercury, and SVOCs. The 2 surface soil samples (1 investigative and 1 duplicate) from the Sand Creek Coal Tipple were also analyzed for VOCs, PCBs, organochlorine pesticides, propellants, and explosives.

The distribution of SRCs in surface soils for each of the three areas in CC RVAAP-73 Facility-Wide Coal Storage is as follows.

5.2.1.1 North Line Road Coal Tipple

Inorganics

As shown on Figure 5-1, 8 metals were retained as SRCs in surface soil at the North Line Road Coal Tipple: arsenic, barium, beryllium, cadmium, manganese, nickel, selenium, and zinc. However, the concentrations of these metals did not exceed their FWCUGs (or RSLs for those analytes without an FWCUG), with the exception of arsenic at 28 milligrams per kilograms (mg/kg) and manganese at 1,900 mg/kg. The concentrations of arsenic and manganese are only slightly greater than their BSVs; the BSV for arsenic is 15.4 mg/kg and the BSV for manganese is 1,450 mg/kg. Arsenic and manganese may be present in coal, but are not major coal constituents. In fact, the USGS (2013) does not list either of these two metals as major, minor, or trace constituents in coal. Furthermore, arsenic and manganese were not detected in concentrations greater than their BSVs at the other two former coal storage areas, which is not expected if arsenic and manganese leached from piles of coal storage at the AOC. Therefore, it is unlikely that the presence of arsenic and manganese in surface soil at the North Line Road Coal Tipple is due to historical coal storage, and additional sampling to further define the extent of these two metals was deemed unnecessary. However, because arsenic and manganese exceed their FWCUG, arsenic and manganese have been retained as SRCs to be evaluated in the risk assessments (Chapter 7). The fate and transport of surface soil away from the DU is discussed in Chapter 6.

Semivolatile Organic Compounds

As shown on Figure 5-2, 16 SVOCs were retained as SRCs in surface soil at the North Line Road Coal Tipple: 2-methylnaphthalene; acenaphthene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenzofuran; fluoranthene; indeno(1,2,3-c,d)pyrene; naphthalene, phenanthrene; and pyrene. Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are the only SVOC SRCs that exceed their respective FWCUG.

Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are polycyclic aromatic hydrocarbons (PAHs). Coal may contain non-regulated and/or USEPA-regulated PAHs. The regulated PAH composition and quantity depends on the coal rank or grade of the coal. Higher grade coal (e.g., anthracite) contains fewer regulated PAHs than lower grade coal (e.g., sub-bituminous). The percentage PAH composition that comprises the total amount of regulated PAHs varies depending on the coal grade. For medium coal, the percentage PAH composition is predominantly methy-naphthalenes up to 25 percent and phenanthrenes and methyl phenanthrenes up to 18 percent with trace levels of benzo(a)pyrene and benzo(a)anthracene (<1 percent). For higher grade coal, the percentage PAH composition is predominantly phenanthrenes and methyl phenanthrenes up to 20 percent and benzo(b)fluoranthene may be up to 12 percent with trace levels of benzo(a)pyrene and benzo(a)anthracene (<1 percent) (Achten and Hoffman 2008). The grade of coal storage at CC RVAAP-73 Facility-Wide Coal Storage is not available in historical documents reviewed as part of this RI.

If PAHs leached from coal storage at the AOC, naphthalene, methyl-naphthalenes (i.e., 2-methylnaphthatlene), phenanthrene and benzo(b)fluoranthene would be expected to be present in concentrations greater than the FWCUGs at the other two coal storage areas; however, benzo(a)pyrene was the only organic compound present at concentrations greater than the FWCUG at the Sand Creek Coal Tipple, and PAHs were not detected at the Building U-16 Boiler House. Benzo(a)pyrene typically only present only at trace levels in coal, as stated above, and benzo(a)anthracene and benzo(b)fluoranthene were detected at concentrations that only slightly exceeded the FWCUGs: benzo(a)anthracene at 0.73 mg/kg with an FWCUG of 0.221 mg/kg and benzo(b)fluoranthene at 0.67 mg/kg with an FWCUG of 0.221 mg/kg.

Rather than leaching from coal, it is more likely, as literature studies suggest, that the relatively low PAH concentrations reported within the DU are indicative of a release from common anthropogenic sources such as road dust, vehicle exhaust, tire wear particles, asphalt pavement, and slag used as fill (Agency for Toxic Substances and Disease Registry 1995; Bradley et. al. 1994; Illinois Environmental Protection Agency 2005; Massachusetts Department of Environmental Protection 2002; Teaf et. al. 2008). Asphalt is comprised of high molecular weight residual crude oil components and asphalt binder, both of which contain USEPA-regulated PAHs. The asphalt binder may contain up to 150 mg/kg of regulated USEPA PAHs (Fernandes et al. 2009).

Therefore, it is unlikely that the presence of PAHs in surface soil at the North Line Road Coal Tipple is due to historical coal storage, and additional sampling to further define the extent of benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene was deemed unnecessary. However, because benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene exceeded their FWCUG, these compounds have been retained as SRCs to be evaluated in the risk assessments (Chapter 7). The fate and transport of surface soil away from the DU is discussed in Chapter 6.

Other Analytes

Based on recommendations in the HRR and the record of historical AOC operations, surface soil samples at the North Line Road Coal Tipple were not analyzed for organochlorine pesticides, PCBs, VOCs, and explosives/propellants per the Final SI/RI Work Plan. There is no known or suspected use or storage of these analytes within the AOC.

5.2.1.2 Sand Creek Coal Tipple

Inorganics

As shown on Figure 5-5, 5 metals were identified as SRCs in surface soil within the Sand Creek Coal Tipple: cadmium, chromium, nickel, silver, and zinc. However, the concentrations of these metals did not exceed their respective most stringent Resident Receptor FWCUG. Therefore, the horizontal extent of inorganics in surface soil at the Sand Creek Coal Tipple has been defined.

Semivolatile Organic Compounds

As shown on Figure 5-6, 16 SVOCs were retained as SRCs in surface soil at the Sand Creek Coal Tipple: 2-methylnaphthalene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenzofuran; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; naphthalene, phenanthrene; and pyrene. Of these 16 SRCs, acenaphthylene, anthracene, and fluorene were detected in the field duplicate (073SS-0003M-0001-SO) only, not in the investigative sample (073SS-0002M-0001-SO). Only benzo(a)pyrene was detected at concentrations that exceeded its FWCUG. Benzo(a)pyrene was detected at 0.087 mg/kg in the investigative sample and 0.065 mg/kg in the field duplicate, and these concentrations only slightly exceeded the FWCUG of 0.022 mg/kg. In addition, the coal tipple is adjacent to Paris Windham Road (i.e., near to road dust, vehicle exhaust, tire wear particles, and asphalt pavement) and, as stated above, benzo(a)pyrene is only a trace component in coal. Therefore, the presence of this PAH is likely not related to the historical coal storage at the Sand Creek Coal Tipple, and additional sampling to further define the extent of benzo(a)pyrene was deemed unnecessary. However, because this compound exceeded its FWCUG, it has been retained as an SRC to be evaluated in the risk assessments (Chapter 7). The fate and transport of surface soil away from the DU is discussed in Chapter 6.

Volatile Organic Compounds

As shown on Figure 5-6, 1 VOC was retained as an SRC in surface soil at the Sand Creek Coal Tipple, carbon disulfide. However, this compound was detected only in the field duplicate (073SS-0003M-0001-SO) at an estimated concentration of 0.0013 mg/kg, but was not detected in the investigative parent sample (073SS-0002M-0001-SO). In addition, this concentration did not exceed its Residential RSL of 82 mg/kg (no FWCUG has been established for this compound). Therefore, the horizontal extent of VOCs in surface soil at the Sand Creek Coal Tipple has been defined.

Explosives

As shown on Figure 5-6, 1 explosive constituent was retained as an SRC in surface soil at the Sand Creek Coal Tipple: tetryl. However, this compound was detected only in the field duplicate (073SS-0003M-0001-SO) at an estimated concentration of 0.024 mg/kg, but was not detected in the investigative parent sample (073SS-0002M-0001-SO). In addition, this concentration did not exceed its Residential RSL of 12 mg/kg (no FWCUG has been established for this compound). Therefore, the horizontal extent of explosives in surface soil at the Sand Creek Coal Tipple has been defined.

Other Analytes

Organochlorine pesticides, PCBs, and propellants were not detected in surface soil at the Sand Creek Coal Tipple and, therefore, were not retained as SRCs.

5.2.1.3 Building U-16 Boiler House

Inorganics

As shown on Figure 5-9, 6 metals were identified as SRCs in surface soil: cadmium, cobalt, copper, nickel, silver, and thallium; none of which exceeded their respective most stringent Resident Receptor FWCUGs. Therefore, the horizontal extent of metals in surface soil at the Building U-16 Boiler House has been defined.

Semivolatile Organic Compounds

As shown on Figure 5-10, only 2 SVOCs were retained as SRCs in surface soil at the Building U-16 Boiler House: 2-methylnaphthalene and naphthalene. However, the concentrations of these two compounds did not exceed their most stringent Resident Receptor FWCUG; therefore, the horizontal extent of SVOCs in surface soil at the Building U-16 Boiler House has been defined.

Other Analytes

Based on recommendations in the HRR and the record of historical AOC operations, surface soil samples at the Building U-16 Boiler House were not analyzed for organochlorine pesticides, PCBs, VOCs, and explosives/propellants per the Final SI/RI Work Plan. There is no known or suspected use or storage of these analytes within the AOC.

5.2.2 Subsurface Soil

The dataset for subsurface soil consists of 24 horizontal and vertical ISM (investigative and field duplicate) samples and 3 vertical composite samples for a total of 27 samples. Tables 5-4 through 5-6 present the results of the SRC screening for the subsurface soil at each of the three coal storage areas. Table 5-7 presents the MDCs of the SRCs in subsurface soil at each area. Figures 5-3, 5-4, 5-7, 5-8, 5-11, and 5-12 graphically present the distribution and concentrations of inorganic and organic SRCs occurring in the subsurface soil at CC RVAAP-73 Facility-Wide Coal Storage.

All of the subsurface soil ISM samples were analyzed for TAL metals, including mercury, and SVOCs. Two subsurface soil samples (1 from North Line Road Coal Tipple and 1 from Building U-16 Boiler House) were also analyzed for VOCs, PCBs, organochlorine pesticides, propellants, and explosives.

The distribution of SRCs in subsurface soils for each of the three areas in CC RVAAP-73 Facility-Wide Coal Storage is as follows.

5.2.2.1 North Line Road Coal Tipple

5.2.2.1.1 Horizontal Extent

Inorganics

As shown on Figure 5-3, 3 metals were identified as SRCs in subsurface soil at the North Line Road Coal Tipple: beryllium, cadmium, and silver. However, concentrations of these metals did not exceed their respective most stringent Resident Receptor FWCUGs (or Residential RSL for beryllium, which does not have an FWCUG) and, therefore, the horizontal extent of inorganics in subsurface soil at the North Line Road Coal Tipple has been defined.

Semivolatile Organic Compounds

As shown on Figure 5-4, 16 SVOCs were retained as SRCs in subsurface soil at the North Line Road Coal Tipple: 1,4-dichlorobenzene; 2-methylnaphthalene; benzo(a)anthracene, benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; chrysene; dibenzofuran; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; isophorone; naphthalene, phenanthrene; and pyrene. However, the concentrations of only 1 of these SVOCs (benzo[a] pyrene) exceeded its FWCUG. These two concentrations (0.049 mg/kg from the investigative parent sample and an estimated concentration of 0.033 mg/kg from the field duplicate) only slightly exceeded the FWCUG of 0.022 mg/kg. These concentrations of benzo(a)pyrene were from only one vertical ISM soil boring (73-NLCT-DU1-SB1). Benzo(a)pyrene was not detected in the other soil borings except for the vertical composite at 73-NLCT-DU1-SB5 at an estimated concentration of 0.0049 mg/kg, which is an order of magnitude less than its FWCUG. In addition, benzo(a)pyrene was not detected in the horizontal ISM samples from 1 to 4 ft bgs and from 4 to 7 ft bgs (073SB-0025M-0001-SO and 073SB-0026M-001-SO, respectively). Furthermore, as discussed in Section 5.2.1.1, it is unlikely that the presence of PAHs, especially benzo(a)pyrene, is related to historical coal storage at the tipple. For these reasons, additional sampling to further define the extent of benzo(a)pyrene was deemed unnecessary. Benzo(a)pyrene was, however, retained as an SRC for further screening in the risk assessments (Chapter 7).

Volatile Organic Compounds

As shown on Figure 5-4, 1 VOC was retained as an SRC in subsurface soil at the North Line Road Coal Tipple: carbon disulfide. The concentration of 0.003 mg/kg is less than the Residential RSL of 82 mg/kg (an FWCUG has not been established for this compound). Therefore, the horizontal extent of VOCs in subsurface soil at the North Line Road Coal Tipple has been defined.

Explosives

As shown on Figure 5-4, 2 explosive constituents were retained as SRCs in subsurface soil at the North Line Road Coal Tipple: 2,4-dinitrotoluene and tetryl. However, the concentrations of these two compounds did not exceed their respective FWCUGs, and therefore, the horizontal extent of explosives in subsurface soil at the North Line Road Coal Tipple has been defined.

Propellants

One propellant, nitrocellulose, was retained as an SRC in subsurface soil at the North Line Road Coal Tipple at an estimated concentration of 0.87 mg/kg; however, the concentration does not exceed its Residential RSL of 18,000,000 mg/kg (an FWCUG has not been established for this analyte). Therefore, the horizontal extent of propellants in subsurface soil at the North Line Road Coal Tipple has been defined.

Other Analytes

Organochlorine pesticides and PCBs were not detected in subsurface soil at the North Line Road Coal Tipple and, therefore, were not retained as SRCs.

5.2.2.1.2 Vertical Extent

Inorganics

The concentrations of metals in subsurface soil did not exceed their respective FWCUGs (or Residential RSLs for those metals without an FWCUG). Therefore, the vertical extent of inorganics in subsurface soil at the North Line Road Coal Tipple has been defined.

Semivolatile Organic Compounds

As stated above, only one SVOC slightly exceeded its FWCUG in subsurface soil at the North Line Road Coal Tipple: benzo(a)pyrene. The only location with benzo(a)pyrene concentrations that exceeded the FWCUG is at SB1 from 1 vertical ISM soil sample, which represents the entire soil column from 1 to 7 ft bgs. However, benzo(a)pyrene was not detected in the horizontal ISM subsurface soil samples from 1 to 4 and from 4 to 7 ft bgs, which include SB1 and four other borings within the DU. Therefore, the vertical extent of benzo(a)pyrene is delineated at 4 of the 5 borings within the DU and in the deepest horizontal ISM sample. In addition, these horizontal ISM samples are more representative of the entire DU than 1 vertical ISM sample. Furthermore, as discussed previously, it is unlikely that benzo(a)pyrene concentrations greater than the FWCUG are related to historical coal storage within the DU. As discussed in Section 3.3, the water table beneath this DU may not have been encountered during drilling; however, the soil is silty clay and the water table is difficult to discern from the boring logs. Based on the elevation of the ground surface and the unconsolidated aquifer surface map (Figure 2-4), it is likely that the water table would be encountered with deeper drilling. Therefore, additional sampling to further define the vertical extent of benzo(a)pyrene at this one location was not deemed necessary. Fate and transport of benzo(a)pyrene in unconsolidated groundwater is evaluated in Chapter 6 (and to be conservative, a leaching zone of zero was assumed in the fate and transport calculations).

Volatile Organic Compounds

The concentration of the 1 VOC SRC in subsurface soil at the North Line Road Coal Tipple (carbon disulfide) is less than its residential RSL (there is no FWCUG for this compound). Therefore, the vertical extent of VOCs in subsurface soil at the North Line Road Coal Tipple has been defined.

Explosives

The concentrations of the two explosives SRCs in subsurface soil at the North Line Road Coal Tipple (2,4-dinitrotoluene and tetryl) did not exceed their respective FWCUG (or Residential RSL for tetryl, which does not have an FWCUG). Therefore, the vertical extent of explosives in subsurface soil at the North Line Road Coal Tipple has been defined.

Propellants

The concentration of the one propellant SRC in subsurface soil at the North Line Road Coal Tipple (nitrocellulose) did not exceed its Residential RSL (no FWCUG has been established for nitrocellulose). Therefore, the vertical extent of propellants in subsurface soil at the North Line Road Coal Tipple has been defined.

Other Analytes

Organochlorine pesticides and PCBs were not detected in subsurface soil at the North Line Road Coal Tipple and, therefore, were not retained as SRCs.

5.2.2.2 Sand Creek Coal Tipple

5.2.2.2.1 Horizontal Extent

Inorganics

As shown on Figure 5-7, 2 metals were identified as SRCs in subsurface soil at the Sand Creek Coal Tipple: cadmium and silver. However, the concentrations of cadmium and silver did not exceed their respective Residential FWCUGs (BSVs are not established for these metals). Therefore, the horizontal extent of inorganics in subsurface soil at the Sand Creek Coal Tipple has been defined.

Semivolatile Organic Compounds

As shown on Figure 5-8, 19 SVOCs were retained as SRCs in subsurface soil from the Sand Creek Coal Tipple: 1,4-dichlorobenzene; 2-methylnaphthalene; acenaphthylene; anthracene; benzo(a)anthracene, benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; benzyl alcohol; chrysene; dibenzofuran; fluoranthene; fluorene; indeno(1,2,3-c,d)pyrene; isophorone; naphthalene, phenanthrene; and pyrene. However, the concentration of only 1 of these SVOCs slightly exceeded its FWCUG; benzo(a)pyrene at

0.062 mg/kg (and 0.058 mg/kg from the field duplicate) compared to a FWCUG of 0.022 mg/kg. These detections of benzo(a)pyrene were from the horizontal ISM sample from 1 to 4 ft bgs obtained from the five soil borings within the DU and its corresponding field duplicate (073SB-0016M-0001-SO and 073SB-0017M-0001-SO, respectively); however, benzo(a)pyrene was not detected at a concentration exceeding the FWCUG in the vertical ISM samples (1-7 ft bgs) or the deeper horizontal ISM sample (4-7 ft bgs) from the same five borings. In addition, as discussed in Section 5.2.1.1, it is unlikely that the presence of PAHs is related to historical coal storage at the tipple. Therefore, the horizontal extent of SVOCs in subsurface soil at the Sand Creek Coal Tipple has been defined.

Other Analytes

Based on recommendations in the HRR and the record of historical AOC operations, subsurface soil samples at the Sand Creek Coal Tipple were not analyzed for organochlorine pesticides, PCBs, VOCs, and explosives/propellants per the Final SI/RI Work Plan. There is no known or suspected use or storage of these analytes within the AOC.

5.2.2.2.2 Vertical Extent

Inorganics

Only cadmium and silver were retained as SRCs in subsurface soil at the Sand Creek Coal Tipple. However, concentrations were less than their respective Residential FWCUGs, and therefore, the vertical extent of inorganics has been delineated in this area.

Semivolatile Organic Compounds

Only 1 SVOC, benzo(a)pyrene, slightly exceeded its FWCUG in subsurface soil at the Sand Creek Coal Tipple. Benzo(a)pyrene was detected in the horizontal ISM sample representing 1-4 ft bgs from the five borings, but was not detected in the horizontal ISM sample representing 4-7 ft bgs from the same five borings. In addition, benzo(a)pyrene was not detected in the 5 vertical ISM samples representing 1-7 ft bgs or in the vertical composite sample representing 7-13 ft bgs. Therefore, the vertical extent of SVOCs in subsurface soil at the Sand Creek Coal Tipple has been defined.

5.2.2.3 Building U-16 Boiler House

5.2.2.3.1 Horizontal Extent

Inorganics

As shown on Figure 5-11, only cadmium and silver were identified as SRCs in subsurface soil at the Building U-16 Boiler House. However, the concentrations of these two metals were less than their respective Residential FWCUGs (BSVs have not been established). Therefore, the horizontal extent of metals in subsurface soil at the Building U-16 Boiler House has been defined.

Semivolatile Organic Compounds

As shown on Figure 5-12, no SVOCs were retained as SRCs in subsurface soil at the Building U-16 Boiler House.

Organochlorine Pesticides

As shown on Figure 5-12, two organochlorine pesticides were retained as SRCs in subsurface soil at the Building U-16 Boiler House: alpha-hexachlorocyclohexane (alpha-BHC) at an estimated concentration of 0.0012 mg/kg and p,p'-dichlrodiphenyldichloroethylene at an estimated concentration of 0.00066 mg/kg. These two pesticides were only detected at low concentrations that did not exceed their respective screening criteria: Residential RSL of 0.077 mg/kg for alpha-BHC (no FWCUG has been established for this compound) and the FWCUG of 2.63 mg/kg for p,p'-dichlrodiphenyldichloroethylene. Therefore, the horizontal extent of organochlorine pesticides has been defined.

Propellants

One propellant, nitrocellulose, was retained as an SRC in subsurface soil at the Building U-16 Boiler House. However, the estimated concentration of 0.91 mg/kg is orders of magnitude less than the Residential RSL of 18,000,000 mg/kg (no FWCUG has been established for this compound). Therefore, the horizontal extent of propellants in subsurface soil at the Building U-16 Boiler House had been defined.

Other Analytes

PCBs, VOCs, and explosives were not detected in subsurface soil at the Building U-16 Boiler House, and therefore, were not retained as SRCs.

5.2.2.3.2 Vertical Extent

Inorganics

Cadmium and silver were retained as SRCs in in subsurface soil, but not in concentrations that exceed FWCUGs or Residential RSLs (if no FWCUGS are available). Therefore, the vertical extent of inorganics has been defined at the Building U-16 Boiler House.

Semivolatile Organic Compounds

As discussed above, no SVOCs were retained as SRCs in subsurface soil at the Building U-16 Boiler House.

Organochlorine Pesticides

The two organochlorine pesticides that were detected in subsurface soil at the Building U-16 Boiler House had concentrations less than their screening criteria and, therefore, the vertical extent of organochlorine pesticides in subsurface soil at the Building U-16 Boiler House has been defined.

Propellants

As discussed above, only nitrocellulose was retained as a propellant SRC in subsurface soil from one sample representing 1-7 ft bgs. However, the concentration was less than the Residential RSL (no FWCUG is established); therefore, the vertical extent of propellants has been established at the Building U-16 Boiler House.

5.3 SUMMARY OF CONTAMINANT NATURE AND EXTENT

SRCs were identified in all media evaluated at CC RVAAP-73 Facility-Wide Coal Storage (surface and subsurface soil). For this RI, the identification of inorganic SRCs was accomplished by comparing analytical data to the BSVs. If organic compounds were detected, they were retained as SRCs because BSVs have not been established. The majority of SRCs identified were metals and SVOCs. PCBs were not identified in any of the samples analyzed. Based on the composition of coal, it is unlikely that the relatively low concentrations of SRCs are due to historical coal storage at the AOC. However, these SRCs were retained to evaluate the risk to downgradient groundwater receptors as well as human and ecological receptors.

To delineate the horizontal and vertical extent of contamination, those SRCs identified in surface and subsurface soil were compared with the most stringent Resident Receptor FWCUGs (or Residential RSLs if a FWCUG was not established) at a target risk of 1×10^{-6} and HQ of 0.1. The majority of SRCs identified had concentrations less than the FWCUGs (or RSLs for those SRCs without FWCUGs).

Surface Soil

Thirty-two SRCs were identified in surface soil at the AOC: 13 inorganics, 1 VOC, 17 SVOCs, and 1 explosive. The SRCs with concentrations that exceeded the FWCUGs (or Residential RSLs for chemicals without an established FWCUG) in surface soil for each of the three former coal storage areas are as follows:

- Inorganics
  - Arsenic and manganese at the North Line Road Coal Tipple
- Organics
  - Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene at the North Line Road Coal Tipple
  - Benzo(a)pyrene at the Sand Creek Coal Tipple.

Subsurface Soil

Twenty-eight SRCs were identified in subsurface soil at the AOC: 3 inorganics, 2 organochlorine pesticides, 1 VOC, 19 SVOCs, 2 explosives, and 1 propellant. The SRCs with concentrations that exceeded the FWCUGs (or the Residential RSLs for chemicals without an established FWCUG) in subsurface soil for each of the three former coal storage areas are as follows:

- Inorganics

  - None identified

- Organics

  - Benzo(a)pyrene at the North Line Road Coal Tipple
  - Benzo(a)pyrene at the Sand Creek Coal Tipple.

Because arsenic and manganese are not known to be coal constituents, additional sampling beyond the DUs was deemed unnecessary to define the extent of these metals in surface soil at the North Line Road Coal Tipple. Benzo(a)anthracene and benzo(a)pyrene may be present in coal in only trace amounts. These two PAHs were detected at concentrations only slightly greater than their FWCUGs, and their presence in surface soil is most likely from anthropogenic sources such as asphalt and tire particles rather than historical coal storage. Benzo(b)fluoranthene is a known constituent in coal; however, if its presence was due to historical coal storage, it would be expected to be detected above the FWCUG at all three coal storage areas, but it was only detected in exceedance of the FWCUG at the North Line Road Coal Tipple. No SRCs were detected in concentrations exceeding the most stringent Resident Receptor FWCUGs (or Residential RSLs for those SRCs without FWCUGs) at the Building U-16 Boiler House. For these reasons, additional sampling to define the extent of PAHs beyond the DUs in either surface or subsurface soil was deemed unnecessary.

Table 5-1: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Surface Soil

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Metals								
Aluminum	mg/kg	1/1	16,000	16,000	16,000	17,700	No	Less than Background
Antimony	mg/kg	0/1	0.85	None	None	0.96	No	Not Detected
Arsenic	mg/kg	1/1	28	28	28	15.4	Yes	Exceeds Background
Barium	mg/kg	1/1	160	160	160	88.4	Yes	Exceeds Background
Beryllium	mg/kg	1/1	3.3	3.3	3.3	0.88	Yes	Exceeds Background
Cadmium	mg/kg	1/1	0.61	0.61	0.61	0	Yes	Exceeds Background
Calcium	mg/kg	1/1	62,000	62,000	62,000	15,800	No	Less than Background
Chromium	mg/kg	1/1	13	13	13	17.4	No	Less than Background
Cobalt	mg/kg	1/1	8.7	8.7	8.7	10.4	No	Less than Background
Copper	mg/kg	1/1	16	16	16	17.7	No	Less than Background
Iron	mg/kg	1/1	16,000	16,000	16,000	23,100	No	Less than Background
Lead	mg/kg	1/1	26	26	26	26.1	No	Less than Background
Magnesium	mg/kg	1/1	9,800	9,800	9,800	3,030	No	Less than Background
Manganese	mg/kg	1/1	1,900	1,900	1,900	1,450	Yes	Exceeds Background
Nickel	mg/kg	1/1	24	24	24	21.1	Yes	Exceeds Background
Potassium	mg/kg	1/1	1,000	1,000	1,000	927	No	Less than Background
Selenium	mg/kg	1/1	2.3	2.3	2.3	1.4	Yes	Exceeds Background
Silver	mg/kg	0/1	0.435	None	None	0	No	Not Detected
Sodium	mg/kg	1/1	410	410	410	123	No	Less than Background
Thallium	mg/kg	0/1	0.85	None	None	0	No	Not Detected
Vanadium	mg/kg	1/1	6.5	6.5	6.5	31.1	No	Less than Background
Zinc	mg/kg	1/1	99	99	99	61.8	Yes	Exceeds Background
Mercury	mg/kg	0/1	0.050	None	None	0.036	No	Not Detected
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	µg/kg	0/1	250	None	None	NB	No	Not Detected
1,2-Dichlorobenzene	µg/kg	0/1	250	None	None	NB	No	Not Detected
1,3-Dichlorobenzene	µg/kg	0/1	250	None	None	NB	No	Not Detected
1,4-Dichlorobenzene	µg/kg	0/1	250	None	None	NB	No	Not Detected
2,4,5-Trichlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
2,4,6-Trichlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected

Table 5-1: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Surface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
2,4-Dichlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
2,4-Dimethylphenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
2,4-Dinitrophenol	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2-Chloronaphthalene	µg/kg	0/1	250	None	None	NB	No	Not Detected
2-Chlorophenol	µg/kg	0/1	250	None	None	NB	No	Not Detected
2-Methylnaphthalene	µg/kg	1/1	9,100	9100	9100	NB	Yes	Exceeds Detection Limit
2-Methylphenol (o-Cresol)	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2-Nitroaniline	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2-Nitrophenol	µg/kg	0/1	250	None	None	NB	No	Not Detected
3,3'-Dichlorobenzidine	µg/kg	0/1	500	None	None	NB	No	Not Detected
3-Nitroaniline	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
4,6-Dinitro-2-Methylphenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
4-Bromophenyl phenyl ether	µg/kg	0/1	250	None	None	NB	No	Not Detected
4-Chloro-3-Methylphenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
4-Chloroaniline	µg/kg	0/1	750	None	None	NB	No	Not Detected
4-Chlorophenyl Phenyl Ether	µg/kg	0/1	250	None	None	NB	No	Not Detected
4-Nitroaniline	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
4-Nitrophenol	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
Acenaphthene	µg/kg	1/1	240	240	240	NB	Yes	Exceeds Detection Limit
Acenaphthylene	µg/kg	1/1	160	160	160	NB	Yes	Exceeds Detection Limit
Anthracene	µg/kg	1/1	300	300	300	NB	Yes	Exceeds Detection Limit
Benzo(a)anthracene	µg/kg	1/1	730	730	730	NB	Yes	Exceeds Detection Limit
Benzo(a)pyrene	µg/kg	1/1	570	570	570	NB	Yes	Exceeds Detection Limit
Benzo(b)fluoranthene	µg/kg	1/1	670	670	670	NB	Yes	Exceeds Detection Limit
Benzo(g,h,i)perylene	µg/kg	1/1	160	160	160	NB	Yes	Exceeds Detection Limit
Benzo(k)fluoranthene	µg/kg	1/1	190	190	190	NB	Yes	Exceeds Detection Limit
Benzyl alcohol	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
Benzyl butyl phthalate	µg/kg	0/1	250	None	None	NB	No	Not Detected

Table 5-1: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Surface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
bis(2-Chloroethoxy) Methane	µg/kg	0/1	500	None	None	NB	No	Not Detected
bis(2-Chloroethyl) Ether (2-Chloroethyl Ether)	µg/kg	0/1	500	None	None	NB	No	Not Detected
bis(2-Chloroisopropyl) Ether	µg/kg	0/1	500	None	None	NB	No	Not Detected
bis(2-Ethylhexyl) Phthalate	µg/kg	0/1	250	None	None	NB	No	Not Detected
Carbazole	µg/kg	0/1	250	None	None	NB	No	Not Detected
Chrysene	µg/kg	1/1	1,000	1,000	1,000	NB	Yes	Exceeds Detection Limit
Cresols, m & p	µg/kg	0/1	2,000	None	None	NB	No	Not Detected
Dibenz(a,h)anthracene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Dibenzofuran	µg/kg	1/1	2,500	2,500	2,500	NB	Yes	Exceeds Detection Limit
Diethyl Phthalate	µg/kg	0/1	250	None	None	NB	No	Not Detected
Dimethyl Phthalate	µg/kg	0/1	250	None	None	NB	No	Not Detected
Di-n-Butyl Phthalate	µg/kg	0/1	250	None	None	NB	No	Not Detected
Di-n-Octylphthalate	µg/kg	0/1	250	None	None	NB	No	Not Detected
Fluoranthene	µg/kg	1/1	860	860	860	NB	Yes	Exceeds Detection Limit
Fluorene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Hexachlorobenzene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Hexachlorobutadiene	µg/kg	0/1	250	None	None	NB	No	Not Detected
Hexachlorocyclopentadiene	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
Hexachloroethane	µg/kg	0/1	250	None	None	NB	No	Not Detected
Indeno(1,2,3-c,d)pyrene	µg/kg	1/1	140	140	140	NB	Yes	Exceeds Detection Limit
Isophorone	µg/kg	0/1	250	None	None	NB	No	Not Detected
Naphthalene	µg/kg	1/1	4,600	4,600	4,600	NB	Yes	Exceeds Detection Limit
Nitrobenzene	µg/kg	0/1	500	None	None	NB	No	Not Detected
n-Nitrosodi-n-propylamine	µg/kg	0/1	250	None	None	NB	No	Not Detected
n-Nitrosodiphenylamine	µg/kg	0/1	250	None	None	NB	No	Not Detected
Pentachlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
Phenanthrene	µg/kg	1/1	5,500	5,500	5,500	NB	Yes	Exceeds Detection Limit
Phenol	µg/kg	0/1	250	None	None	NB	No	Not Detected
Pyrene	µg/kg	1/1	1,000	1,000	1,000	NB	Yes	Exceeds Detection Limit

Table 5-1: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Surface Soil (continued)

Notes:

a. Average result was calculated by using one-half of the reported limit of quantitation as a surrogate value for each non-detected chemical.

b. Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (United States Army Corps of Engineers 2001b).

Yellow shading indicates analyte is an SRC.

µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
NB = No background.
SRC = Site-related chemical.

Table 5-2: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Surface Soil

Chemical	Units	Results> Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
Metals								
Aluminum	mg/kg	2/2	6,750	6,600	6,900	17,700	No	Less than Background
Antimony	mg/kg	2/2	0.0925	0.087	0.098	0.96	No	Less than Background
Arsenic	mg/kg	2/2	9.55	9.4	9.7	15.4	No	Less than Background
Barium	mg/kg	2/2	48.5	48	49	88.4	No	Less than Background
Beryllium	mg/kg	2/2	0.48	0.47	0.49	0.88	No	Less than Background
Cadmium	mg/kg	2/2	0.215	0.21	0.22	0	Yes	Exceeds Background
Calcium	mg/kg	2/2	4,550	4,400	4,700	15,800	No	Less than Background
Chromium	mg/kg	2/2	18	17	19	17.4	Yes	Exceeds Background
Cobalt	mg/kg	2/2	6.95	6.8	7.1	10.4	No	Less than Background
Copper	mg/kg	2/2	13.5	13	14	17.7	No	Less than Background
Iron	mg/kg	2/2	17,500	17,000	18,000	23,100	No	Less than Background
Lead	mg/kg	2/2	14.5	14	15	26.1	No	Less than Background
Magnesium	mg/kg	2/2	2,300	2,300	2,300	3,030	No	Less than Background
Manganese	mg/kg	2/2	395	380	410	1,450	No	Less than Background
Nickel	mg/kg	2/2	22	22	22	21.1	Yes	Exceeds Background
Potassium	mg/kg	2/2	895	840	950	927	No	Essential Nutrient
Selenium	mg/kg	2/2	0.455	0.44	0.47	1.4	No	Less than Background
Silver	mg/kg	2/2	0.41	0.38	0.44	0	Yes	Exceeds Background
Sodium	mg/kg	2/2	41	40	42	123	No	Less than Background
Thallium	mg/kg	0/2	0.11	ND	ND	0	No	Not Detected
Vanadium	mg/kg	2/2	11	11	11	31.1	No	Less than Background
Zinc	mg/kg	2/2	64	64	64	61.8	Yes	Exceeds Background
Mercury	mg/kg	0/2	0.048	None	None	0.036	No	Not Detected
Organochlorine Pesticides								
Aldrin	µg/kg	0/2	41	None	None	NB	No	Not Detected
alpha-BHC (alpha-Hexachlorocyclohexane)	µg/kg	0/2	26	None	None	NB	No	Not Detected
alpha-Chlordane	µg/kg	0/2	31	None	None	NB	No	Not Detected
alpha-Endosulfan	µg/kg	0/2	17	None	None	NB	No	Not Detected
beta-BHC (beta-Hexachlorocyclohexane)	µg/kg	0/2	36	None	None	NB	No	Not Detected

Table 5-2: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Surface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
beta-Endosulfan	µg/kg	0/2	25	None	None	NB	No	Not Detected
delta-BHC (delta-Hexachlorocyclohexane)	µg/kg	0/2	41	None	None	NB	No	Not Detected
Dieldrin	µg/kg	0/2	17	None	None	NB	No	Not Detected
Endosulfan Sulfate	µg/kg	0/2	31	None	None	NB	No	Not Detected
Endrin	µg/kg	0/2	17	None	None	NB	No	Not Detected
Endrin Aldehyde	µg/kg	0/2	31	None	None	NB	No	Not Detected
Endrin Ketone	µg/kg	0/2	20	None	None	NB	No	Not Detected
gamma-BHC (Lindane)	µg/kg	0/2	26	None	None	NB	No	Not Detected
gamma-Chlordane	µg/kg	0/2	17	None	None	NB	No	Not Detected
Heptachlor	µg/kg	0/2	36	None	None	NB	No	Not Detected
Heptachlor Epoxide	µg/kg	0/2	25	None	None	NB	No	Not Detected
Methoxychlor	µg/kg	0/2	50	None	None	NB	No	Not Detected
p,p'-Dichlorodiphenyldichloroethane	µg/kg	0/2	20	None	None	NB	No	Not Detected
p,p'-Dichlrodiphenyldichloroethylene	µg/kg	0/2	17	None	None	NB	No	Not Detected
p,p'-Dichlorodiphenyltrichloroethane	µg/kg	0/2	20	None	None	NB	No	Not Detected
Toxaphene	µg/kg	0/2	700	None	None	NB	No	Not Detected
Polychlorinated Biphenyls								
PCB-1016 (Arochlor 1016)	µg/kg	0/2	33	None	None	NB	No	Not Detected
PCB-1221 (Arochlor 1221)	µg/kg	0/2	26	None	None	NB	No	Not Detected
PCB-1232 (Arochlor 1232)	µg/kg	0/2	23	None	None	NB	No	Not Detected
PCB-1242 (Arochlor 1242)	µg/kg	0/2	20	None	None	NB	No	Not Detected
PCB-1248 (Arochlor 1248)	µg/kg	0/2	28	None	None	NB	No	Not Detected
PCB-1254 (Arochlor 1254)	µg/kg	0/2	28	None	None	NB	No	Not Detected
PCB-1260 (Arochlor 1260)	µg/kg	0/2	28	None	None	NB	No	Not Detected
Volatile Organic Compounds								
1,1,1-Trichloroethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
1,1,2,2-Tetrachloroethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
1,1,2-Trichloroethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
1,1-Dichloroethane	µg/kg	0/2	4	None	None	NB	No	Not Detected

Table 5-2: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Surface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
1,1-Dichloroethene	µg/kg	0/2	4	None	None	NB	No	Not Detected
1,2-Dibromoethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
1,2-Dichloroethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
1,2-Dichloroethene	µg/kg	0/2	7	None	None	NB	No	Not Detected
1,2-Dichloropropane	µg/kg	0/2	4	None	None	NB	No	Not Detected
2-Butanone	µg/kg	0/2	14	None	None	NB	No	Not Detected
2-Hexanone	µg/kg	0/2	14	None	None	NB	No	Not Detected
4-Methyl-2-pentanone	µg/kg	0/2	14	None	None	NB	No	Not Detected
Acetone	µg/kg	0/2	14	None	None	NB	No	Not Detected
Benzene	µg/kg	0/2	4	None	None	NB	No	Not Detected
Bromochloromethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
Bromodichloromethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
Bromoform	µg/kg	0/2	4	None	None	NB	No	Not Detected
Bromomethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
Carbon Disulfide	µg/kg	1/2	2	1.3	1.3	NB	Yes	Exceeds Detection Limit
Carbon Tetrachloride	µg/kg	0/2	4	None	None	NB	No	Not Detected
Chlorobenzene	µg/kg	0/2	4	None	None	NB	No	Not Detected
Chloroethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
Chloroform	µg/kg	0/2	4	None	None	NB	No	Not Detected
Chloromethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
cis-1,3-Dichloropropene	µg/kg	0/2	4	None	None	NB	No	Not Detected
Dibromochloromethane	µg/kg	0/2	4	None	None	NB	No	Not Detected
Ethylbenzene	µg/kg	0/2	4	None	None	NB	No	Not Detected
Methylene Chloride	µg/kg	0/2	4	None	None	NB	No	Not Detected
Styrene	µg/kg	0/2	4	None	None	NB	No	Not Detected
Tetrachloroethene (PCE)	µg/kg	0/2	4	None	None	NB	No	Not Detected
Toluene	µg/kg	0/2	4	None	None	NB	No	Not Detected
trans-1,3-Dichloropropene	µg/kg	0/2	4	None	None	NB	No	Not Detected
Trichloroethene (TCE)	µg/kg	0/2	4	None	None	NB	No	Not Detected
Vinyl Chloride	µg/kg	0/2	4	None	None	NB	No	Not Detected
Xylenes, Total	µg/kg	0/2	7	None	None	NB	No	Not Detected

Table 5-2: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Surface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
1,2-Dichlorobenzene	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
1,3-Dichlorobenzene	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
1,4-Dichlorobenzene	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
2,4,5-Trichlorophenol	µg/kg	0/2	190	None	None	NB	No	Not Detected
2,4,6-Trichlorophenol	µg/kg	0/2	190	None	None	NB	No	Not Detected
2,4-Dichlorophenol	µg/kg	0/2	190	None	None	NB	No	Not Detected
2,4-Dimethylphenol	µg/kg	0/2	190	None	None	NB	No	Not Detected
2,4-Dinitrophenol	µg/kg	0/2	407.5	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	µg/kg	0/2	252.5	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	µg/kg	0/2	252.5	None	None	NB	No	Not Detected
2-Chloronaphthalene	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
2-Chlorophenol	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
2-Methylnaphthalene	µg/kg	2/2	76	62	90	NB	Yes	Exceeds Detection Limit
2-Methylphenol (o-Cresol)	µg/kg	0/2	252.5	None	None	NB	No	Not Detected
2-Nitroaniline	µg/kg	0/2	252.5	None	None	NB	No	Not Detected
2-Nitrophenol	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
3,3'-Dichlorobenzidine	µg/kg	0/1	200	None	None	NB	No	Not Detected
3-Nitroaniline	µg/kg	0/2	252.5	None	None	NB	No	Not Detected
4,6-Dinitro-2-Methylphenol	µg/kg	0/2	190	None	None	NB	No	Not Detected
4-Bromophenyl phenyl ether	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
4-Chloro-3-Methylphenol	µg/kg	0/2	190	None	None	NB	No	Not Detected
4-Chloroaniline	µg/kg	0/2	190	None	None	NB	No	Not Detected
4-Chlorophenyl Phenyl Ether	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
4-Nitroaniline	µg/kg	0/2	252.5	None	None	NB	No	Not Detected
4-Nitrophenol	µg/kg	0/2	407.5	None	None	NB	No	Not Detected
Acenaphthene	µg/kg	0/2	8.45	None	None	NB	No	Not Detected
Acenaphthylene	µg/kg	1/2	10.05	6.6	6.6	NB	Yes	Exceeds Detection Limit

Table 5-2: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Surface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Anthracene	μg/kg	1/2	14.75	16	16	NB	Yes	Exceeds Detection Limit
Benzo(a)anthracene	μg/kg	2/2	54.5	52	57	NB	Yes	Exceeds Detection Limit
Benzo(a)pyrene	μg/kg	2/2	76	65	87	NB	Yes	Exceeds Detection Limit
Benzo(b)fluoranthene	μg/kg	2/2	115	110	120	NB	Yes	Exceeds Detection Limit
Benzo(g,h,i)perylene	μg/kg	2/2	38	29	47	NB	Yes	Exceeds Detection Limit
Benzo(k)fluoranthene	μg/kg	2/2	27.5	26	29	NB	Yes	Exceeds Detection Limit
Benzyl alcohol	μg/kg	0/2	407.5	None	None	NB	No	Not Detected
Benzyl butyl phthalate	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
bis(2-Chloroethoxy) Methane	μg/kg	0/2	125	None	None	NB	No	Not Detected
bis(2-Chloroethyl) Ether (2-Chloroethyl Ether)	μg/kg	0/2	125	None	None	NB	No	Not Detected
bis(2-Chloroisopropyl) Ether	μg/kg	0/2	125	None	None	NB	No	Not Detected
bis(2-Ethylhexyl) Phthalate	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Carbazole	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Chrysene	μg/kg	2/2	75.5	71	80	NB	Yes	Exceeds Detection Limit
Cresols, m & p	μg/kg	0/2	502.5	None	None	NB	No	Not Detected
Dibenz(a,h)anthracene	μg/kg	0/2	8.45	None	None	NB	No	Not Detected
Dibenzofuran	μg/kg	2/2	19	15	23	NB	Yes	Exceeds Detection Limit
Diethyl Phthalate	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Dimethyl Phthalate	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Di-n-Butyl Phthalate	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Di-n-Octylphthalate	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Fluoranthene	μg/kg	2/2	109.5	99	120	NB	Yes	Exceeds Detection Limit
Fluorene	μg/kg	1/2	11	8.5	8.5	NB	Yes	Exceeds Detection Limit
Hexachlorobenzene	μg/kg	0/2	8.45	None	None	NB	No	Not Detected
Hexachlorobutadiene	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Hexachlorocyclopentadiene	μg/kg	0/2	407.5	None	None	NB	No	Not Detected
Hexachloroethane	μg/kg	0/2	62.75	None	None	NB	No	Not Detected
Indeno(1,2,3-c,d)pyrene	μg/kg	2/2	50	46	54	NB	Yes	Exceeds Detection Limit
Isophorone	μg/kg	0/2	62.75	None	None	NB	No	Not Detected

Table 5-2: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Surface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Naphthalene	µg/kg	2/2	56	49	63	NB	Yes	Exceeds Detection Limit
Nitrobenzene	µg/kg	0/2	125	None	None	NB	No	Not Detected
n-Nitrosodi-n-propylamine	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
n-Nitrosodiphenylamine	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
Pentachlorophenol	µg/kg	0/2	190	None	None	NB	No	Not Detected
Phenanthrene	µg/kg	2/2	66	61	71	NB	Yes	Exceeds Detection Limit
Phenol	µg/kg	0/2	62.75	None	None	NB	No	Not Detected
Pyrene	µg/kg	2/2	83	78	88	NB	Yes	Exceeds Detection Limit
Explosives								
1,3,5-Trinitrobenzene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
1,3-Dinitrobenzene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
2,4,6-Trinitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
2-Amino-4,6-dinitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
2-Nitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
3-Nitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
4-Amino-2,6-Dinitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
4-Nitrotoluene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
Nitrobenzene	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
Nitroglycerin	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
Pentaerythritol Tetranitrate	mg/kg	0/2	0.13	None	None	NB	No	Not Detected
Tetryl	mg/kg	1/2	0.02	0.024	0.024	NB	Yes	Exceeds Detection Limit
Propellants								
Nitrocellulose	mg/kg	0/2	24	None	None	NB	No	Not Detected

Table 5-2: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Surface Soil (continued)

Notes:

a. Average result was calculated by using one-half of the reported limit of quantitation as a surrogate value for each non-detected chemical.

b. Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (United States Army Corps of Engineers 2001b).

Yellow shading indicates analyte is an SRC.

µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
N = No background.
SRC = Site-related chemical.

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Table 5-3: Summary of Site-Related Chemicals, Building U-16 Boiler House – Surface Soil

Chemical	Units	Results>Detection Level	Average Result(a)	Minimum Detection	Maximum Detection	Site Background Criteria(b)	SRC - Yes/No	Site Justification
Metals								
Aluminum	mg/kg	1/1	11,000	11,000	11,000	17,700	No	Less than Background
Antimony	mg/kg	1/1	0.35	0.35	0.35	0.96	No	Less than Background
Arsenic	mg/kg	1/1	14	14	14	15.4	No	Less than Background
Barium	mg/kg	1/1	57	57	57	88.4	No	Less than Background
Beryllium	mg/kg	1/1	0.52	0.52	0.52	0.88	No	Less than Background
Cadmium	mg/kg	1/1	0.18	0.18	0.18	0	Yes	Exceeds Background
Calcium	mg/kg	1/1	720	720	720	15,800	No	Less than Background
Chromium	mg/kg	1/1	14	14	14	17.4	No	Less than Background
Cobalt	mg/kg	1/1	11	11	11	10.4	Yes	Exceeds Background
Copper	mg/kg	1/1	19	19	19	17.7	Yes	Exceeds Background
Iron	mg/kg	1/1	24,000	24,000	24,000	23,100	No	Essential Nutrient
Lead	mg/kg	1/1	15	15	15	26.1	No	Less than Background
Magnesium	mg/kg	1/1	2,700	2,700	2,700	3,030	No	Less than Background
Manganese	mg/kg	1/1	340	340	340	1,450	No	Less than Background
Nickel	mg/kg	1/1	22	22	22	21.1	Yes	Exceeds Background
Potassium	mg/kg	1/1	990	990	990	927	No	Essential Nutrient
Selenium	mg/kg	1/1	0.36	0.36	0.36	1.4	No	Less than Background
Silver	mg/kg	1/1	0.029	0.029	0.029	0	Yes	Exceeds Background
Sodium	mg/kg	1/1	36	36	36	123	No	Less than Background
Thallium	mg/kg	1/1	0.16	0.16	0.16	0	Yes	Exceeds Background
Vanadium	mg/kg	1/1	18	18	18	31.1	No	Less than Background
Zinc	mg/kg	1/1	54	54	54	61.8	No	Less than Background
Mercury	mg/kg	1/1	0.027	0.027	0.027	0.036	No	Less than Background
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	µg/kg	0/1	255	None	None	NB	No	Not Detected
1,2-Dichlorobenzene	µg/kg	0/1	255	None	None	NB	No	Not Detected
1,3-Dichlorobenzene	µg/kg	0/1	255	None	None	NB	No	Not Detected
1,4-Dichlorobenzene	µg/kg	0/1	255	None	None	NB	No	Not Detected
2,4,5-Trichlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
2,4,6-Trichlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
2,4-Dichlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
2,4-Dimethylphenol	µg/kg	0/1	750	None	None	NB	No	Not Detected

Table 5-3: Summary of Site-Related Chemicals, Building U-16 Boiler House – Surface Soil (continued)

Chemical	Units	Results>Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
2,4-Dinitrophenol	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2-Chloronaphthalene	µg/kg	0/1	255	None	None	NB	No	Not Detected
2-Chlorophenol	µg/kg	0/1	255	None	None	NB	No	Not Detected
2-Methylnaphthalene	µg/kg	1/1	36	36	36	NB	Yes	Exceeds Detection Limit
2-Methylphenol (o-Cresol)	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2-Nitroaniline	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
2-Nitrophenol	µg/kg	0/1	255	None	None	NB	No	Not Detected
3,3'-Dichlorobenzidine	µg/kg	0/1	500	None	None	NB	No	Not Detected
3-Nitroaniline	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
4,6-Dinitro-2-Methylphenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
4-Bromophenyl phenyl ether	µg/kg	0/1	255	None	None	NB	No	Not Detected
4-Chloro-3-Methylphenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
4-Chloroaniline	µg/kg	0/1	750	None	None	NB	No	Not Detected
4-Chlorophenyl Phenyl Ether	µg/kg	0/1	255	None	None	NB	No	Not Detected
4-Nitroaniline	µg/kg	0/1	1,000	None	None	NB	No	Not Detected
4-Nitrophenol	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
Acenaphthene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Acenaphthylene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Anthracene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Benzo(a)anthracene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Benzo(a)pyrene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Benzo(b)fluoranthene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Benzo(g,h,i)perylene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Benzo(k)fluoranthene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Benzyl alcohol	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
Benzyl butyl phthalate	µg/kg	0/1	355	None	None	NB	No	Not Detected
bis(2-Chloroethoxy) Methane	µg/kg	0/1	500	None	None	NB	No	Not Detected
bis(2-Chloroethyl) Ether (2-Chloroethyl Ether)	µg/kg	0/1	500	None	None	NB	No	Not Detected
bis(2-Chloroisopropyl) Ether	µg/kg	0/1	500	None	None	NB	No	Not Detected
bis(2-Ethylhexyl) Phthalate	µg/kg	0/1	355	None	None	NB	No	Not Detected

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Table 5-3: Summary of Site-Related Chemicals, Building U-16 Boiler House – Surface Soil (continued)

Chemical	Units	Results>Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Carbazole	µg/kg	0/1	255	None	None	NB	No	Not Detected
Chrysene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Cresols, m & p	µg/kg	0/1	2,000	None	None	NB	No	Not Detected
Dibenz(a,h)anthracene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Dibenzofuran	µg/kg	0/1	255	None	None	NB	No	Not Detected
Diethyl Phthalate	µg/kg	0/1	355	None	None	NB	No	Not Detected
Dimethyl Phthalate	µg/kg	0/1	355	None	None	NB	No	Not Detected
Di-n-Butyl Phthalate	µg/kg	0/1	355	None	None	NB	No	Not Detected
Di-n-Octylphthalate	µg/kg	0/1	355	None	None	NB	No	Not Detected
Fluoranthene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Fluorene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Hexachlorobenzene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Hexachlorobutadiene	µg/kg	0/1	255	None	None	NB	No	Not Detected
Hexachlorocyclopentadiene	µg/kg	0/1	1,650	None	None	NB	No	Not Detected
Hexachloroethane	µg/kg	0/1	255	None	None	NB	No	Not Detected
Indeno(1,2,3-c,d)pyrene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Isophorone	µg/kg	0/1	255	None	None	NB	No	Not Detected
Naphthalene	µg/kg	1/1	34	34	34	NB	Yes	Exceeds Detection Limit
Nitrobenzene	µg/kg	0/1	500	None	None	NB	No	Not Detected
n-Nitrosodi-n-propylamine	µg/kg	0/1	255	None	None	NB	No	Not Detected
n-Nitrosodiphenylamine	µg/kg	0/1	255	None	None	NB	No	Not Detected
Pentachlorophenol	µg/kg	0/1	750	None	None	NB	No	Not Detected
Phenanthrene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Phenol	µg/kg	0/1	255	None	None	NB	No	Not Detected
Pyrene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected

Notes:
Yellow shading indicates analyte is an SRC.
a. Average result was calculated by using one-half of the reported limit of quantitation as a surrogate value for each non-detected chemical.
b. Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (United States Army Corps of Engineers 2001b).
µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
NB = No background.
SRC = Site-related chemical.

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Table 5-4: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Subsurface Soil

Chemical	Units	Results> Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
Metals								
Aluminum	mg/kg	9/9	7011	4700	8500	19,500	No	Less than Background
Antimony	mg/kg	2/9	0.089	0.045	0.047	0.96	No	Less than Background
Arsenic	mg/kg	9/9	6.6	4.1	8.3	19.8	No	Less than Background
Barium	mg/kg	9/9	71	24	120	124.0	No	Less than Background
Beryllium	mg/kg	9/9	0.57	0.25	0.97	0.88	Yes	Exceeds Background
Cadmium	mg/kg	9/9	0.20	0.088	0.26	0	Yes	Exceeds Background
Calcium	mg/kg	9/9	10989	2900	24000	35,500	No	Less than Background
Chromium	mg/kg	9/9	9	7.2	11	27.2	No	Less than Background
Cobalt	mg/kg	9/9	6.9	5.1	8.8	23.2	No	Less than Background
Copper	mg/kg	9/9	13	8.3	19	32.3	No	Less than Background
Iron	mg/kg	9/9	15444	10000	20000	35,200	No	Less than Background
Lead	mg/kg	9/9	10	8.1	13	19.1	No	Less than Background
Magnesium	mg/kg	9/9	3089	2300	3900	8,790	No	Less than Background
Manganese	mg/kg	9/9	669	170	1100	3,030	No	Less than Background
Nickel	mg/kg	9/9	15	11	21	60.7	No	Less than Background
Potassium	mg/kg	9/9	706	570	840	3,350	No	Less than Background
Selenium	mg/kg	9/9	0.58	0.46	0.72	1.5	No	Less than Background
Silver	mg/kg	9/9	0.033	0.021	0.041	0	Yes	Exceeds Background
Sodium	mg/kg	9/9	73	34	160	145	No	Essential Nutrient
Thallium	mg/kg	9/9	0.10	0.072	0.13	1	No	Less than Background
Vanadium	mg/kg	9/9	10	7.5	13	37.6	No	Less than Background
Zinc	mg/kg	9/9	39	28	53	93.3	No	Less than Background
Mercury	mg/kg	0/9	0.0534	None	None	0.0444	No	Not Detected
Organochlorine Pesticides								
Aldrin	µg/kg	0/1	10	None	None	NB	No	Not Detected
alpha-BHC (alpha-Hexachlorocyclohexane)	µg/kg	0/1	6	None	None	NB	No	Not Detected
alpha-Chlordane	µg/kg	0/1	7.5	None	None	NB	No	Not Detected
alpha-Endosulfan	µg/kg	0/1	4.2	None	None	NB	No	Not Detected
beta-BHC (beta-Hexachlorocyclohexane)	µg/kg	0/1	8.5	None	None	NB	No	Not Detected
beta-Endosulfan	µg/kg	0/1	6	None	None	NB	No	Not Detected

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Table 5-4: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
delta-BHC (delta-Hexachlorocyclohexane)	µg/kg	0/1	10	None	None	NB	No	Not Detected
Dieldrin	µg/kg	0/1	4.2	None	None	NB	No	Not Detected
Endosulfan Sulfate	µg/kg	0/1	7.5	None	None	NB	No	Not Detected
Endrin	µg/kg	0/1	4.2	None	None	NB	No	Not Detected
Endrin Aldehyde	µg/kg	0/1	7.5	None	None	NB	No	Not Detected
Endrin Ketone	µg/kg	0/1	4.95	None	None	NB	No	Not Detected
gamma-BHC (Lindane)	µg/kg	0/1	6	None	None	NB	No	Not Detected
gamma-Chlordane	µg/kg	0/1	4.2	None	None	NB	No	Not Detected
Heptachlor	µg/kg	0/1	8.5	None	None	NB	No	Not Detected
Heptachlor Epoxide	µg/kg	0/1	6	None	None	NB	No	Not Detected
Methoxychlor	µg/kg	0/1	12.5	None	None	NB	No	Not Detected
p,p'-Dichlorodiphenyldichloroethane	µg/kg	0/1	4.95	None	None	NB	No	Not Detected
p,p'-Dichlrodiphenyldichloroethylene	µg/kg	0/1	4.2	None	None	NB	No	Not Detected
p,p'-Dichlorodiphenyltrichloroethane	µg/kg	0/1	4.95	None	None	NB	No	Not Detected
Toxaphene	µg/kg	0/1	165	None	None	NB	No	Not Detected
Polychlorinated Biphenyls								
PCB-1016 (Arochlor 1016)	µg/kg	0/1	32	None	None	NB	No	Not Detected
PCB-1221 (Arochlor 1221)	µg/kg	0/1	25	None	None	NB	No	Not Detected
PCB-1232 (Arochlor 1232)	µg/kg	0/1	22.5	None	None	NB	No	Not Detected
PCB-1242 (Arochlor 1242)	µg/kg	0/1	20	None	None	NB	No	Not Detected
PCB-1248 (Arochlor 1248)	µg/kg	0/1	27	None	None	NB	No	Not Detected
PCB-1254 (Arochlor 1254)	µg/kg	0/1	27	None	None	NB	No	Not Detected
PCB-1260 (Arochlor 1260)	µg/kg	0/1	27	None	None	NB	No	Not Detected
Volatile Organic Compounds								
1,1,1-Trichloroethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
1,1,2,2-Tetrachloroethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
1,1,2-Trichloroethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
1,1-Dichloroethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
1,1-Dichloroethene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
1,2-Dibromoethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected

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Table 5-4: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
1,2-Dichloroethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
1,2-Dichloroethene	µg/kg	0/1	4.6	None	None	NB	No	Not Detected
1,2-Dichloropropane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
2-Butanone	µg/kg	0/1	9	None	None	NB	No	Not Detected
2-Hexanone	µg/kg	0/1	9	None	None	NB	No	Not Detected
4-Methyl-2-pentanone	µg/kg	0/1	9	None	None	NB	No	Not Detected
Acetone	µg/kg	0/1	9	None	None	NB	No	Not Detected
Benzene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Bromochloromethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Bromodichloromethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Bromoform	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Bromomethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Carbon Disulfide	µg/kg	1/1	2.9	2.9	2.9	NB	Yes	Exceeds Detection Limit
Carbon Tetrachloride	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Chlorobenzene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Chloroethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Chloroform	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Chloromethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
cis-1,3-Dichloropropene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Dibromochloromethane	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Ethylbenzene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Methylene Chloride	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Styrene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Tetrachloroethene (PCE)	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Toluene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
trans-1,3-Dichloropropene	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Trichloroethene (TCE)	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Vinyl Chloride	µg/kg	0/1	2.3	None	None	NB	No	Not Detected
Xylenes, Total	µg/kg	0/1	4.6	None	None	NB	No	Not Detected
1,2,4-Trichlorobenzene	µg/kg	0/9	98	None	None	NB	No	Not Detected

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Table 5-4: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Semivolatile Organic Compounds								
1,2-Dichlorobenzene	µg/kg	0/9	98	None	None	NB	No	Not Detected
1,3-Dichlorobenzene	µg/kg	0/9	98	None	None	NB	No	Not Detected
1,4-Dichlorobenzene	µg/kg	2/9	97	21	22	NB	Yes	Exceeds Detection Limit
2,4,5-Trichlorophenol	µg/kg	0/9	293	None	None	NB	No	Not Detected
2,4,6-Trichlorophenol	µg/kg	0/9	293	None	None	NB	No	Not Detected
2,4-Dichlorophenol	µg/kg	0/9	293	None	None	NB	No	Not Detected
2,4-Dimethylphenol	µg/kg	0/9	293	None	None	NB	No	Not Detected
2,4-Dinitrophenol	µg/kg	0/9	645	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	µg/kg	0/9	391	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	µg/kg	0/9	391	None	None	NB	No	Not Detected
2-Chloronaphthalene	µg/kg	0/9	98	None	None	NB	No	Not Detected
2-Chlorophenol	µg/kg	0/9	98	None	None	NB	No	Not Detected
2-Methylnaphthalene	µg/kg	9/9	50	12	140	NB	Yes	Exceeds Detection Limit
2-Methylphenol (o-Cresol)	µg/kg	0/9	391	None	None	NB	No	Not Detected
2-Nitroaniline	µg/kg	0/9	391	None	None	NB	No	Not Detected
2-Nitrophenol	µg/kg	0/9	98	None	None	NB	No	Not Detected
3,3'-Dichlorobenzidine	µg/kg	1/9	141	1,000	1,000	NB	No	Weight of Evidence
3-Nitroaniline	µg/kg	0/9	391	None	None	NB	No	Not Detected
4,6-Dinitro-2-Methylphenol	µg/kg	0/9	293	None	None	NB	No	Not Detected
4-Bromophenyl phenyl ether	µg/kg	0/9	98	None	None	NB	No	Not Detected
4-Chloro-3-Methylphenol	µg/kg	0/9	293	None	None	NB	No	Not Detected
4-Chloroaniline	µg/kg	0/9	293	None	None	NB	No	Not Detected
4-Chlorophenyl Phenyl Ether	µg/kg	0/9	98	None	None	NB	No	Not Detected
4-Nitroaniline	µg/kg	0/9	391	None	None	NB	No	Not Detected
4-Nitrophenol	µg/kg	1/9	462	3,300	3,300	NB	No	Weight of Evidence
Acenaphthene	µg/kg	0/9	13	None	None	NB	No	Not Detected
Acenaphthylene	µg/kg	0/9	13	None	None	NB	No	Not Detected
Anthracene	µg/kg	0/9	13	None	None	NB	No	Not Detected
Benzo(a)anthracene	µg/kg	2/9	18	27	48	NB	Yes	Exceeds Detection Limit
Benzo(a)pyrene	µg/kg	3/9	19	4.9	49	NB	Yes	Exceeds Detection Limit
Benzo(b)fluoranthene	µg/kg	7/9	32	4.9	110	NB	Yes	Exceeds Detection Limit

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Table 5-4: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Benzo(g,h,i)perylene	µg/kg	6/9	22	4.7	41	NB	Yes	Exceeds Detection Limit
Benzo(k)fluoranthene	µg/kg	2/9	15	20	30	NB	Yes	Exceeds Detection Limit
Benzyl alcohol	µg/kg	0/9	645	None	None	NB	No	Not Detected
Benzyl butyl phthalate	µg/kg	0/9	98	None	None	NB	No	Not Detected
bis(2-Chloroethoxy) Methane	µg/kg	0/9	196	None	None	NB	No	Not Detected
bis(2-Chloroethyl) Ether (2-Chloroethyl Ether)	µg/kg	0/9	196	None	None	NB	No	Not Detected
bis(2-Chloroisopropyl) Ether	µg/kg	0/9	196	None	None	NB	No	Not Detected
bis(2-Ethylhexyl) Phthalate	µg/kg	5/9	112	31	74	NB	No	Weight of Evidence
Carbazole	µg/kg	0/9	98	None	None	NB	No	Not Detected
Chrysene	µg/kg	4/9	27	5.1	88	NB	Yes	Exceeds Detection Limit
Cresols, m & p	µg/kg	0/9	782	None	None	NB	No	Not Detected
Dibenz(a,h)anthracene	µg/kg	0/9	13	None	None	NB	No	Not Detected
Dibenzofuran	µg/kg	7/9	64	3.5	22	NB	Yes	Exceeds Detection Limit
Diethyl Phthalate	µg/kg	1/9	97	16	16	NB	No	Exceeds Detection Limit
Dimethyl Phthalate	µg/kg	0/9	98	None	None	NB	No	Not Detected
Di-n-Butyl Phthalate	µg/kg	1/9	97	18	18	NB	No	Weight of Evidence
Di-n-Octylphthalate	µg/kg	0/9	98	None	None	NB	No	Not Detected
Fluoranthene	µg/kg	8/9	36	4.2	98	NB	Yes	Exceeds Detection Limit
Fluorene	µg/kg	1/9	13.5	7.3	7.3	NB	Yes	Exceeds Detection Limit
Hexachlorobenzene	µg/kg	0/9	13	None	None	NB	No	Not Detected
Hexachlorobutadiene	µg/kg	0/9	98	None	None	NB	No	Not Detected
Hexachlorocyclopentadiene	µg/kg	0/9	645	None	None	NB	No	Not Detected
Hexachloroethane	µg/kg	0/9	98	None	None	NB	No	Not Detected
Indeno(1,2,3-c,d)pyrene	µg/kg	3/9	16	8.2	33	NB	Yes	Exceeds Detection Limit
Isophorone	µg/kg	1/9	98	31	31	NB	Yes	Exceeds Detection Limit
Naphthalene	µg/kg	7/9	26	5.4	55	NB	Yes	Exceeds Detection Limit
Nitrobenzene	µg/kg	0/9	196	None	None	NB	No	Not Detected
n-Nitrosodi-n-propylamine	µg/kg	0/9	98	None	None	NB	No	Not Detected
n-Nitrosodiphenylamine	µg/kg	0/9	98	None	None	NB	No	Not Detected
Pentachlorophenol	µg/kg	0/9	293	None	None	NB	No	Not Detected

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Table 5-4: Summary of Site-Related Chemicals, North Line Road Coal Tipple – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
Phenanthrene	µg/kg	7/9	44	8.3	180	NB	Yes	Exceeds Detection Limit
Phenol	µg/kg	0/9	98	None	None	NB	No	Not Detected
Pyrene	µg/kg	8/9	33	4.3	80	NB	Yes	Exceeds Detection Limit
Explosives								
1,3,5-Trinitrobenzene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
1,3-Dinitrobenzene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
2,4,6-Trinitrotoluene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	mg/kg	1/1	0.01	0.01	0.01	NB	Yes	Exceeds Detection Limit
2,6-Dinitrotoluene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
2-Amino-4,6-dinitrotoluene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
2-Nitrotoluene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
3-Nitrotoluene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
4-Amino-2,6-Dinitrotoluene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
4-Nitrotoluene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
Nitrobenzene	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
Nitroglycerin	mg/kg	0/1	0.25	None	None	NB	No	Not Detected
Nitroguanidine	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	mg/kg	0/1	0.13	None	None	NB	No	Not Detected
Pentaerythritol Tetranitrate	mg/kg	0/1	0.25	None	None	NB	No	Not Detected
Tetryl	mg/kg	1/1	0.01	0.01	0.01	NB	Yes	Exceeds Detection Limit
Propellants								
Nitrocellulose	mg/kg	1/1	0.87	0.87	0.87	NB	Yes	Exceeds Detection Limit

Notes:
Yellow shading indicates analyte is an SRC.
a. Average result was calculated by using one-half of the reported limit of quantitation as a surrogate value for each non-detected chemical.
b. Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (United States Army Corps of Engineers 2001b).
µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
NB = No background.
SRC = Site-related chemical.

Table 5-5: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Subsurface Soil

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Metals								
Aluminum	mg/kg	9/9	5089	3900	6200	19,500	No	Less than Background
Antimony	mg/kg	1/9	0.094	0.047	0.047	0.96	No	Less than Background
Arsenic	mg/kg	9/9	7	4.4	12	19.8	No	Less than Background
Barium	mg/kg	9/9	41	25	56	124	No	Less than Background
Beryllium	mg/kg	9/9	0.33	0.25	0.38	0.9	No	Less than Background
Cadmium	mg/kg	9/9	0.2	0.093	0.2	0	Yes	Exceeds Background
Calcium	mg/kg	9/9	2389	1100	5500	35,500	No	Essential Nutrient
Chromium	mg/kg	9/9	8	6.7	11	27	No	Less than Background
Cobalt	mg/kg	9/9	6.0	4.8	8.6	23	No	Less than Background
Copper	mg/kg	9/9	10	7.3	14	32.3	No	Less than Background
Iron	mg/kg	9/9	12944	9500	17000	35,200	No	Essential Nutrient
Lead	mg/kg	9/9	9	6.3	16	19.1	No	Less than Background
Magnesium	mg/kg	9/9	1767	1200	3000	8,790	No	Less than Background
Manganese	mg/kg	9/9	262	120	400	3,030	No	Less than Background
Nickel	mg/kg	9/9	14	11	20	61	No	Less than Background
Potassium	mg/kg	9/9	619	420	1100	3,030	No	Less than Background
Selenium	mg/kg	9/9	0.25	0.16	0.33	1.5	No	Less than Background
Silver	mg/kg	9/9	0.12	0.016	0.38	0	Yes	Exceeds Background
Sodium	mg/kg	9/9	38	27	69	145	No	Essential Nutrient
Thallium	mg/kg	9/9	0.079	0.059	0.099	1	No	Less than Background
Vanadium	mg/kg	9/9	9	7.4	10	37.6	No	Less than Background
Zinc	mg/kg	9/9	36	29	43	93.3	No	Less than Background
Mercury	mg/kg	8/9	0.029	0.015	0.03	0.044	No	Less than Background
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	µg/kg	0/9	25	None	None	NB	No	Not Detected
1,2-Dichlorobenzene	µg/kg	0/9	25	None	None	NB	No	Not Detected
1,3-Dichlorobenzene	µg/kg	0/9	25	None	None	NB	No	Not Detected
1,4-Dichlorobenzene	µg/kg	7/9	25	20	35	NB	Yes	Exceeds Detection Limit
2,4,5-Trichlorophenol	µg/kg	0/9	76	None	None	NB	No	Not Detected
2,4,6-Trichlorophenol	µg/kg	0/9	76	None	None	NB	No	Not Detected
2,4-Dichlorophenol	µg/kg	0/9	76	None	None	NB	No	Not Detected

Table 5-5: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
2,4-Dimethylphenol	µg/kg	0/9	76	None	None	NB	No	Not Detected
2,4-Dinitrophenol	µg/kg	0/9	168	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	µg/kg	0/9	102	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	µg/kg	0/9	102	None	None	NB	No	Not Detected
2-Chloronaphthalene	µg/kg	0/9	25	None	None	NB	No	Not Detected
2-Chlorophenol	µg/kg	0/9	25	None	None	NB	No	Not Detected
2-Methylnaphthalene	µg/kg	8/9	25	12	60	NB	Yes	Exceeds Detection Limit
2-Methylphenol (o-Cresol)	µg/kg	0/9	102	None	None	NB	No	Not Detected
2-Nitroaniline	µg/kg	0/9	102	None	None	NB	No	Not Detected
2-Nitrophenol	µg/kg	0/9	25	None	None	NB	No	Not Detected
3,3'-Dichlorobenzidine	µg/kg	0/9	50	None	None	NB	No	Not Detected
3-Nitroaniline	µg/kg	0/9	102	None	None	NB	No	Not Detected
4,6-Dinitro-2-Methylphenol	µg/kg	0/9	76	None	None	NB	No	Not Detected
4-Bromophenyl phenyl ether	µg/kg	0/9	25	None	None	NB	No	Not Detected
4-Chloro-3-Methylphenol	µg/kg	0/9	76	None	None	NB	No	Not Detected
4-Chloroaniline	µg/kg	0/9	76	None	None	NB	No	Not Detected
4-Chlorophenyl Phenyl Ether	µg/kg	0/9	25	None	None	NB	No	Not Detected
4-Nitroaniline	µg/kg	0/9	102	None	None	NB	No	Not Detected
4-Nitrophenol	µg/kg	0/9	168	None	None	NB	No	Not Detected
Acenaphthene	µg/kg	0/9	3	None	None	NB	No	Not Detected
Acenaphthylene	µg/kg	4/9	4.4	3.3	9.4	NB	Yes	Exceeds Detection Limit
Anthracene	µg/kg	3/9	7	4.5	25	NB	Yes	Exceeds Detection Limit
Benzo(a)anthracene	µg/kg	7/9	24	7.2	77	NB	Yes	Exceeds Detection Limit
Benzo(a)pyrene	µg/kg	6/9	20	7	62	NB	Yes	Exceeds Detection Limit
Benzo(b)fluoranthene	µg/kg	7/9	32	7.7	110	NB	Yes	Exceeds Detection Limit
Benzo(g,h,i)perylene	µg/kg	7/9	14	5.4	38	NB	Yes	Exceeds Detection Limit
Benzo(k)fluoranthene	µg/kg	6/9	11	4.5	31	NB	Yes	Exceeds Detection Limit
Benzyl alcohol	µg/kg	4/9	123	34	130	NB	Yes	Exceeds Detection Limit
Benzyl butyl phthalate	µg/kg	0/9	28	None	None	NB	No	Not Detected
bis(2-Chloroethoxy) Methane	µg/kg	0/9	50	None	None	NB	No	Not Detected

Table 5-5: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
bis(2-Chloroethyl) Ether (2-Chloroethyl Ether)	µg/kg	0/9	50	None	None	NB	No	Not Detected
bis(2-Chloroisopropyl) Ether	µg/kg	0/9	50	None	None	NB	No	Not Detected
bis(2-Ethylhexyl) Phthalate	µg/kg	0/9	35	None	None	NB	No	Not Detected
Carbazole	µg/kg	0/9	25	None	None	NB	No	Not Detected
Chrysene	µg/kg	7/9	26	6.1	77	NB	Yes	Exceeds Detection Limit
Cresols, m & p	µg/kg	0/9	203	None	None	NB	No	Not Detected
Dibenz(a,h)anthracene	µg/kg	0/9	3	None	None	NB	No	Not Detected
Dibenzofuran	µg/kg	7/9	13	5	14	NB	Yes	Exceeds Detection Limit
Diethyl Phthalate	µg/kg	0/9	28	None	None	NB	No	Not Detected
Dimethyl Phthalate	µg/kg	0/9	28	None	None	NB	No	Not Detected
Di-n-Butyl Phthalate	µg/kg	0/9	28	None	None	NB	No	Not Detected
Di-n-Octylphthalate	µg/kg	0/9	28	None	None	NB	No	Not Detected
Fluoranthene	µg/kg	7/9	44	8.7	150	NB	Yes	Exceeds Detection Limit
Fluorene	µg/kg	5/9	4.9	4.4	9.6	NB	Yes	Exceeds Detection Limit
Hexachlorobenzene	µg/kg	0/9	3	None	None	NB	No	Not Detected
Hexachlorobutadiene	µg/kg	0/9	25	None	None	NB	No	Not Detected
Hexachlorocyclopentadiene	µg/kg	0/9	168	None	None	NB	No	Not Detected
Hexachloroethane	µg/kg	0/9	25	None	None	NB	No	Not Detected
Indeno(1,2,3-c,d)pyrene	µg/kg	6/9	12	6.2	33	NB	Yes	Exceeds Detection Limit
Isophorone	µg/kg	6/9	20	13	23	NB	Yes	Exceeds Detection Limit
Naphthalene	µg/kg	8/9	23	12	51	NB	Yes	Exceeds Detection Limit
Nitrobenzene	µg/kg	0/9	50	None	None	NB	No	Not Detected
n-Nitrosodi-n-propylamine	µg/kg	0/9	25	None	None	NB	No	Not Detected
n-Nitrosodiphenylamine	µg/kg	0/9	25	None	None	NB	No	Not Detected
Pentachlorophenol	µg/kg	0/9	76	None	None	NB	No	Not Detected
Phenanthrene	µg/kg	8/9	30	7.7	87	NB	Yes	Exceeds Detection Limit
Phenol	µg/kg	0/9	25	None	None	NB	No	Not Detected
Pyrene	µg/kg	8/9	36	3.9	120	NB	Yes	Exceeds Detection Limit

Table 5-5: Summary of Site-Related Chemicals, Sand Creek Coal Tipple – Subsurface Soil (continued)

Notes:
Yellow shading indicates analyte is an SRC.
a. Average result was calculated by using one-half of the reported limit of quantitation as a surrogate value for each non-detected chemical.
b. Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (United States Army Corps of Engineers 2001b).
µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
NB = No background.
SRC = Site-related chemical.

Table 5-6: Summary of Site-Related Chemicals, Building U-16 Boiler House – Subsurface Soil

Chemical	Units	Results> Detection Level	Average Result[a]	Minimum Detection	Maximum Detection	Site Background Criteria[b]	SRC - Yes/No	Site Justification
Metals								
Aluminum	mg/kg	9/9	6,467	3,700	10,000	19,500	No	Less than Background
Antimony	mg/kg	9/9	0.08	0.044	0.24	0.96	No	Less than Background
Arsenic	mg/kg	9/9	13	7.7	19	19.8	No	Less than Background
Barium	mg/kg	9/9	31	20	41	124	No	Less than Background
Beryllium	mg/kg	9/9	0.37	0.27	0.52	0.9	No	Less than Background
Cadmium	mg/kg	9/9	0.17	0.12	0.26	0	Yes	Exceeds Background
Calcium	mg/kg	9/9	3,380	640	9,400	35,500	No	Essential Nutrient
Chromium	mg/kg	9/9	10	6.1	15	27	No	Less than Background
Cobalt	mg/kg	9/9	9	6.4	12	23	No	Less than Background
Copper	mg/kg	9/9	17	14	20	32.3	No	Less than Background
Iron	mg/kg	9/9	21,444	17,000	27,000	35,200	No	Essential Nutrient
Lead	mg/kg	9/9	13	11	17	19.1	No	Less than Background
Magnesium	mg/kg	9/9	2,933	2,100	5,500	8,790	No	Less than Background
Manganese	mg/kg	9/9	394	300	490	3,030	No	Less than Background
Nickel	mg/kg	9/9	20	14	28	61	No	Less than Background
Potassium	mg/kg	9/9	910	660	1,400	3,030	No	Less than Background
Selenium	mg/kg	4/9	0.25	0.19	0.28	1.5	No	Less than Background
Silver	mg/kg	9/9	0.02	0.017	0.03	0	Yes	Exceeds Background
Sodium	mg/kg	9/9	41	35	60	145	No	Essential Nutrient
Thallium	mg/kg	9/9	0.13	0.11	0.15	1	No	Less than Background
Vanadium	mg/kg	9/9	11	7	15	37.6	No	Less than Background
Zinc	mg/kg	9/9	60	51	80	93.3	No	Less than Background
Mercury	mg/kg	5/9	0.034	0.015	0.027	0.044	No	Less than Background
Organochlorine Pesticides								
Aldrin	µg/kg	0/1	2	None	None	NB	No	Not Detected
alpha-BHC (alpha-Hexachlorocyclohexane)	µg/kg	1/1	1.2	1.2	1.2	NB	Yes	Exceeds Detection Limit
alpha-Chlordane	µg/kg	0/1	1.5	None	None	NB	No	Not Detected
alpha-Endosulfan	µg/kg	0/1	0.85	None	None	NB	No	Not Detected
beta-BHC (beta-Hexachlorocyclohexane)	µg/kg	0/1	1.75	None	None	NB	No	Not Detected
beta-Endosulfan	µg/kg	0/1	1.25	None	None	NB	No	Not Detected

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Table 5-6: Summary of Site-Related Chemicals, Building U-16 Boiler House – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
delta-BHC (delta-Hexachlorocyclohexane)	µg/kg	0/1	2	None	None	NB	No	Not Detected
Dieldrin	µg/kg	0/1	0.85	None	None	NB	No	Not Detected
Endosulfan Sulfate	µg/kg	0/1	1.5	None	None	NB	No	Not Detected
Endrin	µg/kg	0/1	0.85	None	None	NB	No	Not Detected
Endrin Aldehyde	µg/kg	0/1	1.5	None	None	NB	No	Not Detected
Endrin Ketone	µg/kg	0/1	1	None	None	NB	No	Not Detected
gamma-BHC (Lindane)	µg/kg	0/1	1.25	None	None	NB	No	Not Detected
gamma-Chlordane	µg/kg	0/1	0.85	None	None	NB	No	Not Detected
Heptachlor	µg/kg	0/1	1.75	None	None	NB	No	Not Detected
Heptachlor Epoxide	µg/kg	0/1	1.25	None	None	NB	No	Not Detected
Methoxychlor	µg/kg	0/1	2.5	None	None	NB	No	Not Detected
p,p'-Dichlorodiphenyldichloroethane	µg/kg	0/1	1	None	None	NB	No	Not Detected
p,p'-Dichlrodiphenyldichloroethylene	µg/kg	1/1	0.66	0.66	0.66	NB	Yes	Exceeds Detection Limit
p,p'-Dichlorodiphenyltrichloroethane	µg/kg	0/1	1	None	None	NB	No	Not Detected
Toxaphene	µg/kg	0/1	33.5	None	None	NB	No	Not Detected
Polychlorinated Biphenyls								
PCB-1016 (Arochlor 1016)	µg/kg	0/1	32	None	None	NB	No	Not Detected
PCB-1221 (Arochlor 1221)	µg/kg	0/1	24.5	None	None	NB	No	Not Detected
PCB-1232 (Arochlor 1232)	µg/kg	0/1	22	None	None	NB	No	Not Detected
PCB-1242 (Arochlor 1242)	µg/kg	0/1	19.5	None	None	NB	No	Not Detected
PCB-1248 (Arochlor 1248)	µg/kg	0/1	27	None	None	NB	No	Not Detected
PCB-1254 (Arochlor 1254)	µg/kg	0/1	27	None	None	NB	No	Not Detected
PCB-1260 (Arochlor 1260)	µg/kg	0/1	27	None	None	NB	No	Not Detected
Volatile Organic Compounds								
1,1,1-Trichloroethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
1,1,2,2-Tetrachloroethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
1,1,2-Trichloroethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
1,1-Dichloroethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
1,1-Dichloroethene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected

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Table 5-6: Summary of Site-Related Chemicals, Building U-16 Boiler House – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
1,2-Dibromoethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
1,2-Dichloroethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
1,2-Dichloroethene	µg/kg	0/1	4.15	None	None	NB	No	Not Detected
1,2-Dichloropropane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
2-Butanone	µg/kg	0/1	8.5	None	None	NB	No	Not Detected
2-Hexanone	µg/kg	0/1	8.5	None	None	NB	No	Not Detected
4-Methyl-2-pentanone	µg/kg	0/1	8.5	None	None	NB	No	Not Detected
Acetone	µg/kg	0/1	8.5	None	None	NB	No	Not Detected
Benzene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Bromochloromethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Bromodichloromethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Bromoform	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Bromomethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Carbon Disulfide	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Carbon Tetrachloride	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Chlorobenzene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Chloroethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Chloroform	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Chloromethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
cis-1,3-Dichloropropene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Dibromochloromethane	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Ethylbenzene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Methylene Chloride	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Styrene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Tetrachloroethene (PCE)	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Toluene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
trans-1,3-Dichloropropene	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Trichloroethene (TCE)	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Vinyl Chloride	µg/kg	0/1	2.05	None	None	NB	No	Not Detected
Xylenes, Total	µg/kg	0/1	4.15	None	None	NB	No	Not Detected

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Table 5-6: Summary of Site-Related Chemicals, Building U-16 Boiler House – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result(a)	Minimum Detection	Maximum Detection	Site Background Criteria(b)	SRC - Yes/No	Site Justification
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	µg/kg	0/9	212	None	None	NB	No	Not Detected
1,2-Dichlorobenzene	µg/kg	0/9	212	None	None	NB	No	Not Detected
1,3-Dichlorobenzene	µg/kg	0/9	212	None	None	NB	No	Not Detected
1,4-Dichlorobenzene	µg/kg	0/9	212	None	None	NB	No	Not Detected
2,4,5-Trichlorophenol	µg/kg	0/9	634	None	None	NB	No	Not Detected
2,4,6-Trichlorophenol	µg/kg	0/9	634	None	None	NB	No	Not Detected
2,4-Dichlorophenol	µg/kg	0/9	634	None	None	NB	No	Not Detected
2,4-Dimethylphenol	µg/kg	0/9	634	None	None	NB	No	Not Detected
2,4-Dinitrophenol	µg/kg	0/9	1398	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	µg/kg	0/9	846	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	µg/kg	0/9	846	None	None	NB	No	Not Detected
2-Chloronaphthalene	µg/kg	0/9	212	None	None	NB	No	Not Detected
2-Chlorophenol	µg/kg	0/9	212	None	None	NB	No	Not Detected
2-Methylnaphthalene	µg/kg	0/9	28	None	None	NB	No	Not Detected
2-Methylphenol (o-Cresol)	µg/kg	0/9	846	None	None	NB	No	Not Detected
2-Nitroaniline	µg/kg	0/9	846	None	None	NB	No	Not Detected
2-Nitrophenol	µg/kg	0/9	212	None	None	NB	No	Not Detected
3,3'-Dichlorobenzidine	µg/kg	0/9	422	None	None	NB	No	Not Detected
3-Nitroaniline	µg/kg	0/9	846	None	None	NB	No	Not Detected
4,6-Dinitro-2-Methylphenol	µg/kg	0/9	634	None	None	NB	No	Not Detected
4-Bromophenyl phenyl ether	µg/kg	0/9	212	None	None	NB	No	Not Detected
4-Chloro-3-Methylphenol	µg/kg	0/9	634	None	None	NB	No	Not Detected
4-Chloroaniline	µg/kg	0/9	634	None	None	NB	No	Not Detected
4-Chlorophenyl Phenyl Ether	µg/kg	0/9	212	None	None	NB	No	Not Detected
4-Nitroaniline	µg/kg	0/9	846	None	None	NB	No	Not Detected
4-Nitrophenol	µg/kg	0/9	1,398	None	None	NB	No	Not Detected
Acenaphthene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Acenaphthylene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Anthracene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Benzo(a)anthracene	µg/kg	0/9	28	None	None	NB	No	Not Detected

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Table 5-6: Summary of Site-Related Chemicals, Building U-16 Boiler House – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Benzo(a)pyrene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Benzo(b)fluoranthene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Benzo(g,h,i)perylene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Benzo(k)fluoranthene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Benzyl alcohol	µg/kg	0/9	1,398	None	None	NB	No	Not Detected
Benzyl butyl phthalate	µg/kg	0/9	297	None	None	NB	No	Not Detected
bis(2-Chloroethoxy) Methane	µg/kg	0/9	422	None	None	NB	No	Not Detected
bis(2-Chloroethyl) Ether (2-Chloroethyl Ether)	µg/kg	0/9	422	None	None	NB	No	Not Detected
bis(2-Chloroisopropyl) Ether	µg/kg	0/9	422	None	None	NB	No	Not Detected
bis(2-Ethylhexyl) Phthalate	µg/kg	2/9	288	40	95	NB	No	Weight of Evidence
Carbazole	µg/kg	0/9	212	None	None	NB	No	Not Detected
Chrysene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Cresols, m & p	µg/kg	0/9	1,703	None	None	NB	No	Not Detected
Dibenz(a,h)anthracene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Dibenzofuran	µg/kg	0/9	212	None	None	NB	No	Not Detected
Diethyl Phthalate	µg/kg	0/9	297	None	None	NB	No	Not Detected
Dimethyl Phthalate	µg/kg	0/9	297	None	None	NB	No	Not Detected
Di-n-Butyl Phthalate	µg/kg	0/9	297	None	None	NB	No	Not Detected
Di-n-Octylphthalate	µg/kg	0/9	297	None	None	NB	No	Not Detected
Fluoranthene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Fluorene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Hexachlorobenzene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Hexachlorobutadiene	µg/kg	0/9	212	None	None	NB	No	Not Detected
Hexachlorocyclopentadiene	µg/kg	0/9	1,398	None	None	NB	No	Not Detected
Hexachloroethane	µg/kg	0/9	212	None	None	NB	No	Not Detected
Indeno(1,2,3-c,d)pyrene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Isophorone	µg/kg	0/9	212	None	None	NB	No	Not Detected
Naphthalene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Nitrobenzene	µg/kg	0/9	422	None	None	NB	No	Not Detected
n-Nitrosodi-n-propylamine	µg/kg	0/9	212	None	None	NB	No	Not Detected
n-Nitrosodiphenylamine	µg/kg	0/9	212	None	None	NB	No	Not Detected
Pentachlorophenol	µg/kg	0/9	634	None	None	NB	No	Not Detected

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Table 5-6: Summary of Site-Related Chemicals, Building U-16 Boiler House – Subsurface Soil (continued)

Chemical	Units	Results> Detection Level	Average Result[(a)]	Minimum Detection	Maximum Detection	Site Background Criteria[(b)]	SRC - Yes/No	Site Justification
Phenanthrene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Phenol	µg/kg	0/9	212	None	None	NB	No	Not Detected
Pyrene	µg/kg	0/9	28	None	None	NB	No	Not Detected
Explosives								
1,3,5-Trinitrobenzene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
1,3-Dinitrobenzene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
2,4,6-Trinitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
2,4-Dinitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
2,6-Dinitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
2-Amino-4,6-dinitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
2-Nitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
3-Nitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
4-Amino-2,6-Dinitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
4-Nitrotoluene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
Nitrobenzene	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
Nitroglycerin	mg/kg	0/1	0.25	None	None	NB	No	Not Detected
Nitroguandine	mg/kg	0/1	0.12	None	None	NB	No	Not Detected
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
Pentaerythritol Tetranitrate	mg/kg	0/1	0.25	None	None	NB	No	Not Detected
Tetryl	mg/kg	0/1	0.125	None	None	NB	No	Not Detected
Explosives								
Nitrocellulose	mg/kg	1/1	0.91	0.91	0.91	NB	Yes	Exceeds Detection Limit

Notes:
Yellow shading indicates analyte is an SRC.
a. Average result was calculated by using one-half of the reported limit of quantitation as a surrogate value for each non-detected chemical.
b. Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (United States Army Corps of Engineers 2001b).
µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
NB = No background.
SRC = Site-related chemical.

Table 5-7: Summary of Site-Related Chemicals in Media by Coal Storage Area

Chemical	Background Screening Value		Most Stringent Resident Receptor FWCUG (TR = 10-6, HQ = 0.1)		North Line Road Coal Tipple		Sand Creek Coal Tipple		Building U-16 Boiler House	
	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)
Metal										
Arsenic	15.4	19.8	0.425	0.425	**28**	<BSV	<BSV	<BSV	<BSV	<BSV
Barium	88.4	124	351	351	**160**	<BSV	<BSV	<BSV	<BSV	<BSV
Beryllium	0.88	0.88	16	16	**3.3**	**0.97**	<BSV	<BSV	<BSV	<BSV
Cadmium	0	0	6.41	6.41	**0.61**	**0.26**	**0.22**	**0.2**	**0.18**	**0.26**
Chromium (as Cr-III)	17.4[a]	27.2[a]	19.9[b]	19.9[b]	<BSV	<BSV	**19**	<BSV	<BSV	<BSV
Cobalt	10.4	23.2	131	131	<BSV	<BSV	<BSV	<BSV	**11**	<BSV
Copper	17.7	32.3	311	311	<BSV	<BSV	<BSV	<BSV	**19**	<BSV
Manganese	1,450	3,030	35.1	35.1	**1,900**	<BSV	<BSV	<BSV	<BSV	<BSV
Nickel	21.1	60.7	155	155	**24**	<BSV	**22**	<BSV	**22**	<BSV
Selenium	1.4	NA	39	39	**2.3**	<BSV	<BSV	<BSV	<BSV	<BSV
Silver	0	0	38.6	38.6	ND	**0.041**	**0.44**	**0.38**	**0.029**	**0.03**
Thallium	0	0.91	0.612	0.612	ND	<BSV	ND	<BSV	**0.16**	<BSV
Zinc	61.8	93.3	2,321	2,321	**99**	<BSV	**64**	<BSV	<BSV	<BSV
Organochlorine Pesticides										
4,4'-Dichlrodiphenyldichloroethylene	NB	NB	2.63	2.63	NR	ND	ND	NR	NR	**0.00066**
alpha-BHC	NB	NB	0.077	0.077	NR	ND	ND	NR	NR	**0.0012**
Volatile Organic Compounds										
Carbon Disulfide	NB	NB	82	82	NR	**0.0029**	**0.0013**	NR	NR	ND
Semivolatile Organic Compounds										
1,4-Dichlorobenzene	NB	NB	2.4	2.4	ND	**0.022**	ND	**0.035**	ND	ND
2-Methylnaphthalene	NB	NB	30.6	30.6	**9.1**	**0.14**	**0.09**	**0.06**	**0.036**	ND
Acenaphthene	NB	NB	340	340	**0.24**	ND	ND	ND	ND	ND
Acenaphthylene	NB	NB	1,700	1,700	**0.16**	ND	**0.0066**	**0.0094**	ND	ND
Anthracene	NB	NB	1,700	1,700	**0.3**	ND	**0.016**	**0.025**	ND	ND
Benzo(a)anthracene	NB	NB	0.221	0.221	**0.73**	**0.048**	**0.057**	**0.077**	ND	ND

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Table 5-7: Summary of Site-Related Compounds in Media by Coal Storage Area (continued)

SRC	Background Screening Value		Most Stringent Resident Receptor FWCUG (TR = 10-6, HQ = 0.1)		North Line Road Coal Tipple		Sand Creek Coal Tipple		Building U-16 Boiler House	
	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)
Benzo(a)pyrene	NB	NB	0.022	0.022	**0.57**	**0.049**	**0.087**	**0.062**	ND	ND
Benzo(b)fluoranthene	NB	NB	0.221	0.221	**0.67**	**0.11**	**0.12**	**0.11**	ND	ND
Benzo(g,h,i)perylene	NB	NB	122	122	**0.16**	**0.041**	**0.047**	**0.038**	ND	ND
Benzo(k)fluoranthene	NB	NB	2.21	2.21	**0.19**	**0.03**	**0.029**	**0.031**	ND	ND
Benzyl Alcohol	NB	NB	610	610	ND	ND	ND	**0.13**	ND	ND
Chrysene	NB	NB	22.1	22.1	**1**	**0.088**	**0.08**	**0.077**	ND	ND
Dibenzofuran	NB	NB	15.3	15.3	**2.5**	**0.022**	**0.023**	**0.014**	ND	ND
Fluoranthene	NB	NB	163	163	**0.86**	**0.098**	**0.12**	**0.15**	ND	ND
Fluorene	NB	NB	243	243	ND	**0.0073**	**0.0085**	**0.0096**	ND	ND
Indeno(1,2,3-c,d)Pyrene	NB	NB	0.221	0.221	**0.14**	**0.033**	**0.054**	**0.033**	ND	ND
Isophorone	NB	NB	510	510	ND	**0.031**	ND	**0.023**	ND	ND
Naphthalene	NB	NB	122	122	**4.6**	**0.055**	**0.063**	**0.051**	**0.034**	ND
Phenanthrene	NB	NB	1,700	1,700	**5.5**	**0.18**	**0.071**	**0.087**	ND	ND
Pyrene	NB	NB	122	122	**1**	**0.08**	**0.088**	**0.12**	ND	ND
Explosives										
Tetryl	NB	NB	12	12	NR	**0.01**	**0.024**	NR	NR	ND
2,4-Dinitrotoluene	NB	NB	0.753	0.753	NR	**0.01**	ND	NR	NR	ND
Propellants										
Nitrocellulose	NB	NB	18,000,000	18,000,000	NR	**0.87**	ND	NR	NR	**0.91**

Table 5-7: Summary of Site-Related Compounds in Media by Coal Storage Area (continued)

Notes:
Concentrations shown represent the maximum detected concentration for each coal storage area.
Yellow shading indicates concentration greater than most stringent Resident Receptor FWCUG at 1×10^{-6} and HQ of 0.1.
When FWCUG is not available, the Regional Screening Level for resident soil is used (April 2012). Anthracene was used as a surrogate for acenaphthalene and phenanthrene.
Pyrene used as a surrogate for benzo(g,h,i)perylene.
a. BSV for chromium as CR-VI is not available.
b. Most stringent FWCUG is for chromium as Cr-VI.
BSV = Background screening value.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
mg/kg = Milligrams per kilogram.
NB = No background screening value.
ND = Not detected.
NR = Not reported.
SRC = Site-related chemical.
TR = Target cancer risk.

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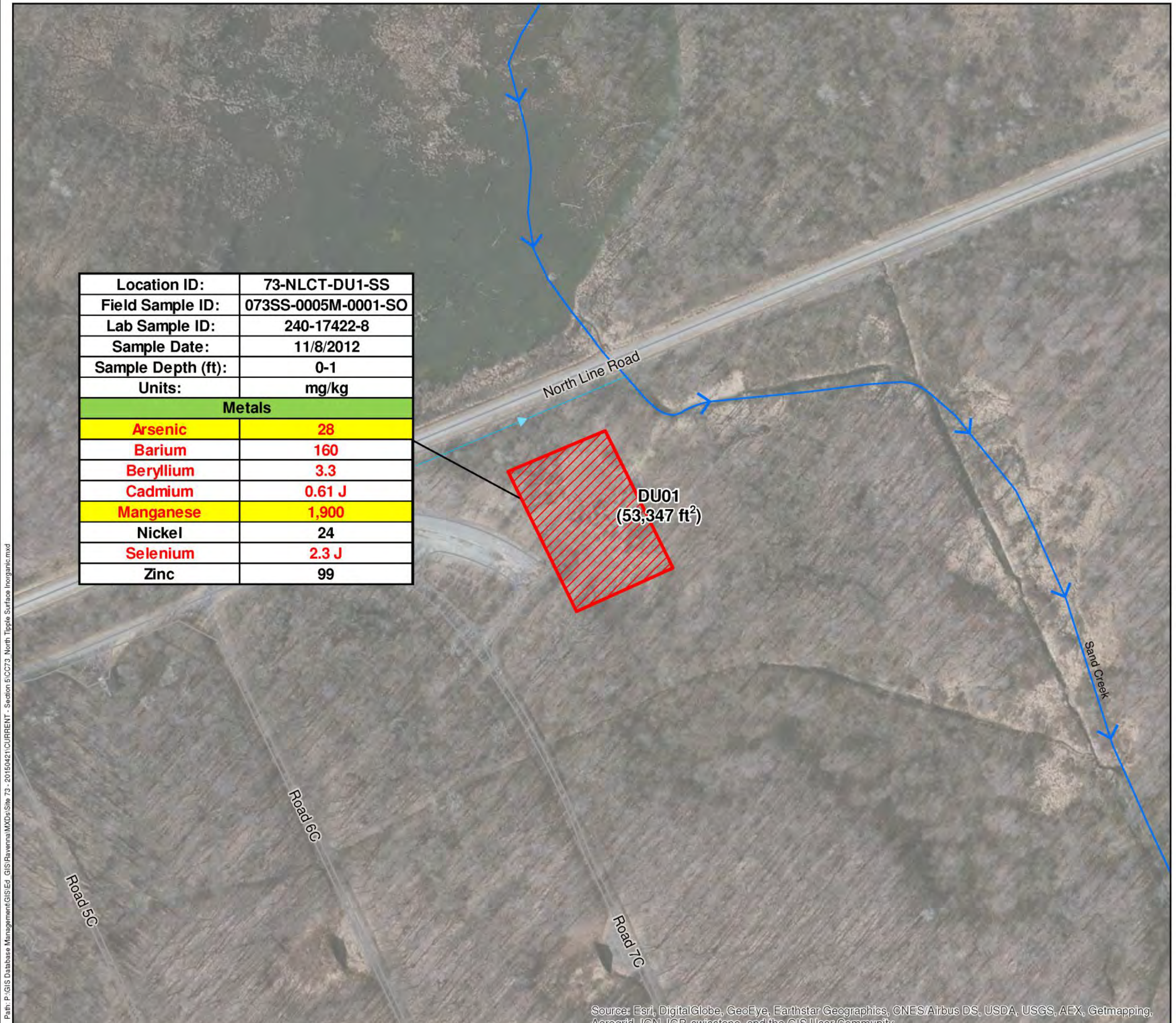

Location ID:	73-NLCT-DU1-SS
Field Sample ID:	073SS-0005M-0001-SO
Lab Sample ID:	240-17422-8
Sample Date:	11/8/2012
Sample Depth (ft):	0-1
Units:	mg/kg
Metals	
Arsenic	28
Barium	160
Beryllium	3.3
Cadmium	0.61 J
Manganese	1,900
Nickel	24
Selenium	2.3 J
Zinc	99

LEGEND

- Decision Unit
- Ditch and Flow Direction
- Creek and Flow Direction
- Road
- Analyte — SRC and Maximum Concentration Detected
- Analyte — SRC
- Analyte — SRC Concentration Exceeds Most Stringent FWCUG (HQ=0.1/Target Cancer Risk=10^{-6})

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft^2 = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg= milligrams per kilogram
6. J = estimated
7. ft = feet
8. FWCUG = Facility-Wide Cleanup Goal
9. HQ = Hazard quotient
10. DU = Decision Unit
11. ID = Identification
12. RVAAP = Ravenna Army Ammunition Plant
13. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Inorganic SRCs in Surface Soil at North Line Road Coal Tipple

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200
Feet

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE
5-1

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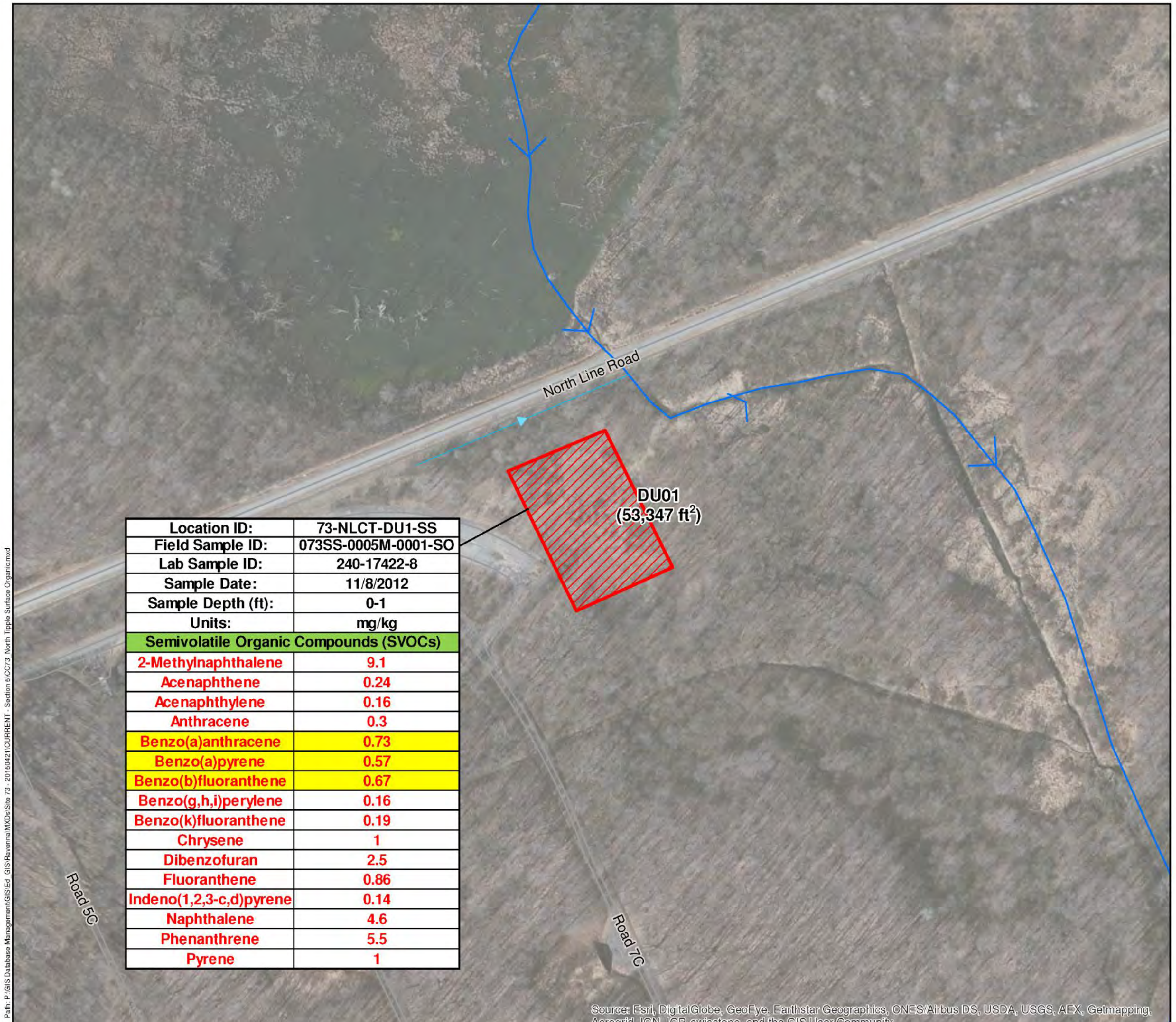

Location ID:	73-NLCT-DU1-SS
Field Sample ID:	073SS-0005M-0001-SO
Lab Sample ID:	240-17422-8
Sample Date:	11/8/2012
Sample Depth (ft):	0-1
Units:	mg/kg
Semivolatile Organic Compounds (SVOCs)	
2-Methylnaphthalene	9.1
Acenaphthene	0.24
Acenaphthylene	0.16
Anthracene	0.3
Benzo(a)anthracene	0.73
Benzo(a)pyrene	0.57
Benzo(b)fluoranthene	0.67
Benzo(g,h,i)perylene	0.16
Benzo(k)fluoranthene	0.19
Chrysene	1
Dibenzofuran	2.5
Fluoranthene	0.86
Indeno(1,2,3-c,d)pyrene	0.14
Naphthalene	4.6
Phenanthrene	5.5
Pyrene	1

LEGEND

- Decision Unit
- Ditch and Flow Direction
- Creek and Flow Direction
- Road
- Analyte: SRC and Maximum Concentration Detected
- Analyte: SRC Concentration Exceeds most stringent FWCUG (HQ=0.1/ Target Cancer Risk = 10^{-6})

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg = milligrams per kilogram
6. J = estimated
7. HQ= hazard quotient
8. ft = feet
9. DU = Decision Unit
10. ID = Identification
11. RVAAP = Ravenna Army Ammunition Plant
12. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Organic SRCs in Surface Soil at North Line Road Coal Tipple

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200 Feet

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE 5-2

3603

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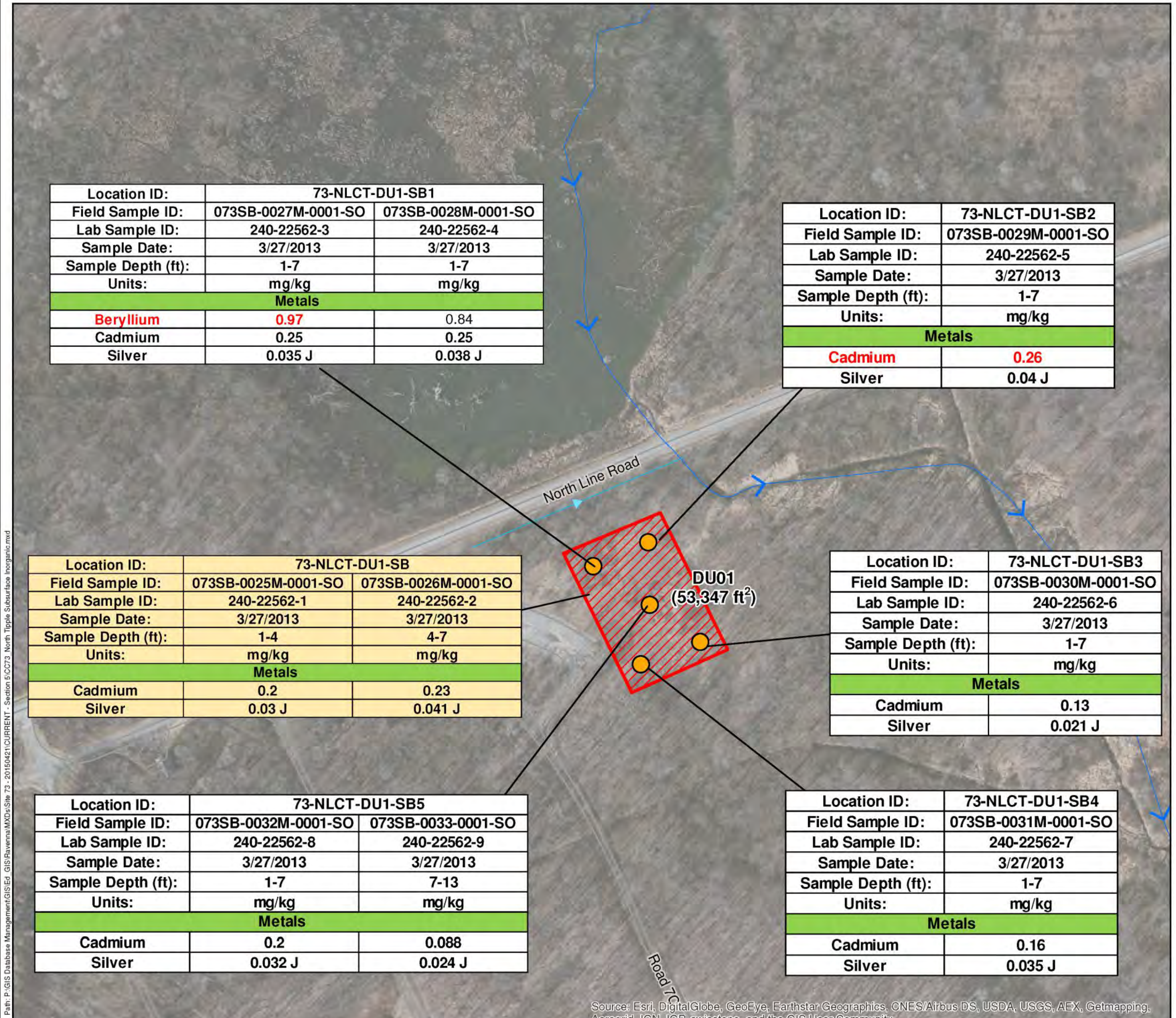

Location ID:	73-NLCT-DU1-SB1	
Field Sample ID:	073SB-0027M-0001-SO	073SB-0028M-0001-SO
Lab Sample ID:	240-22562-3	240-22562-4
Sample Date:	3/27/2013	3/27/2013
Sample Depth (ft):	1-7	1-7
Units:	mg/kg	mg/kg
Metals		
Beryllium	0.97	0.84
Cadmium	0.25	0.25
Silver	0.035 J	0.038 J

Location ID:	73-NLCT-DU1-SB2
Field Sample ID:	073SB-0029M-0001-SO
Lab Sample ID:	240-22562-5
Sample Date:	3/27/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.26
Silver	0.04 J

Location ID:	73-NLCT-DU1-SB	
Field Sample ID:	073SB-0025M-0001-SO	073SB-0026M-0001-SO
Lab Sample ID:	240-22562-1	240-22562-2
Sample Date:	3/27/2013	3/27/2013
Sample Depth (ft):	1-4	4-7
Units:	mg/kg	mg/kg
Metals		
Cadmium	0.2	0.23
Silver	0.03 J	0.041 J

Location ID:	73-NLCT-DU1-SB3
Field Sample ID:	073SB-0030M-0001-SO
Lab Sample ID:	240-22562-6
Sample Date:	3/27/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.13
Silver	0.021 J

Location ID:	73-NLCT-DU1-SB5	
Field Sample ID:	073SB-0032M-0001-SO	073SB-0033-0001-SO
Lab Sample ID:	240-22562-8	240-22562-9
Sample Date:	3/27/2013	3/27/2013
Sample Depth (ft):	1-7	7-13
Units:	mg/kg	mg/kg
Metals		
Cadmium	0.2	0.088
Silver	0.032 J	0.024 J

Location ID:	73-NLCT-DU1-SB4
Field Sample ID:	073SB-0031M-0001-SO
Lab Sample ID:	240-22562-7
Sample Date:	3/27/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.16
Silver	0.035 J

LEGEND

- Direct-Push Boring Location
- Decision Unit
- Ditch and Flow Direction
- Creek and Flow Direction
- Road
- Analyte — SRC and Maximum Concentration Detected
- Analyte — SRC
- ISM Horizontal Sample for Decision Unit
- 0.84 — Analyte is not an SRC in this sample

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft^2 = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg = milligrams per kilogram
6. J = estimated
7. ft = feet
8. DU = Decision Unit
9. ID = Identification
10. RVAAP = Ravenna Army Ammunition Plant
11. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Inorganic SRCs in Subsurface Soil at North Line Road Coal Tipple

CC RVAAP-73
Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200 Feet

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE
5-3

3615

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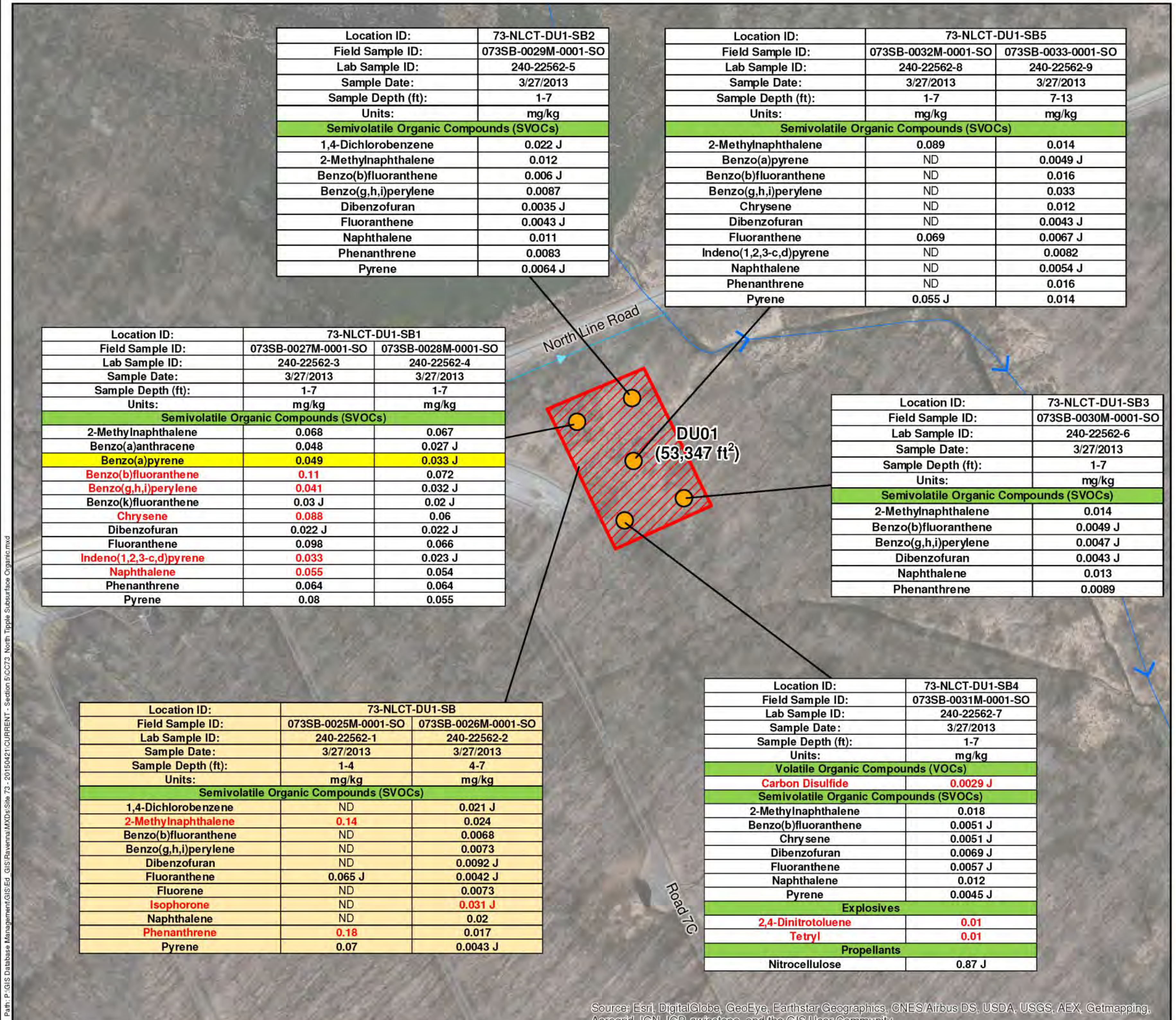

Location ID:	73-NLCT-DU1-SB2
Field Sample ID:	073SB-0029M-0001-SO
Lab Sample ID:	240-22562-5
Sample Date:	3/27/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Semivolatile Organic Compounds (SVOCs)	
1,4-Dichlorobenzene	0.022 J
2-Methylnaphthalene	0.012
Benzo(b)fluoranthene	0.006 J
Benzo(g,h,i)perylene	0.0087
Dibenzofuran	0.0035 J
Fluoranthene	0.0043 J
Naphthalene	0.011
Phenanthrene	0.0083
Pyrene	0.0064 J

Location ID:	73-NLCT-DU1-SB5	
Field Sample ID:	073SB-0032M-0001-SO	073SB-0033-0001-SO
Lab Sample ID:	240-22562-8	240-22562-9
Sample Date:	3/27/2013	3/27/2013
Sample Depth (ft):	1-7	7-13
Units:	mg/kg	mg/kg
Semivolatile Organic Compounds (SVOCs)		
2-Methylnaphthalene	0.089	0.014
Benzo(a)pyrene	ND	0.0049 J
Benzo(b)fluoranthene	ND	0.016
Benzo(g,h,i)perylene	ND	0.033
Chrysene	ND	0.012
Dibenzofuran	ND	0.0043 J
Fluoranthene	0.069	0.0067 J
Indeno(1,2,3-c,d)pyrene	ND	0.0082
Naphthalene	ND	0.0054 J
Phenanthrene	ND	0.016
Pyrene	0.055 J	0.014

Location ID:	73-NLCT-DU1-SB1	
Field Sample ID:	073SB-0027M-0001-SO	073SB-0028M-0001-SO
Lab Sample ID:	240-22562-3	240-22562-4
Sample Date:	3/27/2013	3/27/2013
Sample Depth (ft):	1-7	1-7
Units:	mg/kg	mg/kg
Semivolatile Organic Compounds (SVOCs)		
2-Methylnaphthalene	0.068	0.067
Benzo(a)anthracene	0.048	0.027 J
Benzo(a)pyrene	0.049	0.033 J
Benzo(b)fluoranthene	0.11	0.072
Benzo(g,h,i)perylene	0.041	0.032 J
Benzo(k)fluoranthene	0.03 J	0.02 J
Chrysene	0.088	0.06
Dibenzofuran	0.022 J	0.022 J
Fluoranthene	0.098	0.066
Indeno(1,2,3-c,d)pyrene	0.033	0.023 J
Naphthalene	0.055	0.054
Phenanthrene	0.064	0.064
Pyrene	0.08	0.055

Location ID:	73-NLCT-DU1-SB3
Field Sample ID:	073SB-0030M-0001-SO
Lab Sample ID:	240-22562-6
Sample Date:	3/27/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Semivolatile Organic Compounds (SVOCs)	
2-Methylnaphthalene	0.014
Benzo(b)fluoranthene	0.0049 J
Benzo(g,h,i)perylene	0.0047 J
Dibenzofuran	0.0043 J
Naphthalene	0.013
Phenanthrene	0.0089

Location ID:	73-NLCT-DU1-SB	
Field Sample ID:	073SB-0025M-0001-SO	073SB-0026M-0001-SO
Lab Sample ID:	240-22562-1	240-22562-2
Sample Date:	3/27/2013	3/27/2013
Sample Depth (ft):	1-4	4-7
Units:	mg/kg	mg/kg
Semivolatile Organic Compounds (SVOCs)		
1,4-Dichlorobenzene	ND	0.021 J
2-Methylnaphthalene	0.14	0.024
Benzo(b)fluoranthene	ND	0.0068
Benzo(g,h,i)perylene	ND	0.0073
Dibenzofuran	ND	0.0092 J
Fluoranthene	0.065 J	0.0042 J
Fluorene	ND	0.0073
Isophorone	ND	0.031 J
Naphthalene	ND	0.02
Phenanthrene	0.18	0.017
Pyrene	0.07	0.0043 J

Location ID:	73-NLCT-DU1-SB4
Field Sample ID:	073SB-0031M-0001-SO
Lab Sample ID:	240-22562-7
Sample Date:	3/27/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Volatile Organic Compounds (VOCs)	
Carbon Disulfide	0.0029 J
Semivolatile Organic Compounds (SVOCs)	
2-Methylnaphthalene	0.018
Benzo(b)fluoranthene	0.0051 J
Chrysene	0.0051 J
Dibenzofuran	0.0069 J
Fluoranthene	0.0057 J
Naphthalene	0.012
Pyrene	0.0045 J
Explosives	
2,4-Dinitrotoluene	0.01
Tetryl	0.01
Propellants	
Nitrocellulose	0.87 J

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LEGEND

- Direct-Push Boring Location
- Decision Unit
- Ditch and Flow Direction
- Creek and Flow Direction
- Road
- Analyte: SRC and Maximum Concentration Detected
- Analyte: SRC
- Analyte: SRC Concentration Exceeds most stringent FWCUG (HQ=0.1/ Target Cancer Risk = 10^{-6})
- ND: Analyte not detected and not an SRC at this depth
- ISM Horizontal Sample for Decision Unit

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft^2 = square feet
3. SRC = Site-Related Chemical
4. FWCUG = Facility-Wide Cleanup Goal
5. Concentrations shown are for SRCs at each sample location.
6. mg/kg = milligrams per kilogram
7. J = estimated
8. ND = Not Detected
9. HQ = hazard quotient
10. ft = feet
11. DU = Decision Unit
12. ID = Identification
13. RVAAP = Ravenna Army Ammunition Plant
14. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Organic SRCs in Subsurface Soil at North Line Road Coal Tipple

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200 Feet

N

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE
5-4

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Location ID:	73-SCCT-DU1-SS	
Field Sample ID:	073SS-0002M-0001-SO	073SS-0003M-0001-SO
Lab Sample ID:	240-17422-5	240-17422-6
Sample Date:	11/8/2012	11/8/2012
Sample Depth (ft):	0-1	0-1
Units:	mg/kg	mg/kg
Metals		
Cadmium	0.22	0.21
Chromium	19	17
Nickel	22	22
Silver	0.38	0.44
Zinc	64	64

LEGEND

Decision Unit

Road

Analyte SRC and Maximum Concentration Detected

Analyte SRC

Analyte SRC Concentration Exceeds Most Stringent FWCUG (HQ=0.1/Target Cancer Risk=10^{-6})

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg= milligrams per kilogram
6. J = estimated
7. ft = feet
8. FWCUG = Facility-Wide Cleanup Goal
9. HQ = Hazard Quotient
10. DU = Decision Unit
11. ID = Identification
12. RVAAP = Ravenna Army Ammunition Plant
13. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Inorganic SRCs in Surface Soil at Sand Creek Coal Tipple

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200 Feet

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE
5-5

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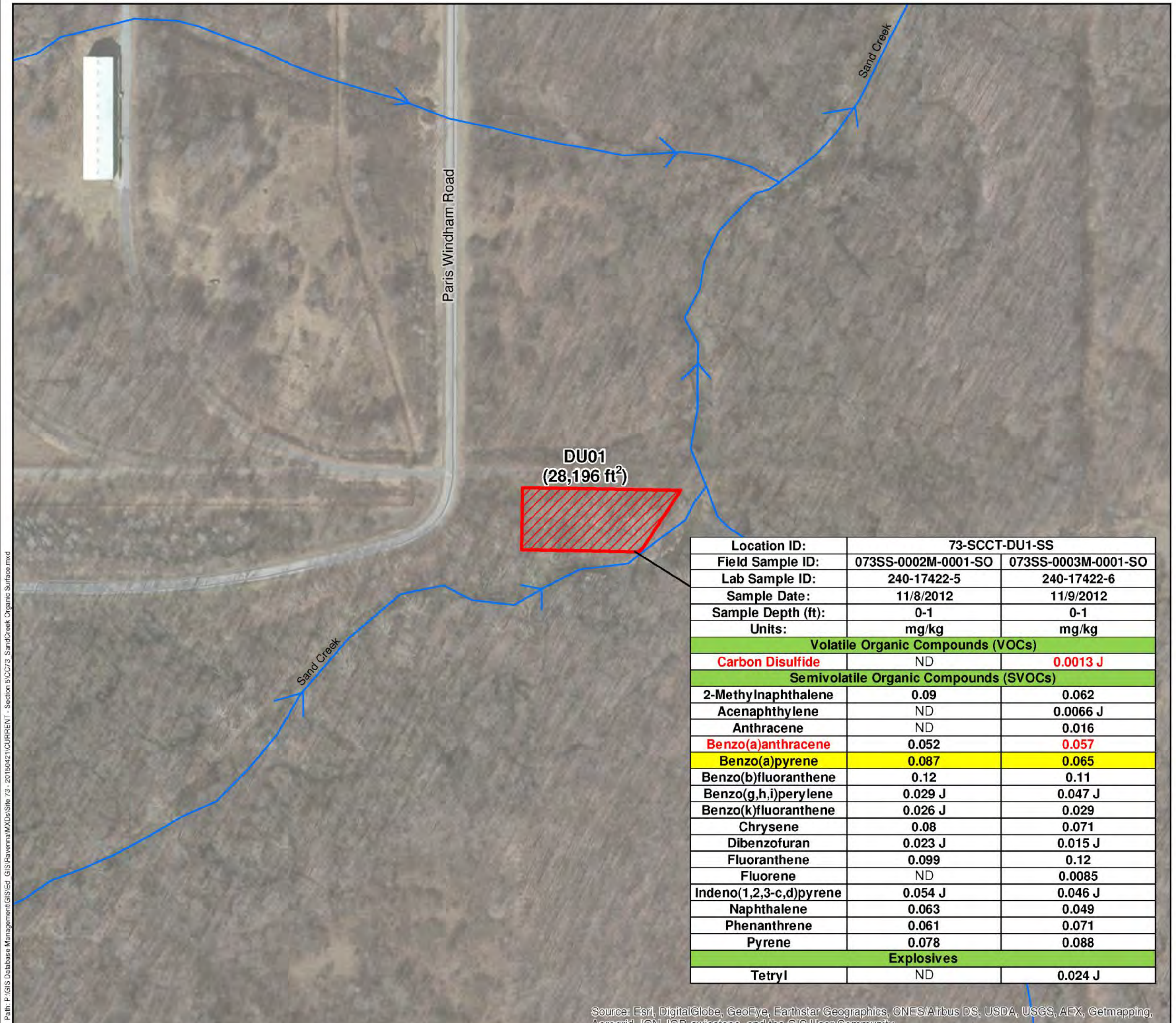

Location ID:	73-SCCT-DU1-SS	
Field Sample ID:	073SS-0002M-0001-SO	073SS-0003M-0001-SO
Lab Sample ID:	240-17422-5	240-17422-6
Sample Date:	11/8/2012	11/9/2012
Sample Depth (ft):	0-1	0-1
Units:	mg/kg	mg/kg
Volatile Organic Compounds (VOCs)		
Carbon Disulfide	ND	0.0013 J
Semivolatile Organic Compounds (SVOCs)		
2-Methylnaphthalene	0.09	0.062
Acenaphthylene	ND	0.0066 J
Anthracene	ND	0.016
Benzo(a)anthracene	0.052	0.057
Benzo(a)pyrene	0.087	0.065
Benzo(b)fluoranthene	0.12	0.11
Benzo(g,h,i)perylene	0.029 J	0.047 J
Benzo(k)fluoranthene	0.026 J	0.029
Chrysene	0.08	0.071
Dibenzofuran	0.023 J	0.015 J
Fluoranthene	0.099	0.12
Fluorene	ND	0.0085
Indeno(1,2,3-c,d)pyrene	0.054 J	0.046 J
Naphthalene	0.063	0.049
Phenanthrene	0.061	0.071
Pyrene	0.078	0.088
Explosives		
Tetryl	ND	0.024 J

LEGEND

- Decision Unit
- Creek and Flow Direction
- Road
- Analyte — SRC and Maximum Concentration Detected
- Analyte — SRC
- Analyte — SRC Concentration Exceeds most stringent FWCUG (HQ=0.1/ Target Cancer Risk = 10^{-6})
- ND — Analyte not detected and not an SRC for this sample

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft^2 = square feet
3. SRC = Site-Related Chemical
4. FWCUG = Facility-Wide Cleanup Goal
5. Concentrations shown are for SRCs at each sample location.
6. mg/kg = milligrams per kilogram
7. J = estimated
8. ft = feet
9. HQ = hazard quotient
10. DU = Decision Unit
11. ID = Identification
12. RVAAP = Ravenna Army Ammunition Plant
13. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Organic SRCs in Surface Soil at Sand Creek Coal Tipple

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200 Feet

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE 5-6

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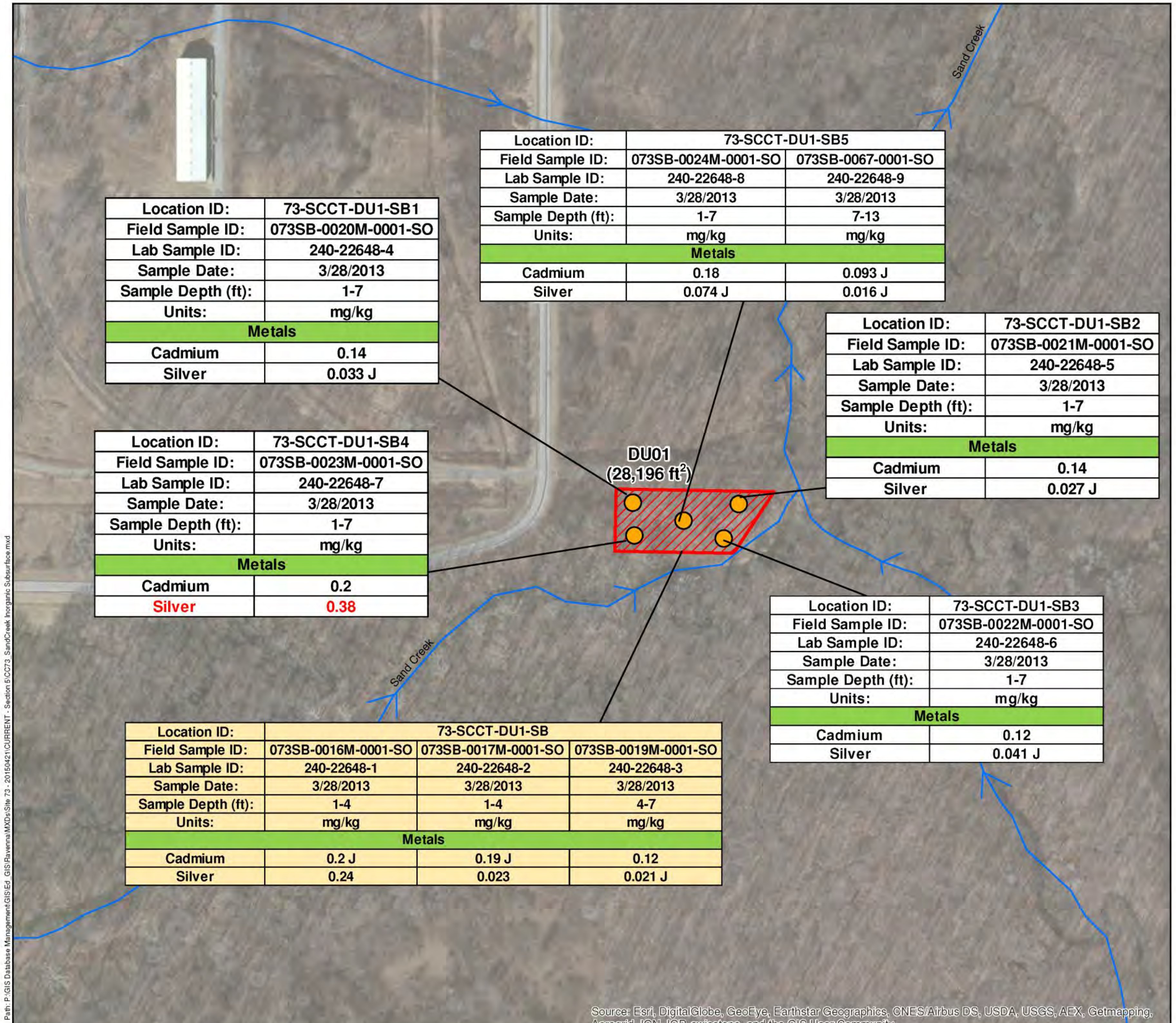

Location ID:	73-SCCT-DU1-SB1
Field Sample ID:	073SB-0020M-0001-SO
Lab Sample ID:	240-22648-4
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.14
Silver	0.033 J

Location ID:	73-SCCT-DU1-SB5	
Field Sample ID:	073SB-0024M-0001-SO	073SB-0067-0001-SO
Lab Sample ID:	240-22648-8	240-22648-9
Sample Date:	3/28/2013	3/28/2013
Sample Depth (ft):	1-7	7-13
Units:	mg/kg	mg/kg
Metals		
Cadmium	0.18	0.093 J
Silver	0.074 J	0.016 J

Location ID:	73-SCCT-DU1-SB2
Field Sample ID:	073SB-0021M-0001-SO
Lab Sample ID:	240-22648-5
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.14
Silver	0.027 J

Location ID:	73-SCCT-DU1-SB4
Field Sample ID:	073SB-0023M-0001-SO
Lab Sample ID:	240-22648-7
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.2
Silver	0.38

Location ID:	73-SCCT-DU1-SB3
Field Sample ID:	073SB-0022M-0001-SO
Lab Sample ID:	240-22648-6
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.12
Silver	0.041 J

Location ID:	73-SCCT-DU1-SB		
Field Sample ID:	073SB-0016M-0001-SO	073SB-0017M-0001-SO	073SB-0019M-0001-SO
Lab Sample ID:	240-22648-1	240-22648-2	240-22648-3
Sample Date:	3/28/2013	3/28/2013	3/28/2013
Sample Depth (ft):	1-4	1-4	4-7
Units:	mg/kg	mg/kg	mg/kg
Metals			
Cadmium	0.2 J	0.19 J	0.12
Silver	0.24	0.023	0.021 J

LEGEND

- Direct-Push Boring Location
- Decision Unit
- Creek and Flow Direction
- Road
- Analyte — SRC and Maximum Concentration Detected
- Analyte — SRC
- ISM Horizontal Sample for Decision Unit

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg = milligrams per kilogram
6. J = estimated
7. ft = feet
8. DU = Decision Unit
9. ID = Identification
10. RVAAP = Ravenna Army Ammunition Plant
11. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Inorganic SRCs in Subsurface Soil at Sand Creek Coal Tipple

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200 Feet

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE
5-7

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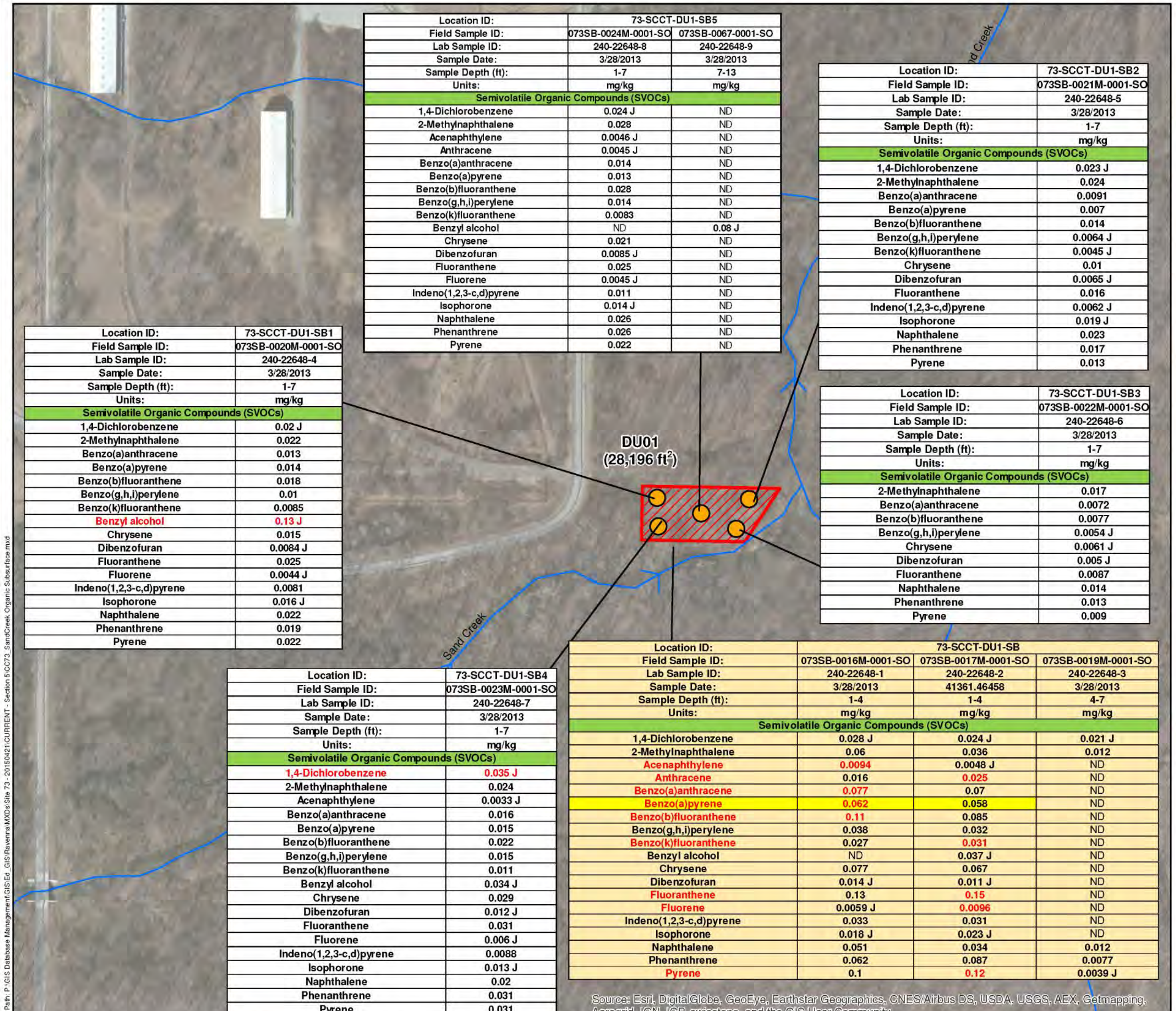

Location ID:	73-SCCT-DU1-SB5	
Field Sample ID:	073SB-0024M-0001-SO	073SB-0067-0001-SO
Lab Sample ID:	240-22648-8	240-22648-9
Sample Date:	3/28/2013	3/28/2013
Sample Depth (ft):	1-7	7-13
Units:	mg/kg	mg/kg
Semivolatile Organic Compounds (SVOCs)		
1,4-Dichlorobenzene	0.024 J	ND
2-Methylnaphthalene	0.028	ND
Acenaphthylene	0.0046 J	ND
Anthracene	0.0045 J	ND
Benzo(a)anthracene	0.014	ND
Benzo(a)pyrene	0.013	ND
Benzo(b)fluoranthene	0.028	ND
Benzo(g,h,i)perylene	0.014	ND
Benzo(k)fluoranthene	0.0083	ND
Benzyl alcohol	ND	0.08 J
Chrysene	0.021	ND
Dibenzofuran	0.0085 J	ND
Fluoranthene	0.025	ND
Fluorene	0.0045 J	ND
Indeno(1,2,3-c,d)pyrene	0.011	ND
Isophorone	0.014 J	ND
Naphthalene	0.026	ND
Phenanthrene	0.026	ND
Pyrene	0.022	ND

Location ID:	73-SCCT-DU1-SB2
Field Sample ID:	073SB-0021M-0001-SO
Lab Sample ID:	240-22648-5
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Semivolatile Organic Compounds (SVOCs)	
1,4-Dichlorobenzene	0.023 J
2-Methylnaphthalene	0.024
Benzo(a)anthracene	0.0091
Benzo(a)pyrene	0.007
Benzo(b)fluoranthene	0.014
Benzo(g,h,i)perylene	0.0064 J
Benzo(k)fluoranthene	0.0045 J
Chrysene	0.01
Dibenzofuran	0.0065 J
Fluoranthene	0.016
Indeno(1,2,3-c,d)pyrene	0.0062 J
Isophorone	0.019 J
Naphthalene	0.023
Phenanthrene	0.017
Pyrene	0.013

Location ID:	73-SCCT-DU1-SB1
Field Sample ID:	073SB-0020M-0001-SO
Lab Sample ID:	240-22648-4
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Semivolatile Organic Compounds (SVOCs)	
1,4-Dichlorobenzene	0.02 J
2-Methylnaphthalene	0.022
Benzo(a)anthracene	0.013
Benzo(a)pyrene	0.014
Benzo(b)fluoranthene	0.018
Benzo(g,h,i)perylene	0.01
Benzo(k)fluoranthene	0.0085
Benzyl alcohol	0.13 J
Chrysene	0.015
Dibenzofuran	0.0084 J
Fluoranthene	0.025
Fluorene	0.0044 J
Indeno(1,2,3-c,d)pyrene	0.0081
Isophorone	0.016 J
Naphthalene	0.022
Phenanthrene	0.019
Pyrene	0.022

Location ID:	73-SCCT-DU1-SB3
Field Sample ID:	073SB-0022M-0001-SO
Lab Sample ID:	240-22648-6
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Semivolatile Organic Compounds (SVOCs)	
2-Methylnaphthalene	0.017
Benzo(a)anthracene	0.0072
Benzo(b)fluoranthene	0.0077
Benzo(g,h,i)perylene	0.0054 J
Chrysene	0.0061 J
Dibenzofuran	0.005 J
Fluoranthene	0.0087
Naphthalene	0.014
Phenanthrene	0.013
Pyrene	0.009

Location ID:	73-SCCT-DU1-SB4
Field Sample ID:	073SB-0023M-0001-SO
Lab Sample ID:	240-22648-7
Sample Date:	3/28/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Semivolatile Organic Compounds (SVOCs)	
1,4-Dichlorobenzene	0.035 J
2-Methylnaphthalene	0.024
Acenaphthylene	0.0033 J
Benzo(a)anthracene	0.016
Benzo(a)pyrene	0.015
Benzo(b)fluoranthene	0.022
Benzo(g,h,i)perylene	0.015
Benzo(k)fluoranthene	0.011
Benzyl alcohol	0.034 J
Chrysene	0.029
Dibenzofuran	0.012 J
Fluoranthene	0.031
Fluorene	0.006 J
Indeno(1,2,3-c,d)pyrene	0.0088
Isophorone	0.013 J
Naphthalene	0.02
Phenanthrene	0.031
Pyrene	0.031

Location ID:	73-SCCT-DU1-SB		
Field Sample ID:	073SB-0016M-0001-SO	073SB-0017M-0001-SO	073SB-0019M-0001-SO
Lab Sample ID:	240-22648-1	240-22648-2	240-22648-3
Sample Date:	3/28/2013	41361.46458	3/28/2013
Sample Depth (ft):	1-4	1-4	4-7
Units:	mg/kg	mg/kg	mg/kg
Semivolatile Organic Compounds (SVOCs)			
1,4-Dichlorobenzene	0.028 J	0.024 J	0.021 J
2-Methylnaphthalene	0.06	0.036	0.012
Acenaphthylene	0.0094	0.0048 J	ND
Anthracene	0.016	0.025	ND
Benzo(a)anthracene	0.077	0.07	ND
Benzo(a)pyrene	0.062	0.058	ND
Benzo(b)fluoranthene	0.11	0.085	ND
Benzo(g,h,i)perylene	0.038	0.032	ND
Benzo(k)fluoranthene	0.027	0.031	ND
Benzyl alcohol	ND	0.037 J	ND
Chrysene	0.077	0.067	ND
Dibenzofuran	0.014 J	0.011 J	ND
Fluoranthene	0.13	0.15	ND
Fluorene	0.0059 J	0.0096	ND
Indeno(1,2,3-c,d)pyrene	0.033	0.031	ND
Isophorone	0.018 J	0.023 J	ND
Naphthalene	0.051	0.034	0.012
Phenanthrene	0.062	0.087	0.0077
Pyrene	0.1	0.12	0.0039 J

LEGEND

- Direct-Push Boring Location
- Decision Unit
- Creek and Flow Direction
- Road
- Analyte — SRC and Maximum Concentration Detected
- Analyte — SRC
- Analyte — SRC Concentration Exceeds most stringent FWCUG (HQ=0.1/ Target Cancer Risk = 10^{-6})
- ND — Analyte not detected and not an SRC at this depth or this sample
- ISM Horizontal Sample for Decision Unit

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. SRC = Site-Related Chemical
4. FWCUG = Facility-Wide Cleanup Goal
5. Concentrations shown are for SRCs at each sample location.
6. mg/kg = milligrams per kilogram
7. J = estimated
8. ft = feet
9. HQ = hazard quotient
10. ND = Not detected
11. DU = Decision Unit
12. ID = Identification
13. RVAAP = Ravenna Army Ammunition Plant
14. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Organic SRCs in Subsurface Soil at Sand Creek Coal Tipple

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 100 200 Feet

N

AMEC
Novi, Michigan

ECC
Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE
5-8

3675

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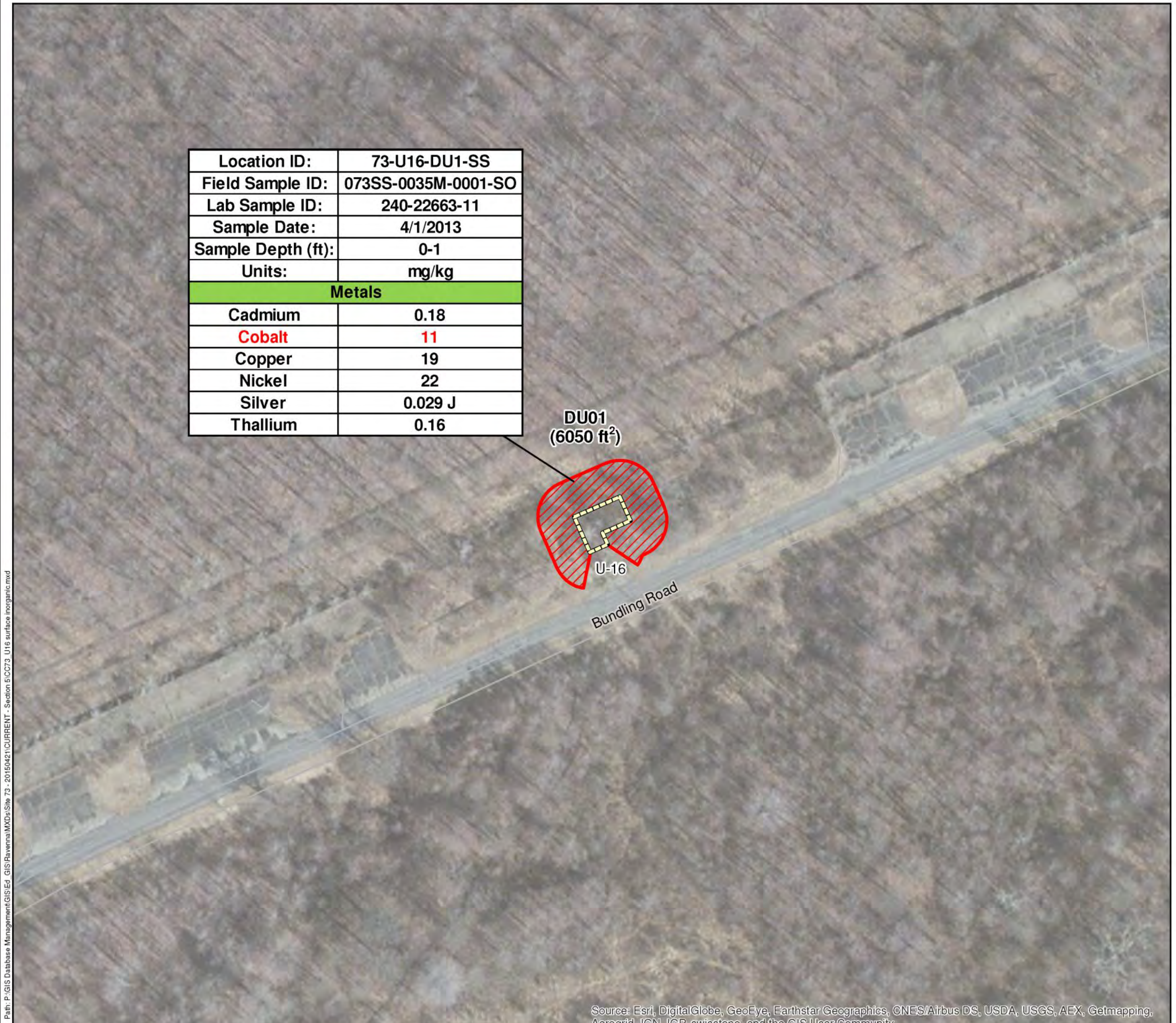

Location ID:	73-U16-DU1-SS
Field Sample ID:	073SS-0035M-0001-SO
Lab Sample ID:	240-22663-11
Sample Date:	4/1/2013
Sample Depth (ft):	0-1
Units:	mg/kg
Metals	
Cadmium	0.18
Cobalt	11
Copper	19
Nickel	22
Silver	0.029 J
Thallium	0.16

LEGEND

Former Structure

Decision Unit

Road

Analyte SRC and Maximum Concentration Detected

Analyte SRC

Analyte SRC Concentration Exceeds Most Stringent FWCUG (HQ=0.1/Target Cancer Risk=10^{-6})

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg = milligrams per kilogram
6. J = estimated
7. ft = feet
8. FWCUG = Facility-Wide Cleanup Goal
9. HQ = Hazard Quotient
10. DU = Decision Unit
11. ID = Identification
12. RVAAP = Ravenna Army Ammunition Plant
13. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Inorganic SRCs in Surface Soil at Building U-16 Boiler House

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 30 60 Feet

N

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Date: June 2015

FIGURE 5-9

3687

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LEGEND

- Decision Unit
- Former Structure
- Road
- Analyte SRC

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft^2 = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg = milligrams per kilogram
6. J = estimated
7. ft = feet
8. DU = Decision Unit
9. ID = Identification
10. RVAAP = Ravenna Army Ammunition Plant
11. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Organic SRCs in Surface Soil at Building U-16 Boiler House

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 30 60 Feet

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FIGURE
5-10

3699

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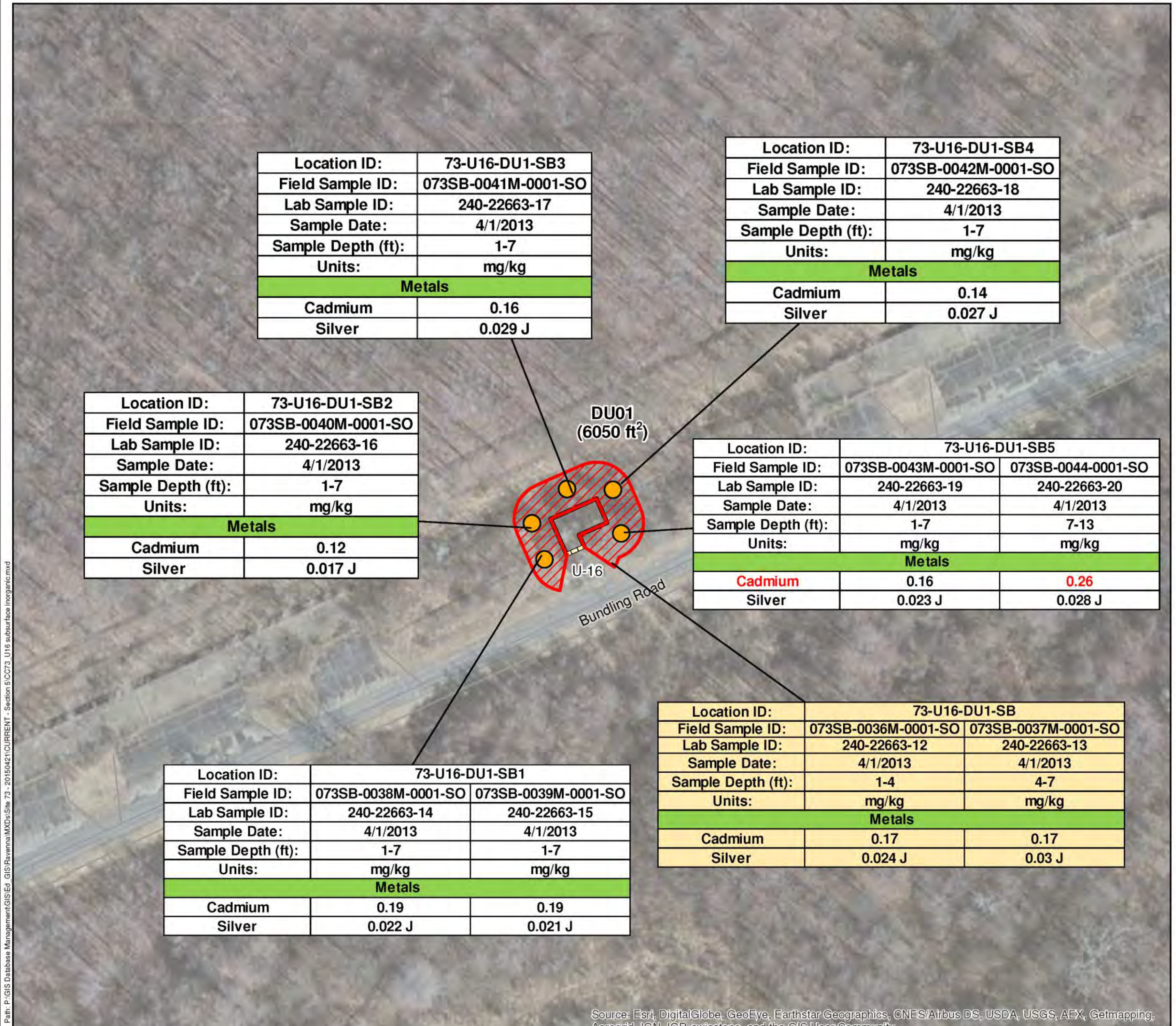

Location ID:	73-U16-DU1-SB3
Field Sample ID:	073SB-0041M-0001-SO
Lab Sample ID:	240-22663-17
Sample Date:	4/1/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.16
Silver	0.029 J

Location ID:	73-U16-DU1-SB4
Field Sample ID:	073SB-0042M-0001-SO
Lab Sample ID:	240-22663-18
Sample Date:	4/1/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.14
Silver	0.027 J

Location ID:	73-U16-DU1-SB2
Field Sample ID:	073SB-0040M-0001-SO
Lab Sample ID:	240-22663-16
Sample Date:	4/1/2013
Sample Depth (ft):	1-7
Units:	mg/kg
Metals	
Cadmium	0.12
Silver	0.017 J

Location ID:	73-U16-DU1-SB5	
Field Sample ID:	073SB-0043M-0001-SO	073SB-0044M-0001-SO
Lab Sample ID:	240-22663-19	240-22663-20
Sample Date:	4/1/2013	4/1/2013
Sample Depth (ft):	1-7	7-13
Units:	mg/kg	mg/kg
Metals		
Cadmium	0.16	0.26
Silver	0.023 J	0.028 J

Location ID:	73-U16-DU1-SB	
Field Sample ID:	073SB-0036M-0001-SO	073SB-0037M-0001-SO
Lab Sample ID:	240-22663-12	240-22663-13
Sample Date:	4/1/2013	4/1/2013
Sample Depth (ft):	1-4	4-7
Units:	mg/kg	mg/kg
Metals		
Cadmium	0.17	0.17
Silver	0.024 J	0.03 J

Location ID:	73-U16-DU1-SB1	
Field Sample ID:	073SB-0038M-0001-SO	073SB-0039M-0001-SO
Lab Sample ID:	240-22663-14	240-22663-15
Sample Date:	4/1/2013	4/1/2013
Sample Depth (ft):	1-7	1-7
Units:	mg/kg	mg/kg
Metals		
Cadmium	0.19	0.19
Silver	0.022 J	0.021 J

LEGEND

- Direct-Push Boring Location
- Decision Unit
- Former Structure
- Road
- Analyte — SRC and Maximum Concentration Detected
- Analyte — SRC
- ISM Horizontal Sample for Decision Unit

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft² = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg = milligrams per kilogram
6. J = estimated
7. ft = feet
8. DU = Decision Unit
9. ID = Identification
10. RVAAP = Ravenna Army Ammunition Plant
11. CC = Army Environmental Compliance-Related Cleanup Program

TITLE

Inorganic SRCs in Subsurface Soil at Building U-16 Boiler House

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 30 60 Feet

AMEC
Novi, Michigan

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Marlborough, Massachusetts

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Date: June 2015

FIGURE 5-11

3711

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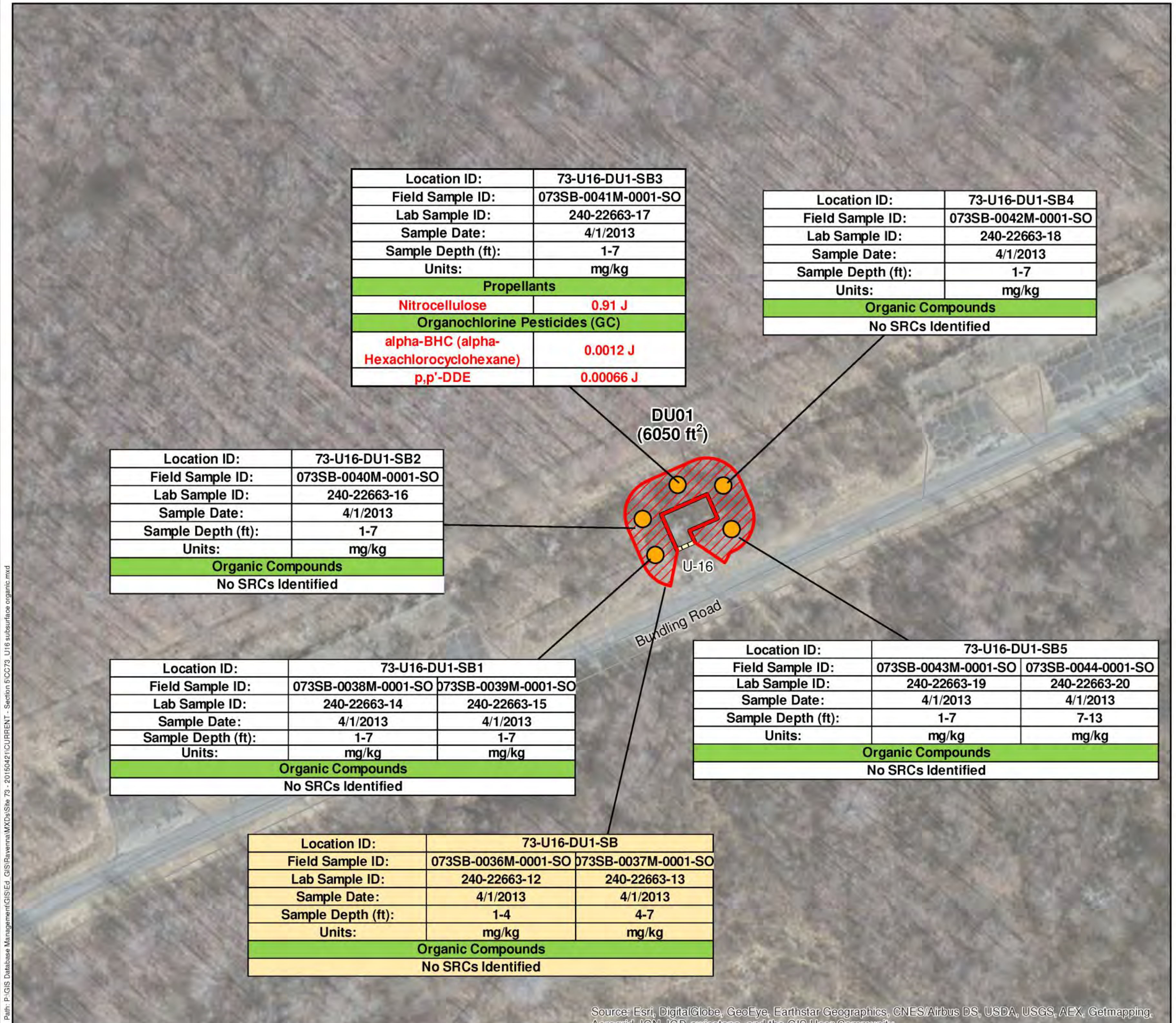

LEGEND

- Direct-Push Boring Location
- Decision Unit
- Former Structure
- Road
- Analyte: SRC and Maximum Concentration Detected
- ISM Horizontal Sample for Decision Unit

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N, 2009 Orthoimagery from USGS.
2. ft^2 = square feet
3. SRC = Site-Related Chemical
4. Concentrations shown are for SRCs at each sample location.
5. mg/kg = milligrams per kilogram
6. J = estimated
7. ft = feet
8. DU = Decision Unit
9. ID = Identification
10. RVAAP = Ravenna Army Ammunition Plant
11. CC = Army Environmental Compliance-Related Cleanup Program
12. p,p'-DDE = dichlorodiphenyldichloroethylene

TITLE

Organic SRCs in Subsurface Soil at Building U-16 Boiler House

CC RVAAP-73 Facility-Wide Coal Storage

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

0 30 60 Feet

N

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Marlborough, Massachusetts

PROJ: 3293111461
Date: June 2015

FIGURE 5-12

3724

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6. CONTAMINANT FATE AND TRANSPORT

This chapter presents an evaluation of contaminant fate and transport in soil to assess the potential for chemicals to leach from soil media at CC RVAAP-73 Facility-Wide Coal Storage and impact underlying groundwater and downgradient receptors. A risk assessment of potential human and ecological receptors within the AOC is presented in Chapter 7. This evaluation is included in the decision-making process to determine whether soil remedial actions may be necessary to protect groundwater resources. SRCs found in surface and subsurface soil are evaluated in the fate and transport assessment for CC RVAAP-73 Facility-Wide Coal Storage. SRCs were developed in Chapter 5.

The fate and transport analyses of contaminants in soil were performed to predict the rate of contaminant migration through the vadose zone soil to groundwater (i.e., transport media) and the rate of contaminant migration within groundwater to the nearest downgradient receptor (i.e., surface water body to which groundwater may discharge). These analyses do not address contamination that may already be in the groundwater. Groundwater beneath this AOC is being addressed under a separate RI (RVAAP-66 Facility-Wide Groundwater).

Section 6.1 describes the physical and chemical properties of SRCs found in the soil at CC RVAAP-73 Facility-Wide Coal Storage. Section 6.2 presents a CSM for contaminant fate and transport. Section 6.3 describes the steps used for the soil contaminant fate and transport evaluation. The summary and conclusions of the soil fate and transport analyses are presented in Section 6.4.

6.1 PHYSICAL AND CHEMICAL PROPERTIES OF CONTAMINANTS IDENTIFIED AS SITE-RELATED CHEMICALS

CC RVAAP-73 Facility-Wide Coal Storage inorganic and organic SRCs are in continuous chemical and physical interaction with subsurface environments. The observed distributions of chemical concentrations in the environment are the result of these interactions. These interactions also determine the chemical fate of these compounds. Chemicals released into the environment are susceptible to several degradation pathways, including hydrolysis, oxidation, reduction, isomerization, photolysis, photo-oxidation, biotransformation, and biodegradation. Transformation daughter products resulting from these processes may behave differently in the environment than the parent chemical.

The migration of chemicals is governed by the physical and chemical properties of the chemicals and the surface and subsurface media through which the chemicals are transferred. In general, chemicals and structures with similar physical and chemical characteristics will show similar patterns of transformation, transport, or attenuation in the environment. Solubility, vapor pressure data, chemical partitioning coefficients, degradation rates, and Henry's Law Constant (HLC) provide information that can be used to evaluate contaminant mobility in the environment. Partitioning coefficients are used to assess the relative affinities of chemicals for solution or solid phase adsorption. However, the synergistic effects of multiple migrating chemicals and the complexity of soil/water interactions, including pH, oxidation-reduction potential, grain size, and clay mineral variability, are typically unknown. The properties are used to assess the anticipated behavior of each chemical under environmental conditions and are used as input parameters to mathematical models for predicting contaminant mass transport in the environmental media.

6.1.1 Chemical Factors Affecting Fate and Transport

The water solubility of a chemical is a measure of the saturated concentration of the chemical in water at a given temperature and pressure. The tendency for a chemical to be transported by groundwater is directly related to its solubility and is inversely related to both its tendencies to adsorb to soil and to volatilize from water (O'Brien and Gere Engineers, Inc. [OGE] 1988). Chemicals with high water solubilities tend to desorb from soil, are less likely to volatilize from water, and are susceptible to biodegradation. The water solubility of a chemical varies with temperature, pH, and the presence of other dissolved chemicals (including organic carbon and humic acids). PAH SRCs are present at most DUs and have solubilities that range as low as 10^{-4} milligrams per liter (mg/L).

The octanol-water partition coefficient (K_{ow}) can be used to estimate the tendency for a chemical to partition between environmental phases of different polarities. The K_{ow} is a laboratory-determined ratio of the concentration of a chemical in the n-octanol phase of a two-phase system to the concentration in the water phase. Chemicals with log K_{ow} values that are less than 1 are highly soluble, while chemicals with log K_{ow} values greater than 4 will partition to soil particles (Lyman et al. 1990).

The water/organic carbon partition coefficient (K_{oc}) is a measure of the tendency of an organic chemical to partition between water and organic carbon in the soil. The K_{oc} is defined as the ratio of the absorbed chemical per unit weight of organic carbon to the aqueous solute concentration. This coefficient can be used to estimate the degree to which an organic chemical will adsorb to soil and, thus, not migrate with groundwater. The higher the K_{oc} value, the greater is the tendency of the chemical to partition into soil (OGE 1988). The soil-water distribution coefficient (K_d) is calculated by multiplying the K_{oc} value by the fraction of organic carbon in the soil. The PAH SRCs have higher K_{oc} than the VOC SRCs, tending to bind to the soil more readily than the VOCs.

Vapor pressure is a measure of the pressure at which a chemical and its vapor are in equilibrium. The value can be used to determine the extent to which a chemical would travel in air, as well as the rate of volatilization from soil and solution (OGE 1988). In general, chemicals with vapor pressures lower than 10^{-7} millimeters of mercury will not be present in the atmosphere or air spaces in soil in significant amounts, while chemicals with vapor pressures higher than 10^{-2} millimeters of mercury will exist primarily in the air (Dragun 1998).

The HLC value for a chemical is a measure of the ratio of the chemical's vapor pressure to its aqueous solubility. The HLC value can be used to make general predictions about the chemical's tendency to volatilize from water. Substances with HLC values less than 10^{-7} atmospheres relative to cubic meters per mol (atm-m^3/mol) will generally volatilize slowly, while chemicals with an HLC greater than 10^{-3} atm-m^3/mol will volatilize rapidly (Lyman et al. 1990). CC

RVAAP-73 Facility-Wide Coal Storage PAH SRCs have HLCs in the 10^{-7} atm-m^3/mol range and, therefore, do not easily volatize.

6.1.2 Biodegradation

Organic chemicals with differing chemical structures will biodegrade at different rates. Primary biodegradation consists of any biologically-induced structural change in an organic chemical. Complete biodegradation is the biologically-mediated degradation of an organic chemical into carbon dioxide, water, oxygen, and other metabolic inorganic products (Dragun 1998). The biodegradation half-life is the time necessary for half of the chemical to degrade. The biodegradation rate of an organic chemical is generally dependent on the presence and population size of soil microorganisms that are capable of degrading the chemical. However, it should be noted that in order to develop conservative results with respect to groundwater impact, the fate and transport analyses for CC RVAAP-73 Facility-Wide Coal Storage do not account for any loss due to biodegradation.

6.1.3 Inorganic Chemicals

Inorganic chemicals detected in soil samples are associated with both the aqueous phase and with leachable metal ions on soil particles. The transport of this material from unsaturated soil to the underlying water table is controlled by the physical processes of precipitation, percolation, chemical interaction with the soil, and downward transport of metal ions by continued percolation. The chemistry of inorganic interaction with percolating precipitation and varying soil conditions is complex and includes numerous chemical transformations that may result in altered oxidation states, ion exchange, adsorption, precipitation, or complexation. The chemical reactions, which are affected by environmental conditions (e.g., pH, oxidation/reduction conditions, type and amount of organic matter, clay content, and the presence of hydrous oxides), may act to enhance or reduce the mobility and toxicity of the metal ions. In general, these reactions are reversible and add to the variability commonly observed in distributions of inorganic chemicals in soil.

The chemical form of an inorganic chemical determines its solubility and mobility in the environment; however, chemical speciation is complex and difficult to delineate in routine laboratory analysis. Inorganic chemicals in soil are commonly found in several forms, including dissolved concentrations in soil pore water, metal ions occupying exchange sites on inorganic soil chemicals (adsorbed to inorganic soil chemicals), metal ions associated with insoluble organic matter, precipitated inorganic chemicals as pure or mixed solids, and metal ions present in the structure of primary or secondary minerals.

The dissolved (aqueous) fraction and its equilibrium sorbed fraction are of primary importance when considering the migration potential of metals through soil. Of the inorganic chemicals that are likely to form, chlorides, nitrates, and nitrites are commonly the most soluble. Sulfate, carbonate, and hydroxides generally have low to moderate solubility. Soluble chemicals are transported in aqueous form subject to attenuation, whereas less soluble chemicals remain as a precipitate and limit the overall dissolution of the metal ions. The solubility of the metal ions is also regulated by ambient chemical conditions, including pH and oxidation/reduction.

The attenuation of metal ions in the environment can be estimated numerically using the retardation factor, dispersion in higher flow systems (high conductivity environments), and diffusion in low conductivity environments. The retardation factor defines the extent to which the velocity of the contaminant is slowed, which is largely derived from K_d.

Metal ion concentrations in the environment do not attenuate by natural or biological degradation because of the low volatility and solubility of the ions. Inorganic chemicals may be biotransformed or bioconcentrated through microbial activity.

Only about 33 of 120 minerals are commonly found in coal; of these, only about 8 (quartz, kaolinite, illite, montmorillonite, chlorite, pyrite, calcite, and siderite) are considered major constituents (USGS 2013). These most common minerals in coal are comprised of common elements, oxygen, aluminum, silicon, iron, sulfur, and calcium, in order of decreasing abundance). These minerals and other less common minerals usually contain the bulk of the trace elements present in coal.

6.1.4 Organic Chemicals

Organic chemicals, such as the CC RVAAP-73 Facility-Wide Coal Storage SVOC or VOC SRCs, detected in soil may be transformed or degraded in the environment by various processes, including hydrolysis, oxidation/reduction, photolysis, volatilization, biodegradation, or biotransformation. The half-life of organic chemicals in the transport media can vary from minutes to years, depending on environmental conditions and the structures of the chemicals. Some types of organic chemicals are very stable, and degradation rates can be very slow (e.g., characterized by half-lives on the order of years). Organic degradation may either enhance (through the production of more toxic byproducts) or reduce (through concentration reduction) the toxicity of a chemical in the environment.

The organic compounds in coal are composed of the elements carbon, hydrogen, oxygen, nitrogen, sulfur, and trace amounts of several other elements. Although only a few elements compose the organic compounds found in coal, these compounds are extremely complex and, therefore, are not well understood (USGS 2013). Heating and pressure during the conversion of plant material into coal creates a highly aromatic three-dimensional network structure. Coal may contain non-regulated and/or USEPA-regulated PAHs. The regulated PAH composition and quantity depends on the coal rank or grade of the coal. Higher grade coal (e.g., anthracite) contains fewer regulated PAHs than lower grade coal (e.g., sub-bituminous). The percentage PAH composition that comprises the total amount of regulated PAHs varies depending on the coal grade. For medium coal, the percentage PAH composition is predominantly methy-naphthalenes at 25 percent and methyl phenanthrenes at 18 percent with trace levels of benzo(a)anthracene and benzo(a)pyrene (<1 percent). For higher grade coal, the percentage PAH composition is predominantly phenanthrenes and methyl phenanthrenes up to 20 percent and benzo(b)fluoranthene at 12 percent with trace levels of benzo(a)anthracene and benzo(a)pyrene (<1 percent). Coal is a very strong sorbent material, and volatilization of PAHs from coal is limited. Coal is noted for its strong sorption affinity to organic compounds and slow desorption kinetics, and PAHs bound to coal are noted to have limited volatility (Achten and

Hoffman 2008). The grade of coal storage at CC RVAAP-73 Facility-Wide Coal Storage is not available in historical documents reviewed as part of this RI.

6.2 CONCEPTUAL MODEL FOR FATE AND TRANSPORT

The CSM, which defines the framework for fate and transport evaluation, describes conditions at CC RVAAP-73 Facility-Wide Coal Storage, including the contaminant sources, surface and subsurface hydrogeologic conditions, contaminant migration and pathways, and the contaminant release mechanisms.

Site conditions described in Chapters 2 through 5 include contaminant source information, the surrounding geologic and hydrologic conditions, and the magnitude of SRCs and their current spatial distribution. Information from the CSM presented in Section 3.6 and the nature and extent evaluation in Chapter 5 was used to develop the CSM for fate and transport modeling by identifying SRCs and migration pathways. Figure 6-1 shows the CSM for this AOC. The CSM is based on information and data collected from historical investigations, this RI report, and informed assumptions regarding CC RVAAP-73 Facility-Wide Coal Storage. Assumptions contained in the CSM are reiterated throughout this section. The better the information and the greater the accuracy of the assumptions, the more accurately the CSM describes CC RVAAP-73 Facility-Wide Coal Storage, and the more reliable the fate and transport evaluation predictions can be. The salient elements of the CSM that apply to fate and transport evaluation are summarized in Figure 6-1. Although the figure specifically shows the North Line Road Coal Tipple, the migration pathways are similar for the other two former coal storage areas.

6.2.1 Contaminant Sources

No primary (continuing) contaminant sources are located in CC RVAAP-73 Facility-Wide Coal Storage. Secondary sources (contaminated media) were identified and characterized during this RI. Based on these characterizations, contaminated soil media may represent a potential secondary source of contamination to groundwater (vertical migration) or surface water (lateral migration to the nearest surface water body).

6.2.2 Hydrogeology

A description of AOC-specific hydrogeology as applicable to soil media is provided in Section 3.3 and is briefly summarized here for each coal storage area. Generic and facility-wide assumptions were used for this evaluation if area-specific information was not available.

No groundwater receptors have been identified for this AOC. Groundwater beneath CC RVAAP-73 Facility-Wide Coal Storage is not currently used for potable purposes. Groundwater associated with this AOC is being investigated on a facility-wide basis (RVAAP-66).

North Line Road Coal Tipple

No groundwater monitoring wells are located within the North Line Road Coal Tipple. The nearest groundwater monitoring wells in the vicinity is FWGmw-003 is located approximately 50 ft east and is screened in the unconsolidated sediments from 8.5 and 18.5 ft bgs. The depth to water in this well was approximately 4.5 ft bgs during the July 2012 groundwater monitoring event, with a potentiometric elevation of 1,124.98 ft amsl. Based on the boring logs of this area (Appendix A), groundwater may not have been encountered during drilling; however, this may be due to the fine-grained nature of the soil, which makes saturation difficult to estimate during logging. Based on the potentiometric surface of the unconsolidated aquifer (Figure 2-4) and the estimated ground surface elevation (Figure 3-1a), the depth to groundwater is likely within a few feet of the ground surface (i.e., <5 ft bgs). To be conservative, an assumed depth to groundwater of 4 ft bgs was used in the soil screening analysis for fate and transport. The groundwater flow direction in the unconsolidated aquifer beneath the area is to the east-southeast toward Sand Creek, as shown on Figure 2-4. As shown on Figure 2-1, Mercer shale and/or Sharon shale likely exist below the unconsolidated aquifer at the North Line Road Coal Tipple.

Sand Creek Coal Tipple

No groundwater monitoring wells are located within the Sand Creek Coal Tipple area. As shown on Figure 2-4, this area is located on the northwestern boundary of an area where the unconsolidated aquifer is missing. The boring logs of this area (Appendix A) do not indicate that the groundwater was encountered during drilling. The estimated depth to groundwater in the Sharon bedrock aquifer is approximately 35 ft bgs, and this depth was used in the soil screening calculations for fate and transport. As shown on Figure 2-6, the generalized groundwater flow direction within the Sharon aquifer beneath this area is to the east-northeast.

Building U-16 Boiler House

No groundwater monitoring wells are located within the Building U-16 Boiler House area. The estimated groundwater elevation of the unconsolidated aquifer beneath the area is 1,165 ft amsl (groundwater may not have been encountered during drilling). A depth to groundwater of 22 ft bgs was used in the soil screening analysis for fate and transport. The direction of groundwater flow is presumed to be to the southeast toward a tributary of Hinkley Creek (Figure 2-4). Based on the 2012 groundwater monitoring report and the topography of the area, a groundwater divide likely exists just north and west of the area. Groundwater in the Homewood bedrock beneath the area is presumed to be 1,150 ft amsl, and the direction of groundwater flow is presumed to be to the east-southeast (Figure 2-5).

6.2.3 Contaminant Release Mechanisms and Migration Pathways

Based on the information above, the following contaminant release mechanism and migration pathways have been identified at CC RVAAP-73 Facility-Wide Coal Storage:

- Percolation of water through the unsaturated soil to the water table (i.e., vertical leaching of chemicals from soil into groundwater)

- Lateral transport of contaminants in groundwater to downgradient receptors (surface water bodies).

During heavy precipitation, SRCs in surface soil may be transported away from the DUs as stormwater runoff. Because Sand Creek is relatively close to two of the three former coal storage areas, collocated surface water and wet sediment samples were collected from the creek to evaluate whether this contaminant transport pathway is complete.

The wet sediment and surface water samples were analyzed for TAL metals, including mercury, and SVOCs. One sediment and 1 surface water sample were also analyzed for organochlorine pesticides, PCBs, VOCs, and explosives/propellants. Sampling locations are shown on Figures 4-1a and 4-1b for the North Line Road Coal Tipple and Sand Creek Coal Tipple, respectively. The surface water and sediment sampling results are shown in Tables 6-1 and 6-2 for the North Line Road Coal Tipple and Tables 6-3 and 6-4 for the San Creek Coal Tipple, respectively. The analytes listed in the tables are those that were retained as SRCs in surface soil within the DU (Table 5-1).

For the North Line Road Coal Tipple, Sand Creek is located approximately 125 ft east of the DU at its nearest point. The creek flows in the general direction of north to south. As shown on Figure 3-1a, the ground surface is relatively flat with a gentle slope to the southeast toward Sand Creek. The estimated distance in the downgradient direction from the DU to the creek is 400 ft. Three collocated wet sediment and surface water samples were collected in Sand Creek: 1 upgradient northeast of DU01 (73-NLCT-DD-SD1/UP-SW1), 1 at a location where runoff from DU01 may enter the creek (73-NLCT-MD-SD2/MD-SW2), and 1 downgradient east of DU01 (73-NLCT-DW-SD3/DW-SW3). A fourth collocated wet sediment and surface water sample was collected from an upgradient ditch that parallels North Line Road, approximately 70 ft north of DU01, and discharges to Sand Creek (73-NLCT-DD-SD4/DW-SW4).

As shown on Table 6-1, only arsenic and manganese were detected in surface water at a concentration exceeding the FWCUG at 10^{-6} or HQ of 0.1. However, these two concentrations were from upgradient samples in the ditch, which is upgradient of the DU (073SW-0067-0001-SW). This ditch flows east into Sand Creek; and, at the two Sand Creek sampling locations downstream from the ditch (073SW-0058-0001-SW and 073SW-0061-0001-SW), these 2 metals were either not detected or detected at concentrations below their BSV.

As shown on the Table 6-2, manganese was detected in sediment at a concentration that exceeded the FWCUG at 10^{-6} or HQ of 0.1 for sediment. However, this concentration was from the 2 upgradient samples in Sand Creek (073SD-0045-0001-SD and 073SD-0047-0001-SD [and its field duplicate 073SD-0048-0001-SD]). Manganese was not detected at a concentration greater than its BSV in the downgradient sediment sample from Sand Creek. Similarly, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were detected in sediment at concentrations that exceeded their FWCUG at 10^{-6} or HQ of 0.1 for sediment. However, these concentrations were from the upgradient ditch sample (073SD-0046-0001-SD). These three PAHs were not detected in concentrations greater than their FWCUGs in the downgradient sediment sample.

For the Sand Creek Coal Tipple, Sand Creek is located within approximately 50 east of the DU. The creek flows in the general direction of south to north. As shown on Figure 3-1b, the ground surface slopes to the east toward Sand Creek. Three collocated wet sediment and surface water samples were collected in Sand Creek: 1 upgradient northeast of DU01 (73-SCCCT-UP-SD1/UP-SW1), 1 sidegradient of DU01 (73-SCCT-MD-SD2/MD-SW2), and 1 downgradient east of DU01 (73-SCCT-DW-SD3/DW-SW3).

As shown on Table 6-3, no analytes were detected in surface water at a concentration exceeding the FWCUG at 10^{-6} or HQ of 0.1 (or RSL for those analytes without an FWCUG) and, as shown in Table 6-4, no analytes were detected in sediment at a concentration exceeding the FWCUG at 10^{-6} or HQ of 0.1 for sediment (or RSLs for those analytes without an FWCUG).

Based on these sampling results, SRCs in surface soil at the DUs of the two coal tipples are not impacting the quality of Sand Creek. This conclusion is supported by the 2003 Facility-Wide Biological and Water Quality Study (USACE 2005a), which demonstrated that analytes detected in Sand Creek were below criteria protective of Warmwater Habitat aquatic life use and that conditions of fish and benthic communities ranged from good to exceptional. Therefore, the contaminant transport pathway from SRCs at the DUs to the nearest surface water body (Sand Creek) is assumed to be incomplete.

Precipitation that does not leave CC RVAAP-73 Facility-Wide Coal Storage as surface runoff percolates into the subsurface. Some of the infiltrating water leaves this environment via evapotranspiration after little or no vertical migration. The remainder of the water percolates into the water table. The rate of percolation is controlled by soil cover, ground slope, saturated conductivity of the soil, and meteorological conditions.

After the contaminant leachate percolates through the soil and reaches the water table in unconsolidated deposits, it migrates with the local groundwater and potentially discharges to a downgradient surface water body. For the Sand Creek Coal Tipple, contaminant leachate percolates through unsaturated silty clays to the bedrock (Sharon Sandstone) and then migrates within the bedrock to Sand Creek located approximately 50 ft east. For the North Line Road Coal Tipple, contaminant leachate percolates through unsaturated silty clays to the unconsolidated aquifer and then migrates within the unconsolidated aquifer to Sand Creek located approximately 400 ft east. For the Building U-16 Boiler House, contaminant leachate percolates through unsaturated soil to the unconsolidated aquifer and then migrates within the unconsolidated aquifer to wetlands located approximately 1,500 ft southeast.

It should be noted that due to the very heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns within the unconsolidated soil are difficult to predict. Groundwater flow likely occurs along preferential pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities. For inorganic chemicals, lateral migration through groundwater is very limited due to their high retardation (USACE 2003).

Additional factors that affect the leaching rate include a chemical's solubility, sorption capacity (expressed by the K_d), and the flux rate of percolation. Insoluble chemicals will precipitate out of solution in the subsurface or remain in insoluble forms with little leaching.

Another factor that affects whether a chemical will reach the water table through percolation of precipitation is the chemical's rate of decay. Most of the organic chemicals decay at characteristic rates that are proportional to the chemical's half-life. For a given percolation rate, those chemicals with long half-lives have a greater potential for contaminating groundwater than do those with shorter half-lives. For this analysis, the rate of decay/half-life was not considered.

Contaminant releases through gaseous emissions and airborne particulates are not significant for this media because of the subsurface nature of the media. Also, the areas are generally vegetated, located in a humid and temperate climate, and soil moisture content is typically high, which prevents dust-borne contaminant migration. Therefore, there is likely little to no gaseous emission, and contaminant levels in the air pathway are minor to nonexistent.

6.2.4 Water Budget

The potential for contaminant transport begins with precipitation. Percolation is the driving mechanism for leaching of soil chemicals to groundwater. The actual amount of rainwater available for flow and percolation to groundwater is highly variable and depends on soil type and climatic conditions. A water balance calculation can be used as a tool to quantitatively account for all components of the hydrologic cycle. The quantified elements of the water balance are used for inputs to the soil leaching and groundwater transport calculations discussed later. The components of a simple steady-state water balance model include precipitation, evapotranspiration, surface runoff, and groundwater recharge or percolation. These terms are defined as follows:

$$P = ET + Sr + q \qquad \text{(Equation 6-1)}$$

or

$$\text{Rainwater available for flow} = Sr + q = P - ET \qquad \text{(Equation 6-2)}$$

where

ET = Evapotranspiration.
p = Precipitation.
q = Groundwater recharge or percolation.
Sr = Surface runoff.

It is expected that loss of runoff also occurs in the form of evaporation. After runoff and evaporation, the remaining water is available for percolation, which includes loss to the atmosphere by evapotranspiration. The water balance estimations were developed using the Hydrologic Evaluation of Landfill Performance (HELP) model (USEPA 1994). See Table 6-5 for parameters used in the HELP model to develop the water budget estimates used in the evaluation. Calculations using precipitation and temperature data for a 100-year period were generated synthetically using coefficients for Youngstown, Ohio.

The annual average water balance estimates indicate an evapotranspiration of 28 percent (10.3 in.) of total precipitation (37 in.). The remaining 72 percent (27 in.) of rainwater is available for surface water runoff and percolation to groundwater. Of the 27 in. of water available for runoff or percolation, groundwater recharge (percolation) accounts for 13 percent

(3.6 in.), and surface runoff (along topography to nearest surface water bodies) accounts for the remaining 87 percent (23 in.).

6.3 SOIL SCREENING ANALYSIS

Soil screening analyses are evaluations performed to identify those SRCs that are initial contaminant migration chemicals of potential concern (CMCOPCs) with the potential to leach to and migrate in groundwater. The soil leachability analysis is a five-step screening process as follows:

1. Identify the SRCs for subsurface soil in the nature and extent evaluation for CC RVAAP-73 Facility-Wide Coal Storage.

2. Compare the MDC of each SRC with generic Soil Screening Levels (SSLs) (USEPA 1996, 2012) to develop initial CMCOPCs.

3. Develop a site-specific dilution attenuation factor (DAF) applicable to CC RVAAP-73 Facility-Wide Coal Storage (USEPA 1996b) and compare the MDCs of initial CMCOPCs with site-specific SSLs (generic SSL multiplied by the site-specific DAF) to refine the initial CMCOPCs.

4. Estimate the contaminant vertical migration travel time to reach the water table and eliminate the initial CMCOPCs that take more than 1,000 years to migrate from the source area to groundwater.

5. Estimate the contaminant lateral migration travel time to the downgradient receptor location and eliminate the remaining initial CMCOPCs that take more than 1,000 years to migrate from the location in groundwater beneath the source area to the downgradient receptor location. The initial CMCOPCs that have lateral travel times less than 1,000 years and have concentrations at the AOC that are greater than FWCUGs (or RSLs for those without FWCUGs) require additional evaluation using fate and transport models.

The contaminant migration COCs are defined as the chemicals with potential to leach to groundwater and migrate to downgradient receptor locations at a concentration exceeding the most stringent FWCUGs or Residential RSLs for the AOC-specific receptors, facility-wide background concentrations, and Maximum Contaminant Level (MCL) or RSL. If a predicted chemical concentration was lower than at least one of these three screening goals at the downgradient receptor locations, the chemical was not considered a contaminant migration COC.

For this AOC, fate and transport modeling was not necessary because the initial CMCOPC travel times to the downgradient receptors are greater than 1,000 years or the initial CMCOPCs have concentrations that are less than the FWCUGs, as discussed below.

6.3.1 Soil Screening Analysis

The SRCs in surface and subsurface soil at the three former coal storage areas are listed in Table 6-6. The screening process begins by comparing the MDCs of those SRCs to MCL-based generic SSLs (Table 6-7). Because the former coal storage areas are noncontiguous areas, this screening process was conducted for each of the three areas rather than as an aggregate. The generic SSLs were developed for Superfund sites for contaminant migration to groundwater (USEPA 1996b, 2012). The generic SSL is defined as the concentration of a constituent in soil that represents a level of contamination below which there is no concern for impacts to groundwater under CERCLA, provided conditions associated with SSLs are met. Generally, if contaminant concentrations in soil are less than the generic SSLs, and there are no groundwater receptors of concern or anticipated exposures, no further study or action is warranted for that area. If the generic SSL for a chemical is not available, the USEPA risk-based (USEPA 2012) SSL for soil for groundwater migration is used. If neither the USEPA generic SSL nor the USEPA risk-based SSL for a chemical is available, no further evaluation of the chemical is performed, and it is eliminated from the list of the initial CMCOPCs. However, some chemicals were assigned surrogates by risk assessors because the chemical without an SSL is similar to another chemical with an SSL.

As shown in Table 6-7, the following initial CMCOPCs were retained after this generic SSL screening.

North Line Road Coal Tipple

- Six metals: arsenic, barium, beryllium, cadmium, manganese, and selenium

- Nine SVOCs: 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, indeno(1,2,3-cd)pyrene, isophorone, naphthalene, and phenanthrene

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- Four SVOCs: benzo(a)anthracene, benzo(b)fluoranthene, isophorone, and naphthalene.

Building U-16 Boiler House

- Two metals: cobalt and thallium
- One organochlorine pesticide: alpha-hexachlorohexane
- One SVOC: naphthalene.

Next, the MDCs of the initial CMCOPCs were compared to the site-specific SSLs shown in Table 6-8. The site-specific SSL is defined as the generic SSL multiplied by the DU-specific DAF. In the derivation of the generic SSLs, direct partitioning was used, assuming groundwater is in contact with the chemicals in soil and the groundwater concentration is equal to the leachate concentration. However, as leachate moves through soil, contaminant concentrations are attenuated by adsorption and degradation. When the leachate reaches the water table, dilution by groundwater further reduces leachate concentrations. This reduction in concentration can be expressed by a DAF. The DAFs can vary based on DU-specific characteristics (e.g., hydrogeologic properties, contaminated source area, depth to contamination) (Table 6-9). Given the proximity and relative size of each AOC DU, an average source area was calculated for the DAF. As described in the Soil Screening Guidance: Technical Background Document (USEPA 1996a), contaminant dilution in groundwater was estimated from the DU-specific DAF. Dilution in groundwater was derived from a simple mixing zone equation (Equation 6-3) and relied upon estimation of the mixing zone depth (Equation 6-4). As shown in Table 6-4, 4 SVOCs were retained as initial CMCOPCs because their MDCs were greater than the site SSLs.

$$DAF = 1+(K*i*d)/(q*L) \qquad \text{(Equation 6-3) (USEPA 1996a)}$$

where

DAF = Dilution attenuation factor.
K = Aquifer hydraulic conductivity (m/year).
i = Horizontal hydraulic gradient (m/m).
q = Percolation rate (m/year).
L = Source length parallel to groundwater flow (m).
d = Mixing zone depth (m) (which is defined below).

$$d=(0.0112*L^2)^{0.5} + da(1-\exp((-L*q)/(K*i*da)) \qquad \text{(Equation 6-4)(USEPA 1996a)}$$

where

da = Aquifer thickness (m).
$d \leq d_2$

As stated above, if the aquifer thickness was less than the calculated mixing zone depth, the aquifer thickness was used for "d" in the DAF calculation as shown in Table 6-9. It should be noted that the purpose of this screen is not to identify the contaminants that may pose risk at downgradient locations, but to target those contaminants that may pose the greatest problem if they migrate from CC RVAAP-73 Facility-Wide Coal Storage. If contaminant concentrations in soil are less than the site-specific SSL, and there were no groundwater receptors of concern or anticipated exposures, no further study or action was warranted for that area. Table 6-10 presents the thickness of the leaching zones for the former coal storage areas.

After site-specific SSL screening, the following were retained as initial CMCOPCs because their MDCs exceeded the site-specific SSLs:

North Line Road Coal Tipple

– Five metals: arsenic, barium, cadmium, manganese, and selenium

- Six SVOCs: 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, and naphthalene

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- Three SVOCs: benzo(a)anthracene, benzo(b)fluoranthene, and naphthalene.

Building U-16 Boiler House

- One metal: cobalt
- One organochlorine pesticide: alpha-hexachlorohexane
- One SVOC: naphthalene.

The soil screening process proceeds by eliminating from further consideration those initial CMCOPCs identified that require more than 1,000 years to leach through the unsaturated zone before reaching the water table, as shown in Table 6-11.

The time period of 1,000 years was conservatively selected to evaluate eventual migration of the contaminant front to the water table despite uncertainties in vadose zone hydraulic parameters and groundwater recharge over time. Additionally, USACE suggests a screening value of 1,000 years be used due to the high uncertainty associated with predicting conditions beyond that time frame (USACE 2003). Therefore, the initial CMCOPCs at the selected sources were screened against a travel time greater than 1,000 years. The travel time in this step is the time required for an initial CMCOPC to migrate vertically from the base of the soil interval detected above its BSV (for inorganics) or FWCUG (for organics) to the water table. This distance is the leaching zone, which varies for CC RVAAP-73 Facility-Wide Coal Storage based on the varying depths of soil sample concentrations exceeding the BSVs/FWCUGs and the elevation of the water table. A conservative value for the leaching zone was always used, based on the minimum distance above the water table for each former coal storage area. The estimated travel time for each initial CMCOPC to reach the water table was determined using the following equations:

$$T_{LC} = \frac{Lz \times R}{V_p}$$

(Equation 6-5)

where

T_{LC} = Leachate travel time to the water table (year).
Lz = Thickness of attenuation zone (ft).
R = Retardation factor (dimensionless).
Vp = Pore water velocity (ft/year).

$$V_p = \frac{q}{\Theta_w}$$

(Equation 6-6)

where

q = Percolation rate (ft/year).
θ_w = Fraction of total porosity that is filled by water.

If the travel time for a chemical from a source area to the water table exceeds 1,000 years, the chemical is eliminated from the list of initial CMCOPCs. See Table 6-12 for leaching and travel parameters. As shown in Table 6-11, the following initial CMCOPCs had travel times less than 1,000 years for each area:

North Line Road Coal Tipple

- Three metals: arsenic, barium, and selenium
- Four SVOCs: 2-methylnaphthalene, benzo(a)pyrene, dibenzofuran, and naphthalene
- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- One SVOC: naphthalene.

Building U-16 Boiler House

- One metal: cobalt
- One organochlorine pesticide: alpha-hexachlorohexane.

This vertical travel time through soil is independent of chemical concentration.

The final soil screening analysis eliminates from further consideration those initial CMCOPCs that require more than 1,000 years to travel laterally with the groundwater through the aquifer to reach the downgradient receptor location. The estimated travel time for each initial CMCOPC to reach the downgradient receptor location is determined using the following equation:

$$T_{RC} = \frac{X_{min} \times R}{(V_s)}$$

(Equation 6-7)

where

T_{RC} = Groundwater travel time to receptor location (year).
X_{min} = Minimum distance to receptor location (ft).
R = Retardation factor (dimensionless).
V_S = Groundwater seepage velocity (ft/year).

As shown in Table 6-13, only two initial CMCOPCs had calculated travel times to the downgradient receptor that were less than 1,000 years:

North Line Road Coal Tipple

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- One SVOC: naphthalene.

If CMCOPCs that remain after the soil screening evaluation have concentrations greater than the most stringent Resident Receptor FWCUGs at 1×10^{-6} and HQ of 0.1 (or RSLs if no FWCUGs are established), the fate and transport evaluation would proceed to include modeling to predict the concentrations of CMCOPCs at the groundwater-surface water interface after leaching and groundwater transport. For this AOC, only 2,4-dinitrotoluene and naphthalene remained as an initial CMCOPC; however, the 2,4-dinitrotoluene MDC of 0.01 mg/kg is an order of magnitude less than its FWCUG of 0.753 mg/kg, and the naphthalene MDC of 0.063 mg/kg is orders of magnitude less than its FWCUG of 122 mg/kg. Therefore, fate and transport modeling was not necessary for this AOC and was not included as part of this RI. Conclusions of the soil screening evaluation are that all of the identified SRCs at this AOC in soil were eliminated as current risks to groundwater.

6.3.2 Limitations and Assumptions of Soil Screening Analysis

Acceptable soil concentrations for individual chemicals are location-specific. The generic SSLs used in this screening are based on a number of default assumptions chosen to be protective of human health for most CC RVAAP-73 Facility-Wide Coal Storage conditions (USEPA 1996a). These generic SSLs are expected to be more conservative than site SSLs based on area-specific conditions. The conservative assumptions included in this analysis are: (1) no adsorption in the unsaturated zone or in the aquifer, (2) no biological or chemical degradation in the soil or in the aquifer, and (3) contamination is uniformly distributed throughout the source. However, the generic SSL does not incorporate the existence of contamination already present within the aquifer.

6.4 FATE AND TRANSPORT SUMMARY AND CONCLUSIONS

No CMCOPCs were identified at the three former coal storage areas of CC RVAAP-73 Facility-Wide Coal Storage. The SRCs were screened out as CMCOPCs during the soil screening analysis. Therefore, results from the fate and transport analyses indicate SRCs in soil do not pose risks to groundwater.

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Table 6-1: Summary of Surface Water Sampling Results, North Line Road Coal Tipple

	Location ID:	Background Screening Value	Facility-Wide Cleanup Goal [b]	Screening Value Source [c]	Maximum Detected Concentration	73-NLCT-DW-SW3	73-NLCT-DW-SW4	73-NLCT-MD-SW2		73-NLCT-UP-SW1
	Field Sample ID:					073SW-0061-0001-SW	073SW-0067-0001-SW	073SW-0058-0001-SW	073SW-0059-0001-SW	073SW-0056-0001-SW
	Lab Sample ID:					240-22648-18	240-22648-21	240-22648-16	240-22648-17	240-22648-15
	Sample Date:					3/28/2013	3/28/2013	3/28/2013	3/28/2013	3/28/2013
	Sample Depth:					0-0	0-0	0-0	0-0	0-0
Metals [a]										
Arsenic	μg/L	3.2	1.1	RR	13	ND	13	ND	0.66 J	ND
Barium	μg/L	47.5	2,901	RR	560	14	560	18	20	15
Beryllium	μg/L	NB	4.0	MCL RSL	0.83	ND	0.83 J	ND	0.057 J	ND
Cadmium	μg/L	0	6.41	RR	2.1	ND	2.1	ND	ND	ND
Manganese	μg/L	391	633	RR	13,000	96	13,000	160	200	95
Nickel	μg/L	0	312	RR	12	0.19 J	12	0.32 J	0.33 J	0.4 J
Selenium	μg/L	NB	50	MCL RSL	ND	ND	ND	ND	ND	ND
Silver	μg/L	0	76.8	RR	2.5	ND	ND	ND	ND	2.5 J
Zinc	μg/L	42	4,617	RR	97	1.9 J	97	3.2 J	3.1 J	1.8 J
Semivolatile Organic Compounds [a]										
2-Methylnaphthalene	μg/L	NB	27	TAP RSL	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	μg/L	NB	0.014	RR	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	μg/L	NB	0.0008	RR	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	μg/L	NB	0.008	RR	ND	ND	ND	ND	ND	ND
Chrysene	μg/L	NB	1.36	RR	ND	ND	ND	ND	ND	ND
Dibenzofuran	μg/L	NB	5.8	TAP RSL	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	μg/L	NB	0.029	TAP RSL	ND	ND	ND	ND	ND	ND
Phenanthrene	μg/L	NB	1,300	TAP RSL	ND	ND	ND	ND	ND	ND
Pyrene	μg/L	NB	469	RR	0.12	ND	0.12 J	ND	ND	ND

Notes:
Yellow shading indicates that maximum detected concentration is greater than the FWCUG for surface water.
a. Analytes listed are those site-related chemicals identified in surface soil at the decision unit.
b. The most stringent Resident Receptor FWCUG for surface water is used; however, if that value is not established, the USEPA RSL MCL is used. If MCL is not available, the Tapwater screening level is used. (USEPA April 2012
Anthracene was used as a surrogate for phenanthrene.
c. Source of Screening Values:
MCL RSL = Maximum Contaminant Level Regional Screening Level.
RR = Residential Receptor (Lower of Adult and Child) (Lower of Hazard Quotient = 0.1 and TR of 1×10^{-6}).
TAP RSL = Tapwater Regional Screening Level.

μg/L = Micrograms per liter.
FWCUG = Facility-Wide Cleanup Goal.
ID = Identification.
J = Estimated: The analyte was positively identified; the quantitation is an estimation.
MCL = Maximum contaminant level.
NA = Not available.
NB = No background screening value.
ND = Not detected.
RSL = Regional Screening Level.
TR = Target Risk.
USEPA = United States Environmental Protection Agency.

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Table 6-2: Summary of Wet Sediment Sampling Results, North Line Road Coal Tipple

Location ID:		Background Screening Value (BSV)	Facility-Wide Cleanup Goal (b)	Screening Value Source (c)	Maximum Detected Concentration	73-NLCT-DD-SD4	73-NLCT-DW-SD3	73-NLCT-MD-SD2		73-NLCT-UP-SD1
Field Sample ID:						073SD-0046-0001-SD	073SD-0050-0001-SD	073SD-0047-0001-SD	073SD-0048-0001-SD	073SD-0045-0001-SD
Lab Sample ID:						240-22648-14	240-22648-13	240-22648-11	240-22648-12	240-22648-10
Sample Date:						3/28/2013	3/28/2013	3/28/2013	3/28/2013	3/28/2013
Sample Depth:						0-1	0-1	0-1	0-1	0-1
Metals (a)										
Arsenic	mg/kg	19.5	0.425	RR	<BSV	<BSV	<BSV	<BSV	<BSV	<BSV
Barium	mg/kg	123	15,000	RRSL	180	140	64	180	180	140
Beryllium	mg/kg	0.38	16	RRSL	0.94	0.66	0.39	0.93	0.94	0.64
Cadmium	mg/kg	0	6.41	RR	0.89	0.83	0.35	0.89	0.79	0.71
Manganese	mg/kg	1,950	293	RR	2,900	330 J	580 J	2,300 J	2,900 J	2,300 J
Nickel	mg/kg	17.7	155	RR	21	20	13	21	21	20
Selenium	mg/kg	NA	39	RRSL	1.7	1.7	0.43 J	0.71 J	0.78	0.87 J
Silver	mg/kg	0	38.6	RR	0.09	0.067 J	0.034 J	0.043 J	0.039 J	0.09 J
Zinc	mg/kg	532	2321	RR	84	<BSV	<BSV	<BSV	<BSV	<BSV
Volatile Organic Compounds (a)										
Carbon Disulfide	mg/kg	NB	82	RRSL	0.0045	NR	0.0045 J	NR	NR	NR
Semivolatile Organic Compounds (a)										
2-Methylnaphthalene	mg/kg	NB	23	RRSL	0.025	0.025	0.0073 J	ND	0.0074 J	0.016 J
Acenaphthene	mg/kg	NB	340	RRSL	ND	ND	ND	ND	ND	ND
Acenaphthylene	mg/kg	NB	1,700	RRSL	0.038	0.038	ND	ND	ND	ND
Anthracene	mg/kg	NB	1,700	RRSL	0.27	0.27	ND	ND	ND	0.01 J
Benzo(a)anthracene	mg/kg	NB	0.221	RR	0.86	0.86	0.018	0.0076 J	ND	0.028
Benzo(a)pyrene	mg/kg	NB	0.022	RR	0.38	0.38	0.018	ND	ND	0.026
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR	0.86	0.86	0.035	0.0082 J	0.01	0.044
Benzo(g,h,i)perylene	mg/kg	NB	170	RRSL	0.19	0.19	0.011	ND	ND	0.022
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR	0.3	0.3	0.0068 J	ND	ND	0.02
Chrysene	mg/kg	NB	15	RRSL	1.1	1.1	0.024	0.0054 J	ND	0.038
Dibenzofuran	mg/kg	NB	7.8	RRSL	0.045	0.035 J	0.018 J	ND	ND	0.045 J
Fluoranthene	mg/kg	NB	230	RRSL	0.62	0.62	0.035	0.011	ND	0.053
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR	0.18	0.18	0.0081 J	ND	ND	0.017
Naphthalene	mg/kg	NB	3.6	RRSL	0.019	0.019	ND	ND	ND	0.012 J
Phenanthrene	mg/kg	NB	1,700	RRSL	0.053	0.053	0.012	ND	ND	0.023
Pyrene	mg/kg	NB	170	RRSL	0.67	0.67	0.032	0.0083 J	0.0082 J	0.046

Notes:
Yellow shading indicates that maximum detected concentration is greater than the FWCUG.
a. Analytes listed are those site-related chemicals identified in surface soil at the decision unit.
b. The most stringent Resident Receptor FWCUG for sediment is used; however, if that value is not established, the USEPA RSL is used (USEPA April 2012). Anthracene was used as a surrogate for acenaphthalene and phenanthrene. Pyrene used as a surrogate for benzo(g,h,i)perylene.
c. Source of Screening Values:
RR = Residential Receptor (Lower of Adult and Child) (Lower of Hazard Quotient = 0.1 and TR of 1×10^{-6}).
RRSL = Residential RSL (Lower of Hazard Quotient = 0.1 and TR of 1×10^{-6}).
BSV = Background screening value.
FWCUG = Facility-Wide Cleanup Goal.
ID = Identification.
J = Estimated: The analyte was positively identified; the quantitation is an estimation.
mg/kg = milligrams per kilogram.
NA = Not available.
NB = No background screening value.
ND = Not detected.
RSL = Regional Screening Level.
TR = Target Risk.
USEPA = United States Environmental Protection Agency.

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Table 6-3: Summary of Surface Water Sampling Results, Sand Creek Coal Tipple

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal [b]	Screening Value Source [c]	Maximum Detected Concentration	73-SCCT-DW-SW3	73-SCCT-MD-SW2	73-SCCT-UP-SW1
Field Sample ID:						073SW-0066-0001-SW	073SW-0064-0001-SW	073SW-0063-0001-SW
Lab Sample ID:						240-22562-16	240-22562-15	240-22562-14
Sample Date:						3/28/2013	3/28/2013	3/28/2013
Sample Depth:						0-0	0-0	0-0
Metals[a]								
Cadmium	μg/L	0	6.41	RR	ND	ND	ND	ND
Chromium (as CrVI)	μg/L	NB	30.3	RR	3.1	2.1	2.6	3.1
Nickel	μg/L	0	312	RR	1	0.87 J	0.87 J	1
Silver	μg/L	0	76.8	RR	0.2	ND	ND	0.16 J
Zinc	μg/L	42	0	RR	ND	ND	ND	ND
Semivolatile Organic Compounds[a]								
2-Methylnaphthalene	μg/L	NB	27	TAP RSL	ND	ND	ND	ND
Acenaphthalene	μg/L	NB	1,300	TAP RSL	ND	ND	ND	ND
Anthracene	μg/L	NB	1,300	TAP RSL	ND	ND	ND	ND
Benzo(a)anthracene	μg/L	NB	0.014	RR	ND	ND	ND	ND
Benzo(a)pyrene	μg/L	NB	0.0008	RR	ND	ND	ND	ND
Benzo(b)fluoranthene	μg/L	NB	0.008	RR	ND	ND	ND	ND
Benzo(g,h,i)perylene	μg/L	NB	469	RR	ND	ND	ND	ND
Benzo(k)fluoranthene	μg/L	NB	23.3	RR	ND	ND	ND	ND
Chrysene	μg/L	NB	1.36	RR	ND	ND	ND	ND
Dibenzofuran	μg/L	NB	5.8	TAP RSL	ND	ND	ND	ND
Fluoranthene	μg/L	NB	630	TAP RSL	ND	ND	ND	ND
Fluorene	μg/L	NB	220	TAP RSL	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	μg/L	NB	0.029	TAP RSL	ND	ND	ND	ND
Naphthalene	μg/L	NB	0.14	TAP RSL	ND	ND	ND	ND
Phenanthrene	μg/L	NB	1,300	TAP RSL	ND	ND	ND	ND
Pyrene	μg/L	NB	469	RR	ND	ND	ND	ND
Explosives [a]								
Tetryl	μg/L	NB	63	TAP RSL	0.82	ND	0.82 J	ND

Notes:

a. Analytes listed are those site-related chemicals identified in surface soil at the decision unit.

b. The most stringent Resident Receptor FWCUG for surface water is used; however, if that value is not established, the USEPA RSL MCL is used. If MCL is not available, the Tapwater screening level is used. (USEPA April 2012). Anthracene was used as a surrogate for acenaphthalene and phenanthrene. Pyrene used as a surrogate for benzo(g,h,i)perylene.

c. Source of Screening Values:
RR = Residential Receptor (Lower of Adult and Child) (Lower of Hazard Quotient = 0.1 and TR of 1×10^{-6}).
TAP RSL = Tapwater Regional Screening Level.

μg/L = Micrograms per liter.
FWCUG = Facility-Wide Cleanup Goal.
ID = Identification.
J = Estimated: The analyte was positively identified; the quantitation is an estimation.
MCL = Maximum Contaminant Level.
NA = Not available.
NB = No background screening value.
ND = Not detected.
RSL = Regional Screening Level.
TR = Target Risk.
USEPA = United States Environmental Protection Agency.

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Table 6-4: Summary of Wet Sediment Sampling Results, Sand Creek Coal Tipple

		Background Screening Value (BSV)	Facility-Wide Cleanup Goal [a]	Screening Value Source [b]	Maximum Detected Concentration			
Location ID:						**73-SCCT-DW-SD3**	**73-SCCT-MD-SD2**	**73-SCCT-UP-SD1**
Field Sample ID:						**073SD-0055-0001-SD**	**073SD-0054-0001-SD**	**073SD-0052-0001-SD**
Lab Sample ID:						**240-22562-13**	**240-22562-12**	**240-22562-11**
Sample Date:						**3/28/2013**	**3/28/2013**	**3/28/2013**
Sample Depth:						**0-1**	**0-1**	**0-1**
Metals [a]								
Cadmium	mg/kg	0	6.41	RR	0.29	0.29	0.2	0.21
Chromium (as CrVI)	mg/kg	NB	19.9	RR	9.5	9.5	6	6.8
Nickel	mg/kg	17.7	155	RR	<BSV	<BSV	<BSV	<BSV
Silver	mg/kg	0	38.6	RR	1	0.19	1	0.09 J
Zinc	mg/kg	532	2,321	RR	<BSV	<BSV	<BSV	<BSV
Semivolatile Organic Compounds [a]								
2-Methylnaphthalene	mg/kg	NB	23	RRSL	0.024	0.024	0.0065 J	ND
Acenaphthylene	mg/kg	NB	1,700	RR	ND	ND	ND	ND
Anthracene	mg/kg	NB	1,700	RRSL	0.0053	ND	0.0053 J	ND
Benzo(a)anthracene	mg/kg	NB	0.221	RR	0.024	0.019	0.024	0.01
Benzo(a)pyrene	mg/kg	NB	0.022	RR	0.018	0.016	0.018	0.0083 J
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR	0.027	0.027	0.027	0.012
Benzo(g,h,i)perylene	mg/kg	NB	170	RRSL	0.015	0.015	0.013	0.0054 J
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR	0.011	0.01	0.011	0.0048 J
Chrysene	mg/kg	NB	15	RRSL	0.022	0.022	0.021	0.0088
Dibenzofuran	mg/kg	NB	7.8	RRSL	0.011	0.011 J	ND	0.0053 J
Fluoranthene	mg/kg	NB	230	RRSL	0.042	0.029	0.042	0.016
Fluorene	mg/kg	NB	230	RR	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR	0.0096	0.0095	0.0096	0.0042 J
Naphthalene	mg/kg	NB	3.6	RRSL	0.018	0.018	ND	0.0084
Phenanthrene	mg/kg	NB	1,700	RRSL	0.023	0.021	0.023	ND
Pyrene	mg/kg	NB	170	RRSL	0.035	0.026	0.035	0.013

Notes:

a. Analytes listed are those site-related chemicals identified in surface soil at the decision unit.

b. The most stringent Resident Receptor FWCUG for sediment is used; however, if that value is not established, the USEPA RSL is used (USEPA April 2012). Anthracene was used as a surrogate for acenaphthalene and phenanthrene. Pyrene used as a surrogate for benzo(g,h,i)perylene.

c. Source of Screening Values:
RR = Residential Receptor (Lower of Adult and Child) (Lower of Hazard Quotient = 0.1 and TR of 1×10^{-6}).
RRSL = Residential RSL (Lower of Hazard Quotient = 0.1 and TR of 1×10^{-6}).

BSV = Background screening value.
FWCUG = Facility-Wide Cleanup Goal.
ID = Identification.
J = Estimated: The analyte was positively identified; the quantitation is an estimation.
mg/kg = milligrams per kilogram.
NA = Not available.
NB = No background screening value.
ND = Not detected.
NR = Not reported.
RSL = Regional Screening Level.
TR = Target Risk.
USEPA = United States Environmental Protection Agency.

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Table 6-5: Climatic Data for Hydrologic Evaluation of Landfill Performance Model

Month	Air Temperature (°C)	Cloud Cover	Humidity	Albedo	Evapotranspiration	Precipitation (centimeters)	Duration (days)	Storms per Month	Model Days in Month
October	12	0.60	0.70	0.17	0.00	6.46	0.42	5.33	30.4
November	5.22	0.70	0.75	0.24	0.00	7.4	0.53	6.67	30.4
December	-1.06	0.80	0.75	0.31	0.00	7.06	0.57	6.14	30.4
January	-2.94	0.80	0.80	0.3	0.00	7.06	0.61	5.69	30.4
February	-2.33	0.70	0.75	0.32	0.00	5.76	0.53	5.09	30.4
March	2.33	0.70	0.70	0.29	0.00	8.26	0.55	7.14	30.4
April	9.11	0.70	0.70	0.19	0.00	8.83	0.48	7.4	30.4
May	14.61	0.60	0.70	0.16	0.00	8.46	0.45	7.15	30.4
June	19.89	0.60	0.70	0.16	0.00	9.07	0.36	6.57	30.4
July	21.89	0.50	0.70	0.16	0.00	9.8	0.3	6.06	30.4
August	21.11	0.55	0.70	0.16	0.00	8.14	0.3	6.06	30.4
September	17.67	0.55	0.70	0.16	0.00	7.85	0.4	5.44	30.4

Notes:
Data from Youngstown, Ohio, Weather Service Office – Airport Station.
°C = Celsius.
HELP = Hydrologic Evaluation of Landfill Performance.

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Table 6-6: Physical and Chemical Properties of Organic and Inorganic Site-Related Chemicals in Soil

Site-Related Chemicals	Maximum Detected Concentration (mg/kg)	K_d (L/kg) or K_{oc} (L/kg)	Reference	HLC (atm-m^3/mol)	Reference	Molecular Weight	Solubility (mg/L)	Reference	Diffusion Coefficient in Air (cm^2/sec)	Reference	Diffusion Coefficient in Water (cm^2/sec)	Reference	Generic SSL (mg/kg)	Reference
Metals														
Arsenic	28	29	b	NA	-	74.9	NA	-	NA	-	NA	-	0.29	d
Barium	160	41	b	NA	-	137	NA	-	NA	-	NA	-	82	d
Beryllium	3.3	790	b	NA	-	9.01	NA	-	NA	-	NA	-	3.2	d
Cadmium	0.61	75	b	NA	-	112	NA	-	NA	-	NA	-	0.38	d
Chromium	19	19	b	NA	-	52	NA	-	NA	-	NA	-	180,000	d
Cobalt	11	NA	b	NA	-	58.9	NA	-	NA	-	NA	-	0.21	d
Copper	19	22	a	NA	-	64	NA	-	NA	-	NA	-	46	d
Manganese	1,900	180	c	NA	-	55	NA	-	NA	-	NA	-	21	d
Nickel	24	65	b	NA	-	59	NA	-	NA	-	NA	-	110	d
Selenium	2.3	NA	b	NA	-	79	NA	-	NA	-	NA	-	0.26	d
Silver	0.44	8	b	NA	-	108	NA	-	NA	-	NA	-	0.6	d
Thallium	0.16	71	b	NA	-	204	NA	-	NA	-	NA	-	0.14	d
Zinc	99	62	b	NA	-	65	NA	-	NA	-	NA	-	290	d
Organochlorine Pesticides														
alpha-BHC (alpha-Hexachlorocyclohexane)	0.0012	2,807	d	0.00000514	d	290.83	2	d	0.043284	d	0.00000506	d	0.000036	d
p,p'-Dichlrodiphenyldichloroethylene	0.00066	118,000	d	0.0000416	d	0.0318	0.04	d	0.0408	d	0.00000476	d	0.046	d
Volatile Organic Compounds														
Carbon Disulfide	0.0029	21.73	d	0.0144	d	76.13	2,160	d	0.106447	d	0.000013	d	0.21	d
Semivolatile Organic Compounds														
1,4-Dichlorobenzene	0.035	375.3	d	0.00241	d	147	81.3	d	0.0550429	d	0.00000868	d	0.072	d
2-Methylnaphthalene	9.1	2,478	d	0.000518	d	142	24.6	d	0.0524	d	0.00000778	d	0.75	d
Acenaphthene	0.24	5,030	d	0.00	d	154	3.90	d	0.0506000	d	0.0000083	d	4.1	d
Acenaphthylene (RSL use Acenaphthene)	0.16	7,400	e	0.0000119	d	152	16.1	R	0.045	R	0.000007	R	4	d
Anthracene	0.3	16,400	d	0.0000556	d	178	0.0434	d	0.039	d	0.00000785	d	42	d
Benzo(a)anthracene	0.73	177,000	d	0.000012	d	228	0.0094	d	0.0509	d	0.00000594	d	0.01	d
Benzo(a)pyrene	0.57	587,000	d	0.000000457	d	252	0.00162	d	0.0476	d	0.00000556	d	0.24	d
Benzo(b)fluoranthene	0.67	599,000	d	0.000000657	d	252	0.0015	d	0.0476	d	0.00000556	d	0.035	d
Benzo(g,h,i)perylene (RSL use Pyrene)	0.16	10,700,000	e	0.00000014	e	276	0.00026	R	NA	R	NA	R	4.1	d
Benzo(k)fluoranthene	0.19	587,000	d	0.000000584	d	252	0.0008	d	0.0476	d	0.00000556	d	0.35	d
Benzyl alcohol	0.13	21.46	d	0.000000337	d	108.14	42,900.00	d	0.0731186	d	0.00000937	d	0.37	d
Chrysene	1	181,000	d	0.00000523	d	228	0.00	d	0.0261	d	0.00000675	d	1.1	d
Dibenzofuran	2.5	9,160	d	0.000213	d	168	3.1	d	0.041	d	0.00000738	d	0.11	d
Fluoranthene	0.86	55,500	d	0.00000886	d	202	0.26	d	0.0276	d	0.00000718	d	70	d
Fluorene	0.0096	9,160	d	0.0000962	d	166	1.69	d	0.044	d	0.00000789	d	4	d
Indeno(1,2,3-c,d)Pyrene	0.14	1,950,000	d	0.000000348	d	276	0.00019	d	0.0448	d	0.00000523	d	0.12	d

Table 6-6: Physical and Chemical Properties of Organic and Inorganic Site-Related Chemicals in Soil (continued)

Site-Related Chemicals	Maximum Concentration (mg/kg)	K_d (L/kg) or K_{oc} (L/kg)	Reference	HLC (atm-m³/mol)	Reference	Molecular Weight	Solubility (mg/L)	Reference	Diffusion Coefficient in Air (cm²/sec)	Reference	Diffusion Coefficient in Water (cm²/sec)	Reference	Generic SSL (mg/kg)	Reference
Isophorone	0.031	65.15	d	0.00000664	d	138.21	12,000	d	0.052505	d	0.00000753	d	0.022	d
Naphthalene	4.6	1,540	d	0.00044	d	128	31	d	0.0605	d	0.00000838	d	0.00047	d
Phenanthrene (used RSL for Acenaphthene)	5.5	18,200	e	0.0000393	e	178	1.15	R	0.0345	R	0.00000669	R	4.1	d
Pyrene	1	54,300	d	0.0000119	d	202	0.135	d	0.0278	d	0.00000725	d	9.5	d
Explosives														
2,4-Dinitrotoluene	0.01	575.6	d	5.4×10^{-8}	d	182.14	200	d	0.0375115	d	0.0000079	d	0.00028	d
Tetryl	0.024	4,605	d	2.71×10^{-9}	d	287.15	74	d	0.0255626	d	0.00000667	d	0.029	d
Propellants														
Nitrocellulose	0.91	10	b	3.29×10^{-23}	b	387.30	1,000,000	b	0.0357593	b	0.00000418	b	1,000	b

Notes:

a. Baes and Sharp. 1983. *A Proposal for Estimation of Soil Leaching and Leaching Constants for Use in Assessment Models*. *Journal of Environmental Quality* 12, pp. 17-28.
b. USEPA. 1996b. Soil Screening Guidance assuming a neutral pH: *Technical Background Document*, May.
c. Sheppard and Thibault. 1990. *Default soil/liquid partition coefficients, K_ds, for four major soil types: a compendium*. *Health Physics* 59; 471-482.
d. USEPA RSL. April 2012. Found at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.
e. USEPA. 1994. Risk Reduction Engineering Laboratory Treatability Database, Ver. 5.0, Office of Research and Development, Cincinnati, Ohio.

atm-m³/mol = Atmospheres relative to mols per cubic meter.
cm²/sec = Centimeters per second.
Cw = Target groundwater concentration (either Maximum Contaminant Level or RSL).
HLC = Henry's Law Constant.
K_d = Distribution coefficient.
K_{oc} = Organic carbon partition coefficient.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not applicable.
NB = No background.
PCB = Polychlorinated biphenyl.
R = Risk Assessment Information System.
RSL = Regional Screening level.
SSL = Soil Screening Level.
USEPA = United States Environmental Protection Agency.

Table 6-7: Initial Contaminant Migration Chemicals of Potential Concern Based on Comparison of Maximum Concentrations of Site-Related Chemicals to Generic Soil Screening Levels

Site-Related Chemicals		Maximum Detected Concentration (mg/kg)			Generic SSL (mg/kg)	CMCOPC? (Yes/No)		
		Former Coal Storage Area				Former Coal Storage Area		
		NLCT	SCCT	U-16		NLCT	SCCT	U-16
Metals								
Arsenic	**mg/kg**	**28**	<BSV	<BSV	0.29	**Yes**	NA	NA
Barium	**mg/kg**	**160**	<BSV	<BSV	82	**Yes**	NA	NA
Beryllium	**mg/kg**	**3.3**	<BSV	<BSV	3.2	**Yes**	NA	NA
Cadmium	**mg/kg**	**0.61**	0.22	0.26	0.38	**Yes**	No	No
Chromium	mg/kg	<BSV	19	<BSV	180,000	NA	No	NA
Cobalt	**mg/kg**	<BSV	<BSV	**11**	0.21	NA	NA	**Yes**
Copper	mg/kg	<BSV	<BSV	19	46	NA	NA	No
Manganese	**mg/kg**	**1,900**	<BSV	<BSV	21	**Yes**	NA	NA
Nickel	mg/kg	24	22	22	110	No	No	No
Selenium	**mg/kg**	**2.3**	<BSV	<BSV	0.26	**Yes**	NA	NA
Silver	mg/kg	0.041	0.44	0.03	0.6	No	No	No
Thallium	**mg/kg**	<BSV	<BSV	**0.16**	0.14	NA	NA	**Yes**
Zinc	mg/kg	99	64	<BSV	290	No	No	NA
Organochlorine Pesticides								
alpha-BHC (alpha-Hexachlorocyclohexane)	**mg/kg**	ND	ND	**0.0012**	**0.000036**	NA	NA	**Yes**
p,p'-Dichlorodiphenyldichloroethene	mg/kg	ND	ND	0.00066	0.046	NA	NA	No
Volatile Organic Compounds								
Carbon Disulfide	mg/kg	0.0029	0.0013	ND	0.21	No	No	NA
Semivolatile Organic Compounds								
1,4-Dichlorobenzene	mg/kg	0.022	0.035	ND	0.072	No	No	NA
2-Methylnaphthalene	**mg/kg**	**9.1**	0.09	0.036	0.75	**Yes**	No	No
Acenaphthene	mg/kg	0.24	ND	ND	22	No	NA	NA
Acenaphthylene (RSL use Acenaphthene)	mg/kg	0.16	0.0094	ND	4.1	No	No	NA
Anthracene	mg/kg	0.3	0.025	ND	42	No	No	NA
Benzo(a)anthracene	mg/kg	0.73	0.077	ND	0.01	Yes	Yes	NA
Benzo(a)pyrene	mg/kg	0.57	0.087	ND	0.24	Yes	No	NA

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Table 6-7: Initial Contaminant Migration Chemicals of Potential Concern Based on Comparison of Maximum Concentrations of Site-Related Chemicals to Generic Soil Screening Levels (continued)

Site-Related Chemicals		Maximum Detected Concentration (mg/kg)			Generic SSL (mg/kg)	CMCOPC? (Yes/No)		
		Former Coal Storage Area				Former Coal Storage Area		
		NLCT	SCCT	U-16		NLCT	SCCT	U-16
Benzo(b)fluoranthene	**mg/kg**	**0.67**	**0.12**	ND	0.035	**Yes**	**Yes**	NA
Benzo(g,h,i)perylene (RSL use Pyrene)	mg/kg	0.16	0.047	ND	9.5	No	No	NA
Benzo(k)fluoranthene	mg/kg	0.19	0.031	ND	0.35	No	No	NA
Benzyl alcohol	**mg/kg**	ND	0.13	ND	0.37	NA	No	NA
Chrysene	mg/kg	1	0.08	ND	1.1	No	No	NA
Dibenzofuran	**mg/kg**	**2.5**	0.023	ND	0.11	**Yes**	No	NA
Fluoranthene	mg/kg	0.86	0.15	ND	70	No	No	NA
Fluorene	mg/kg	0.0073	0.0096	ND	4	No	No	NA
Indeno(1,2,3-c,d)Pyrene	**mg/kg**	**0.14**	0.054	ND	0.12	**Yes**	No	NA
Isophorone	**mg/kg**	**0.031**	**0.023**	ND	0.022	**Yes**	**Yes**	NA
Naphthalene	**mg/kg**	**4.6**	**0.063**	**0.034**	0.00047	**Yes**	**Yes**	**Yes**
Phenanthrene (used RSL for Acenaphthene)	**mg/kg**	**5.5**	0.087	ND	4.1	**Yes**	No	NA
Pyrene	mg/kg	1	0.12	ND	9.5	No	No	NA
Explosives								
2,4-Dinitrotoluene	**mg/kg**	**0.01**	ND	ND	0.00028	**Yes**	**Yes**	NA
Tetryl	mg/kg	0.010	0.024	ND	0.590	No	No	NA
Propellants								
Nitrocellulose	mg/kg	0.87	ND	0.91	10,000	No	NA	No

Notes:
BOLD indicates initial CMCOPCs that exceed the generic SSL.
CMCOPC = Contaminant migration chemical of potential concern.
mg/kg = Milligrams per kilogram.
NA = Not applicable.
ND = Non-detect.
NLCT = North Line Road Coal Tipple.
RSL = Regional Screening Level.
SCCT = Sand Creek Coal Tipple.
SSL = Soil Screening Level.
U-16 = Building U-16 Boiler House.

Table 6-8: Initial Contaminant Migration Chemicals of Potential Concern Based on Comparison of Maximum Concentrations of Site-Related Chemicals to Site Soil Screening Levels

	Maximum Detected Concentration (mg/kg)				DAF		Site SSL (DAF*Generic SSL) (mg/kg)		CMCOPC? (Maximum Concentration>Site SSL)		
	Former Coal Storage Area				Former Coal Storage Area		Former Coal Storage Area		Former Coal Storage Area		
Initial CMCOPCs	**NLCT**	**SCCT**	**U-16**	**Generic SSL (mg/kg)**	**NCLT and SCCT**	**U-16**	**NCLT and SCCT**	**U-16**	**NLCT**	**SCCT**	**U-16**
Metals											
Arsenic	**28**	NA	NA	0.29	1.42	1.59	0.41	0.46	**Yes**	NA	NA
Barium	**160**	NA	NA	82	1.42	1.59	116.4	130.4	**Yes**	NA	NA
Beryllium	3.3	NA	NA	3.2	1.42	1.59	4.54	5.09	No	NA	NA
Cadmium	**0.61**	NA	NA	0.38	1.42	1.59	0.54	0.60	**Yes**	NA	NA
Cobalt	NA	NA	**11**	0.21	1.42	1.59	NA	0.33	NA	NA	**Yes**
Manganese	**1,900**	NA	NA	21	1.42	1.59	29.82	33.39	**Yes**	NA	NA
Selenium	**2.3**	NA	NA	0.26	1.42	1.59	0.37	0.41	**Yes**	NA	NA
Thallium	NA	NA	0.16	0.14	1.42	1.59	NA	0.22	NA	NA	No
Organochlorine Pesticides											
alpha-BHC (alpha-Hexachlorocyclohexane)	ND	ND	**0.0012**	0.000036	1.42	1.59	NA	0.000057	NA	NA	**Yes**
Semivolatile Organic Compounds											
2-Methylnaphthalene	**9.1**	NA	NA	0.75	1.42	1.59	1.07	1.19	**Yes**	NA	NA
Benzo(a)anthracene	**0.73**	**0.077**	NA	0.01	1.42	1.59	0.01	0.02	**Yes**	**Yes**	NA
Benzo(a)pyrene	**0.57**	NA	NA	0.24	1.42	1.59	0.34	0.38	**Yes**	NA	NA
Benzo(b)fluoranthene	**0.67**	**0.12**	NA	0.035	1.42	1.59	0.05	0.06	**Yes**	**Yes**	NA
Dibenzofuran	**2.5**	NA	NA	0.11	1.42	1.59	0.16	0.17	**Yes**	NA	NA
Indeno(1,2,3-c,d)Pyrene	0.14	NA	NA	0.12	1.42	1.59	0.17	0.19	No	NA	NA

Table 6-8: Initial Contaminant Migration Chemicals of Potential Concern Based on Comparison of Maximum Concentrations of Site-Related Chemicals to Site Soil Screening Levels (continued)

	Maximum Detected Concentration (mg/kg)				DAF		Site SSL (DAF*Generic SSL) (mg/kg)		CMCOPC? (Maximum Concentration >Site SSL)		
	Former Coal Storage Area				Former Coal Storage Area		Former Coal Storage Area		Former Coal Storage Area		
Initial CMCOPCs	**NLCT**	**SCCT**	**U-16**	**Generic SSL (mg/kg)**	**NCLT and SCCT**	**U-16**	**NCLT and SCCT**	**U-16**	**NLCT**	**SCCT**	**U-16**
Isophorone	0.031	0.023	NA	0.022	1.42	1.59	0.03	0.035	No	No	NA
Naphthalene	**4.6**	**0.063**	**0.034**	0.00047	1.42	1.59	0.001	0.000747	**Yes**	**Yes**	**Yes**
Phenanthrene (used RSL for Acenaphthene)	5.5	NA	NA	4.1	1.42	1.59	5.82	6.52	No	NA	NA
Explosives											
2,4-Dinitrotoluene	**0.01**	NA	NA	0.00028	1.42	1.59	0.0004	0.000445	**Yes**	**Yes**	NA

Notes:
BOLD indicates initial CMCOPC that exceeds site-specific SSL.
a. USEPA RSL April 2012. Found at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm.
CMCOPC = Contaminant migration chemical of potential concern.
DAF = Dilution Attenuation Factor (calculated on Table 6-9).
mg/kg = milligrams per kilogram.
NA = Not available.
ND = Non-detect.
NLCT = North Line Road Coal Tipple.
RSL = Regional Screening Level.
SCCT = Sand Creek Coal Tipple.
SRC = Site-Related Chemical.
SSL = Soil Screening Level.
U-16 = Building U-16 Boiler House.

Table 6-9: Parameters for Determination of Dilution Attenuation Factor

Parameter	Symbol	Value	Unit	Note
Dilution attenuation factor	DAF	see below	unitless	Calculated from DAF equation below
Aquifer hydraulic conductivity (NLCT, U-16)	K	41	m/year	MKM Engineers, Inc. (2007) unconsolidated deposits
Aquifer hydraulic conductivity (SCCT)	K	18	m/year	MKM Engineers, Inc. (2007) Sharon Sandstone
Horizontal hydraulic gradient (NLCT, U-16)	i	0.0045	unitless	Determined from Figure 2-4 (EQM 2013)
Horizontal hydraulic gradient (SCCT)	i	0.005	unitless	Determined from Figure 2-6 (EQM 2013)
Percolation rate	q	0.091	m/year	Developed from HELP Model using Youngstown, Ohio weather data
Source length parallel to groundwater flow	L	see below	m	Across each decision unit in downgradient direction (see below)
Mixing zone depth	d	see below	m	Calculated from d equation below
Aquifer thickness (SCCT)	da	10	m	Minimum thickness based on screened interval of B12mw-013
Aquifer thickness (NLCT, U-16)	da	6	m	Facility-wide assumption for the unconsolidated aquifer presented in the Load Line 1 Investigation (USACE 2003a)

Notes:
d = $(0.0112*L^2)^{0.5} + da(1-\exp(((-L*q)/(K*i*da))$.
DAF = $1+(K*i*d)/(q*L)$.
USACE = United States Army Corps of Engineers.
USEPA = United States Environmental Protection Agency.
Source: Soil Screening Guidance: Technical Background Document (USEPA 1996b).

Average Source Length Parallel to Groundwater Flow (m)	Source Area	Dilution Attenuation Factor	Mixing Zone Depth
58	North Line Road Coal Tipple	1.42	12
30	Sand Creek Coal Tipple	1.42	13
30	Building U-16 Boiler House	1.59	9

Notes:
m = Meters.
DU = Decision unit.
HELP = Hydrologic Evaluations of Landfill Performance.
NLCT = North Line Road Coal Tipple.
SCCT = Sand Creek Coal Tipple.
U-16 = Building U-16 Boiler House.

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Table 6-10: Leaching Zone Thickness Determinations

Initial CMCOPCs	Deepest Detect > BSV or FWCUG[a] (ft bgs)			Estimated Water Table Depth (ft bgs)			Leaching Zone (ft)			Sample Identification
	Former Coal Storage Area			Former Coal Storage Area			Former Coal Storage Area			
	NLCT	SCCT	U-16	NLCT	SCCT	U-16	NLCT	SCCT	U-16	
Metals										
Arsenic	1	NA	NA	4	NA	NA	3	NA	NA	073SS-0005M-0001-SO
Barium	1	NA	NA	4	NA	NA	3	NA	NA	073SS-0005M-0001-SO
Cadmium	1	NA	NA	4	NA	NA	3	NA	NA	073SS-0005M-0001-SO
Cobalt	NA	NA	1	NA	NA	22	NA	NA	21	073SS-0035M-0001-SO
Manganese	1	NA	NA	4	NA	NA	3	NA	NA	073SS-0005M-0001-SO
Selenium	1	NA	NA	4	NA	NA	3	NA	NA	073SS-0005M-0001-SO
Organochlorine Pesticides										
alpha-BHC (alpha-Hexachlorocyclohexane)	NA	NA	7[b]	NA	NA	22	NA	NA	15	073SS-0041M-0001-SO
Semivolatile Organic Compounds										
2-Methylnaphthalene	1[c]	NA	NA	4	NA	NA	3	NA	NA	073SS-0005M-0001-SO
Benzo(a)anthracene	1	4[c]	NA	4	35	NA	3	31	NA	073SS-0005M-0001-SO, 073SS-0016M-0001-SO
Benzo(a)pyrene	7	4	NA	4	35	NA	0	31	NA	073SS-0027M-0001-SO, 073SS-0028M-0001-SO, 073SS-0016M-0001-SO, 073SS-0017M-0001-SO
Benzo(b)fluoranthene	1	1[c]	NA	4	35	NA	3	34	NA	073SS-0005M-0001-SO, 073SS-0002M-0001-SO
Dibenzofuran	1[c]	1[c]	NA	4	35	NA	3	34	NA	073SS-0005M-0001-SO, 073SS-0002M-0001-SO
Naphthalene	1[c]	1[c]	NA	4	35	NA	3	34	NA	073SS-0005M-0001-SO, 073SS-0002M-0001-SO
Explosives										
2,4-Dinitrotoluene	7[b]	NA	NA	4	NA	NA	0	NA	NA	073SS-0031M-0001-SO

Table 6-10: Leaching Zone Thickness Determinations (continued)

Notes:

a. Represents the maximum depth with an analyte concentration greater than the BSV for inorganics or the most stringent Resident Receptor FWCUG at 10-6 or HQ of 0.1 for organics.
b. Analyte was not detected in soil at concentrations greater than the FWCUG, so this value represents the only detection of this analyte.
c. For this former coal storage area, analyte was not detected in soil at concentrations greater than the FWCUG, so this value represents the sample with the maximum concentration.

bgs	=	Below ground surface.
BSV	=	Background Screening Value.
CMCOPC	=	Contaminant migration chemicals of potential concern.
ft	=	Feet.
FWCUG	=	Facility-Wide Cleanup Goal.
HQ	=	Hazard Quotient.
NA	=	Not applicable.
NLCT	=	North Line Road Coal Tipple.
SCCT	=	Sand Creek Coal Tipple.

Table 6-11: Initial Contaminant Migration Chemicals of Potential Concern Based on Arrival Time to Groundwater Table in Less Than or Equal to 1,000 Years

Initial CMCOPCs		Sample Identification	Sample Depth Interval[(a)] (ft)	Lz[(b)] (ft)	K_{oc} (L/kg)[(c)]	K_d (L/kg)[(d)]	R[(e)]	T (years)	T < 1,000? From Sample Depth to Groundwater Table (Yes/No)
North Line Road Coal Tipple									
Metals									
Arsenic		**073SS-0005M-0001-SO**	**0-1**	**3**	**NA**	**29**	**200.7**	**505**	**Yes**
Barium		**073SS-0005M-0001-SO**	**0-1**	**3**	**NA**	**41**	**283.3**	**713**	**Yes**
Cadmium		073SS-0005M-0001-SO	0-1	3	NA	75	517.3	1,302	No
Manganese		073SS-0005M-0001-SO	0-1	3	NA	180	1,240.2	3,121	No
Selenium		**073SS-0005M-0001-SO**	**0-1**	**3**	**NA**	**5**	**35.4**	**89**	**Yes**
Semivolatile Organic Compounds									
2-Methylnaphthalene		**073SS-0005M-0001-SO**	**0-1**	**3**	**2,478**	**2.48**	**18**	**45**	**Yes**
Benzo(a)anthracene		073SS-0016M-0001-SO	0-1	3	177,000	177	1,220	3,069	No
Benzo(a)pyrene		**073SS-0027M-0001-SO, 073SS-0028M-0001-SO**	**1-7**	**0**	**587,000**	**587**	**4,042**	**0**	**Yes**
Benzo(b)fluoranthene	mg/kg	073SS-0005M-0001-SO	0-1	3	599,000	599	4,125	10,379	No
Dibenzofuran	**mg/kg**	**073SS-0005M-0001-SO**	**0-1**	**3**	**9,160**	**9.16**	**64**	**161**	**Yes**
Naphthalene	**mg/kg**	**073SS-0005M-0001-SO**	**0-1**	**3**	**1,540**	**1.54**	**11.6**	**29**	**Yes**
Explosives									
2,4-Dinitrotoluene		**073SS-0031M-0001-SO**	**1-7**	**0**	**577**	**0.58**	**4**	**0**	**Yes**
Sand Creek Coal Tipple									
Semivolatile Organic Compounds									
Benzo(a)anthracene	mg/kg	073SS-0016M-0001-SO	1-4	31	177,000	177	1,220	31,709	No
Benzo(a)pyrene	mg/kg	073SS-0016M-0001-SO, 073SS-0017M-0001-SO	1-4	31	587,000	587	4,042	105,099	No
Benzo(b)fluoranthene	mg/kg	073SS-0002M-0001-SO	0-1	34	599,000	599	4,125	117,626	No
Dibenzofuran		073SS-0002M-0001-SO	0-1	34	9,160	9.16	64	1,827	No

Table 6-11: Initial Contaminant Migration Chemicals of Potential Concern Based on Arrival Time to Groundwater Table in Less Than or Equal to 1,000 Years (continued)

Initial CMCOPCs	Sample Identification	Sample Depth Interval[(a)] (ft)	Lz[(b)] (ft)	K_{oc} (L/kg)[(c)]	K_d (L/kg)[(d)]	R[(e)]	T (years)	T < 1,000? From Sample Depth to Groundwater Table (Yes/No)
Naphthalene	**073SS-0002M-0001-SO**	**0-1**	**34**	**1,540**	**1.54**	**11.6**	**331**	**Yes**
Building U-16 Boiler House								
Metals								
Cobalt	**073SS-0035M-0001-SO**	**0-1**	**21**	**NA**	**2.1**	**15**	**264**	**Yes**
Organochlorine Pesticides								
alpha-BHC (alpha-Hexachlorocyclohexane)	**073SS-0041M-0001-SO**	**1-7**	**15**	**2,807**	**2.81**	**20**	**253**	**Yes**

Notes:

a. The maximum depth of an initial CMCOPC (based on the maximum depth that an analyte is detected above FWCUG)

b. Leaching zone thickness. See Table 6-10. Building U-16 Boiler House did not have maximum detections of initial CMCOPCs.

c. USEPA. 1996b. Soil Screening Guidance and USEPA RSLs April 2012.

d. K_d values for organic chemicals calculated by multiplying K_{oc} values by a foc of 0.0010 (average from the PBA08 RI geotechnical samples F16SB-23-5425-SO and F16SB-023-5425-SO). K_d values for inorganic chemicals from Sheppard and Thibault 1990.

e. See Table 6-12 for equation.

BOLD indicates initial CMCOPC with travel time < 1,000 years.

CMCOPC = Contaminant migration chemical of potential concern.
ft = Feet.
FWCUG = Facility-Wide Cleanup Goal.
K_d = Soil-water distribution coefficient or sorption capacity.
K_{oc} = Water/organic carbon partition coefficient.
L/kg = Liter per kilogram.
Lz = Leaching zone thickness.
NA Not applicable.
R = Retardation Factor.
T = Arrival time years.
USEPA = United States Environmental Protection Agency.

Table 6-12: Parameters for Contaminant Migration Chemicals of Potential Concern Based on Arrival Time to Nearest Downgradient Receptor

Parameter	Symbol	Value	Unit	Note
Percolation rate	q	0.3	ft/year	Developed from HELP model from Youngstown, Ohio, weather data
Soil-water distribution coefficient	Kd	Chemical-specific	L/kg	See footnotes on Table 6.11 for references
Organic carbon distribution coefficient	Koc	Chemical-specific	L/kg	See footnotes on Table 6.11 for references
Fraction organic carbon	foc	0.0010	unitless	Average from the PBA08 remedial investigation geotechnical samples F16SB-023-5425-SO and F16SB-023-5425-SO (SAIC 2011c)*
Water-filled soil porosity	θw	0.26	unitless	Average from the PBA08 remedial investigation geotechnical samples F16SB-023-5425-SO and F16SB-023-5425-SO (SAIC 2011c)*
Bulk density (dry)	ρb	1.79	gm/cm^3	Average from the PBA08 remedial investigation geotechnical samples F16SB-023-5425-SO and F16SB-023-5425-SO (SAIC 2011c)*
Leaching zone	Lz	See Table 6-10	ft	Distance from deepest detection of initial contaminant migration chemical of potential concern to top of water table
Retardation factor[a]	R	Chemical-specific	unitless	Calculated by equation shown below
Arrival Time[b]	T	Chemical-specific	year	Calculated by equation shown below

Notes:
a. $R = 1 + (Kd*\rho b)/\theta w$
b. $T=Lz*\theta w*R/q$
* SAIC. 2011c. Remedial Investigation/Feasibility Study Report for RAVAAP-67 Facility-Wide Sewers Science and Engineering Science and Engineering Associates, Inc. September.
CMCOPC = Contaminant migration chemical of potential concern.
ft = Feet.
ft/year = Feet per year.
gm/cm^3 = Grams per cubic centimeter.
HELP = Hydrologic Evaluation of Landfill Performance.
K_d = Distribution coefficient.
L/kg = Liters per kilogram.
SAIC = Science Applications International Corporation.

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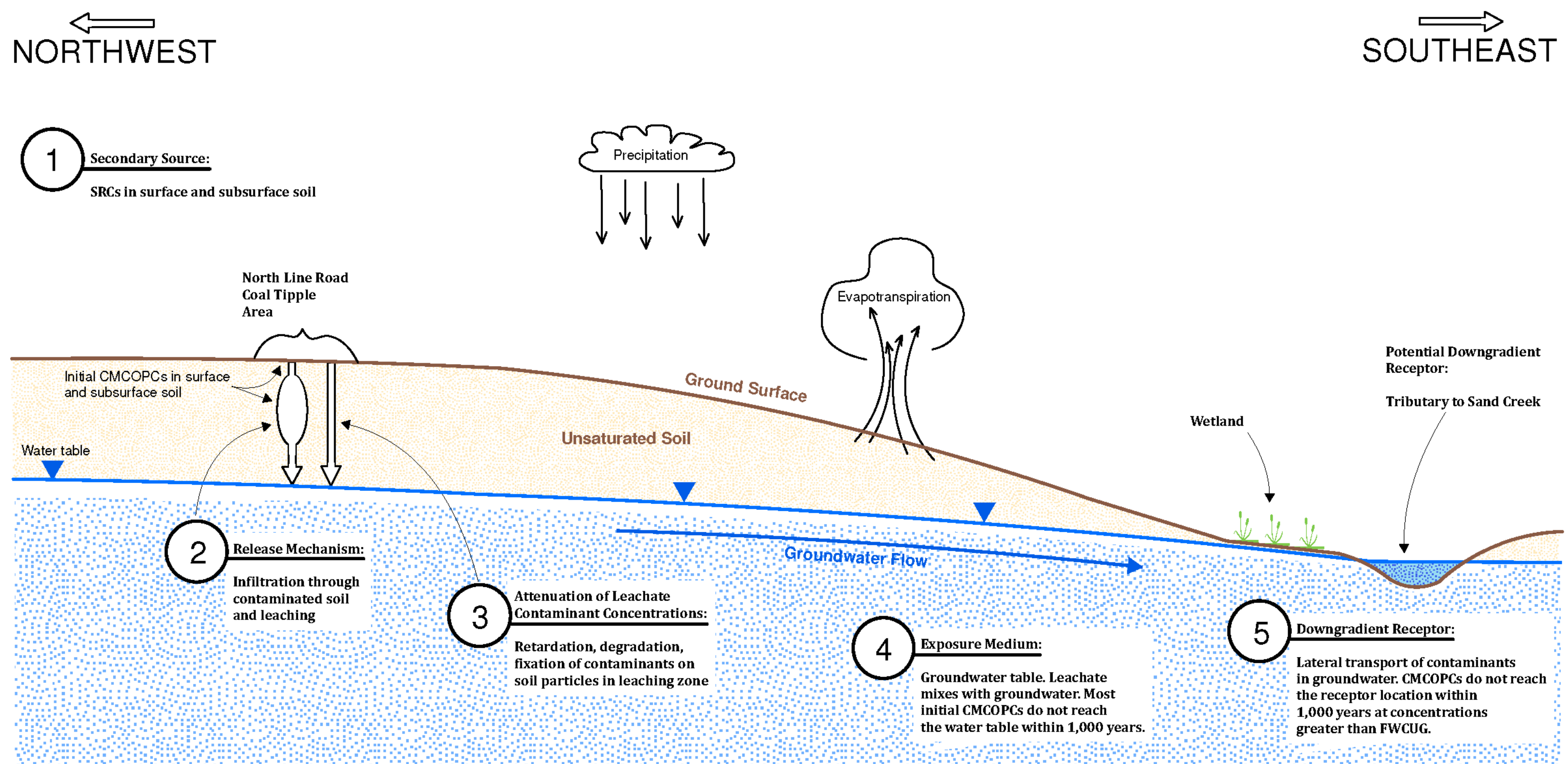
Table 6-13: Contaminant Migration Chemicals of Potential Concern Based on Groundwater Travel Time to Nearest Groundwater Receptor

CMCOPCs	Maximum Detection (mg/kg)	X_{min} (ft)	R	K (ft/year)	i	θw	$T_{RC\ (year)}$	CMCOPC[a] (Yes/No)	CMCOPC Justification[a]
North Line Road Coal Tipple									
Metals									
Arsenic	28	400	200.7	134	0.0045	0.26	34,607	No	T_{RC} > 1,000 years
Barium	160	400	283.3	134	0.0045	0.26	48,856	No	T_{RC} > 1,000 years
Selenium	2.3	400	35.4	134	0.0045	0.26	6,109	No	T_{RC} > 1,000 years
Semivolatile Organic Compounds									
2-Methylnaphthalene	9.1	400	17.7	134	0.0045	0.26	3,053	No	T_{RC} > 1,000 years
Dibenzofuran	2.5	400	64.1	134	0.0045	0.26	11,049		T_{RC} > 1,000 years
Benzo(a)pyrene	0.57	400	4,042.3	134	0.0045	0.26	697,174	No	T_{RC} > 1,000 years
Naphthalene	4.6	400	11.6	134	0.0045	0.26	2,001	No	T_{RC} > 1,000 years
Explosives									
2,4-Dinitrotoluene	**0.01**	**400**	**4.1**	**134**	**0.0045**	**0.26**	**707**	**Yes**	**T_{RC} < 1,000 years**
Sand Creek Coal Tipple									
Semivolatile Organic Compounds									
Naphthalene	**0.063**	**50**	**11.6**	**59**	**0.005**	**0.26**	**511**	**Yes**	**T_{RC} < 1,000 years**
Building U-16 Boiler House									
Metals									
Cobalt	11	1,100	15	134	0.0045	0.26	7,114	No	T_{RC} > 1,000 years
Organochlorine Pesticides									
alpha-BHC (alpha-Hexachlorocyclohexane)	0001	1,100	20.1	134	0.0045	0.26	9,533	No	T_{RC} > 1,000 years

Table 6-13: Contaminant Migration Chemical of Potential Concern Based on Groundwater Travel Time to Nearest Groundwater Receptor (continued)

Notes:
a. Although naphthalene and 2,4-dinitrotoluene may travel to the downgradient receptor in less than 1,000 years, their MDC is less than the most stringent Resident Receptor FWCUG at 10-6 and HQ of 0.1 (122 mg/kg).

θw = Water-filled soil porosity
CMCOPC = Contaminant migration chemical of potential concern.
ft = Feet.
FWCUG = Facility-Wide Cleanup Goal.
HQ = Hazard Quotient.
i = Hydraulic gradient.
K = Hydraulic conductivity.
K_d = Distribution coefficient.
mg/kg = Milligrams per kilogram.
R = Retardation factor = 1 + (Kd*ρb)/θw.
T_{RC} = Groundwater travel time to nearest receptor = Xmin * R / Vs (years).
Vs = Groundwater seepage velocity = K * i / θw (ft/year).
X_{min} = Minimum distance to downgradient surface water body.
See Table 6-12 for assumptions and parameters used.



NOT TO SCALE

NOTES & SOURCES

1) CMCOPC = Contaminant Migration Chemical of Potential Concern
2) FWCUG = Facility-Wide Cleanup Goal
3) SRC = Site-Related Chemical
4) RVAAP = Ravenna Army Ammunition Plant
5) CC = Army Environmental Compliance-Related Cleanup Program

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LOUISVILLE DISTRICT, KENTUCKY

Figure 6-1
Contaminant Migration Conceptual Model
CC RVAAP-73 Facility-Wide Coal Storage
FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

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7. RISK ASSESSMENT

The HHRA and ERA for CC-RVAAP-73 Facility Wide Coal Storage evaluated SRCs (identified in Chapter 5) to first select COPCs and subsequently characterize associated risks, as described in the following sections.

Surface soil and subsurface soil are the only media evaluated in the risk assessments. As described in Section 6.2, surface water and sediment sampling was conducted in Sand Creek upgradient and downgradient of the two coal tipples because of the close proximity of the creek to the DUs. SRCs were not detected in Sand Creek that could be attributable to coal storage within the AOC. Because of the relatively flat topography, the distance to the closest water body, and/or the sediment and surface water sampling results, there is no complete transport pathway from surface soil runoff within the AOC to the closest surface water body. In addition, there is no risk to the surface water bodies from SRCs leaching through the soil to the water table and then migrating to the surface water. Thus, HHRA and ERA were not performed on surface water and sediment as part of this RI. This conclusion is supported by the 2003 Facility-Wide Biological and Water Quality Study (USACE 2005a), which demonstrated that analytes detected in Sand Creek were below criteria protective of Warmwater Habitat aquatic life use and that conditions of fish and benthic communities ranged from good to exceptional.

7.1 HUMAN HEALTH RISK ASSESSMENT

The purpose of this HHRA was to document if chemical constituents are present in the soil at CC RVAAP-73 Facility-Wide Coal Storage that may pose health risks to current or future site receptors. Two Land Uses were evaluated in this HHRA:

- Unrestricted (Residential) Land Use
- Military Training Land Use.

7.1.1 Human Health Risk Assessment Methods

CC RVAAP-73 Facility-Wide Coal Storage was evaluated as three exposure areas for the HHRA. Only SRCs, as selected in Chapter 5, are evaluated in the HHRA. This HHRA followed the streamlined risk assessment approach based on the Facility-Wide Human Health Risk Assessor Manual (USACE 2005c) as presented in the Position Paper (USACE 2012) and FWCUG Report (USACE 2010a). This streamlined approach used site-specific values, where developed, instead of standard default parameters. An overview of the HHRA process for CC RVAAP-73 Facility-Wide Coal Storage is presented below, followed by more detailed descriptions in subsequent sections.

Chemical of Potential Concern Selection

- For COPC selection, soil data for SRCs were grouped into two intervals: surface soil (0-1 ft bgs) and subsurface soil (1-13 ft bgs).

- Following a two-step process, an SRC was selected as a COPC (for a given depth interval) if:

  - The MDC exceeded the most stringent Resident Receptor or NGT FWCUGs corresponding to a target cancer risk of 10^{-6} or an HQ of 0.1. FWCUGs are not standard default screening values but rather are site-specific values. The Resident Receptor is the representative receptor for the Unrestricted (Residential) Land Use and the NGT is the representative receptor for the Military Training Land Use. When FWCUGs are not available for a particular SRC, the Residential RSL, which is not site-specific, was used as the criterion.

  - SRCs that exceed these risk levels were selected as COPCs. Soil COPCs were identified by depth (surface soil [0-1 ft bgs] and subsurface soil [>1 ft bgs]) for each exposure area. Compounds below these initial risk levels were not further evaluated in this HHRA.

Exposure Point Concentration Calculations

- An exposure point concentration (EPC) is the concentration to which a receptor would be exposed.

- EPCs were calculated for each COPC by exposure scenario (exposure area, depth interval, and receptor combination):

  - For the Resident Receptor, the EPC is the average concentration of all DUs for Resident Receptor surface soil (0-1 ft bgs) and the average concentration for all Resident Receptor subsurface soil samples (1-13 ft bgs).

  - For the NGT, the EPC is the average concentration of all DUs for NGT surface soil (0-4 ft bgs) and the average concentration for all NGT subsurface soil samples (4-7 ft bgs).

Chemical of Concern Selection

- To select COCs, EPCs of the COPCs were compared to the most stringent Resident Receptor or NGT FWCUGs (or Residential RSLs for those COPCs without an FWCUG) corresponding to a target cancer risk of 10^{-5} or target HQ of 1.

  - For each exposure scenario, the ratios of EPC/FWCUG are summed for all carcinogens to calculate a total cancer risk.

  - The ratios of EPC/FWCUG are summed for all non-carcinogens that affect similar target organs.

  - COPCs were selected as a COC if the ratio of the EPC to the FWCUG corresponding to a target cancer risk of 10-5 and target HQ of 1 is greater than 1.

- The Resident Receptor is evaluated as a first step; and, if COCs are identified, the NGT is evaluated.

Risk Characterization

- Risk characterization is performed by calculating the applicable HQs and target cancer risks associated with the COCs.

- If the total cancer risk is less than the Ohio EPA acceptable risk limit of 10^{-5}, no remedial actions are required.

- If the total HQ to similar target organs does not exceed the USEPA threshold of 1, no remedial actions are required.

  - If a given chemical is 5-10 percent of the Sum of Ratios (SOR), additional review and consideration are required to adequately determine if the chemical should be retained or excluded as a COC. If a given chemical is greater than 10 percent of SOR, it will automatically be retained as a COC.

- If either the total cancer risk or HQ is greater than the USEPA risk criteria, remedial actions or further investigations may be required.

7.1.2 Data Used in the Human Health Risk Assessment

Data used in the HHRA were obtained from samples collected in November 2012 and March and April 2013 for CC RVAAP-73 Facility-Wide Coal Storage. Samples included in the HHRA datasets are provided in Table 7-1.

The environmental media of concern evaluated in this HHRA include surface soil (from 0 to <1 ft bgs) and subsurface soil (>1 ft bgs). Groundwater at the facility is evaluated on a facility-wide basis as a separate AOC (RVAAP-66). The details of the sampling rationale and methods are provided in Chapter 4. All soil sample results for ISM and vertical composite sampling were used in the HHRA, with the exception of field duplicates and QA samples.

7.1.3 Chemicals of Potential Concern Identification

To identify the COPCs that would be carried through the risk assessment, the MDC of each SRC was screened against the most stringent FWCUGs at a target cancer risk level of 10^{-6} and non-carcinogenic target HQ of 0.1 for each receptor.

The COPC screening was performed by medium (i.e., surface soil and subsurface soil), exposure area, and depth interval. For purposes of this HHRA, the three exposure areas are:

- North Line Road Coal Tipple
- Sand Creek Coal Tipple
- Building U-16 Boiler House.

Each COPC screening table (Tables 7-2 and 7-3) presents the analytical data considered in the COPC screening process, the SRC designation, the MDC, all carcinogenic and non-carcinogenic risk-based Resident Receptor and NGT FWCUGs (or RSLs for those chemicals with no FWCUG) for each chemical, and a column indicating whether or not the SRC is a COPC.

An SRC was identified as a COPC if the EPC exceeded the most stringent FWCUG among Residential Receptor and NGT. Because no FWCUG, reference dose (RfD), or cancer potency factor are available for acenaphthylene, phenanthrene, and benzo(g,h,i)perylene, surrogate values were used. The RSL for anthracene was used as a surrogate for acenaphthylene and phenanthrene, and the FWCUG for pyrene was used for benzo(g,h,i)perylene (Nevada Division of Environmental Protection 2006). As part of the conservative screening approach for identifying COPCs, the FWCUG for hexavalent chromium (the more stringent or lower of the two chromium species evaluated) was used at this stage. These surrogates have been previously reviewed and approved by the USACE and Ohio EPA in the RI/Feasibility Study report for CC RVAAP-43 Load Line 10 (SAIC 2013). COPCs include those SRCs where sample results from any depth within the exposure area exceeded the target cancer risk level of 10^{-6} or non-carcinogenic target HQ of 0.1 for either receptor.

Soil COPCs identified for each exposure area within CC RVAAP-73 Facility-Wide Coal Storage are identified in Tables 7-2 through 7-1, summarized in Tables 7-12 through 7-15, and described in the following sections.

7.1.3.1 Chemicals of Potential Concern in Surface Soil

Samples used to identify COPCs in surface soil were collected using ISM. Each individual ISM result represents an average concentration across the exposure area. The process used to determine COPCs considered a 0- to 1-ft bgs definition for surface soil, and compared concentrations in that interval to those of the FWCUGs (or RSLs for those chemicals that lacked a FWCUG) for both receptors. COPCs in surface soil for each exposure area at CC RVAAP-73 Facility-Wide Coal Storage are summarized in Table 7-12.

The following COPCs were identified in surface soils:

- Two inorganics: arsenic and manganese at the North Line Road Coal Tipple and cobalt at the Building U-16 Boiler House

- Three SVOCs: benzo(a)anthracene and benzo(b)fluoranthene at the North Line Road Coal Tipple and benzo(a)pyrene at all three former coal areas.

7.1.3.2 Chemicals of Potential Concern in Subsurface Soil

Samples used to identify COPCs in subsurface soil were collected using ISM and composite methods. Each individual ISM result represents an average concentration across the exposure area. The COPC screening process uses samples collected from a depth greater than 1 ft bgs for subsurface soil and compares concentrations in that interval against the FWCUGs (or RSLs for those chemicals without an FWCUG) for both the Resident Receptor and NGT. COPCs in subsurface soil (greater than 1 ft bgs) for each DU at CC RVAAP-73 Facility-Wide Coal Storage are summarized in Table 7-13 for each exposure area. Uncertainties associated with combining ISM, composite, and discrete samples results are discussed in Section 7.1.9.

The following COPC was identified in subsurface soil:

- Benzo(a)pyrene in two of the three exposure areas (North Line Road Coal Tipple and Sand Creek Coal Tipple).

7.1.4 Receptor Evaluation

CC RVAAP-73 Facility-Wide Coal Storage consists of three separate exposure areas located throughout the facility:

- North Line Road Coal Tipple
- Sand Creek Coal Tipple
- Building U-16 Boiler House.

Considering that the individual coal storage areas are not contiguous, and considering their small size, each exposure area was evaluated separately to determine whether or not a given exposure area is appropriate for the evaluated land use. The exposure areas are spread out across the facility as shown in Figure 1-3, and in aggregate, consist of only 2.01 acres. For this reason, each exposure area consisted of one DU.

The current and projected future land use for CC RVAAP-73 Facility-Wide Coal Storage is for military training. The representative receptor for military training is the NGT. This use, in conjunction with the evaluation of Unrestricted (Residential) Land Use and associated receptors, forms the basis for identifying COCs. Unrestricted (Residential) Land Use, specifically the Resident Receptor scenario, is included to evaluate COCs for unrestricted land use at CC RVAAP-73 Facility-Wide Coal Storage and to determine baseline conditions. The representative receptor for Unrestricted Land Use is the Resident Receptor. FWCUGs for both receptors were obtained from the FWCUG Report (USACE 2010a) and are provided in Table 7-16 (surface soil) and Table 7-17 (subsurface soil) for all COPCs.

The Resident Receptor is evaluated as a first step and, if COCs are identified, the NGT is evaluated to refine potential risks. If no COCs are identified for the Resident Receptor, the NGT is not evaluated because Unrestricted Land Use would be achieved and additional remedial actions would not be warranted.

7.1.5 Exposure Point Concentration Development

EPCs are intended to estimate representative concentrations that a receptor might contact during the period of exposure. EPCs were calculated as the average (arithmetic mean) of results for each exposure area, receptor, and depth interval evaluated in the HHRA and are explained in more detail in Section 7.1.6.

Based on CC RVAAP-73 Facility-Wide Coal Storage characteristics and the recorded operational areas, the sample coverage to define nature and extent of these former coal storage areas is adequate. The discussion of nature and extent is presented in Section 5.2.

7.1.6 Identification of Chemicals of Concern: Resident Receptor

The process for identifying COCs was described in Section 7.1.1 of this HHRA. For the Resident Receptor evaluation, soil samples were aggregated into Resident Receptor surface soil (0-1 ft) and Resident Receptor subsurface soil (1-13 ft). All samples used in the Resident Receptor surface soil interval were ISM samples. Each exposure area consists of only one ISM surface soil sample. The EPC for surface soil is represented by the one ISM sample in each exposure area. Subsurface soil samples consisted of ISM soil samples collected from the depth intervals of 1-4, 4-7, and 1-7 ft bgs, and vertical composite samples from 7 to 13 ft bgs. The average of all data collected between the 1-13 ft depth intervals was used to calculate the EPC for Resident Receptor subsurface soil. EPC calculations are provided in Appendix I, Tables I-1 through I-3. The evaluations of COCs in surface soil and subsurface soil, by area, for the Resident Receptor are provided in Appendix I, Tables I-4 through I-9. The COC evaluation includes a comparison of the selected FWCUG (or RSL for those chemicals without an FWCUG) to the EPC including an SOR assessment. For non-carcinogens, the EPC was compared to the target HQ FWCUG. The SOR was used where COPCs affect similar target organs. For carcinogens, the EPC was compared to the target risk FWCUG. The SOR method was used for all carcinogens.

For the Resident Receptor, COCs were identified as follows:

- Surface Soil
  - Arsenic and benzo(a)pyrene at the North Line Road Coal Tipple
- Subsurface Soil
  - No COCs were identified at the North Line Road Coal Tipple, Sand Creek Coal Tipple, or Building U-16 Boiler House.

A discussion of each identified COC and a comparison of the EPCs to the applicable FWCUGs (or RSLs for those chemicals without an FWCUG) is presented below.

Arsenic

The EPC for arsenic in North Line Road Coal Tipple surface soil is 28 mg/kg. This EPC is 6.59 (North Line Road Coal Tipple) times greater than the FWCUG of 4.25 mg/kg. The EPCs were based on the ISM sampling results from one DU. The BSV for arsenic in surface soil is 15.4 mg/kg. The arsenic BSV for subsurface soil is 19.8 mg/kg.

Benzo(a)pyrene

The EPC for benzo(a)pyrene in North Line Road Coal Tipple surface soil is 0.57 mg/kg. This EPC is 2.59 times greater than the FWCUG of 0.22 mg/kg. The EPC is based on the ISM sampling results from one DU.

In summary, no COCs have been identified in Sand Creek Coal Tipple or Building U-16 Boiler House. Arsenic and benzo(a)pyrene were identified as COCs in surface soil at the North Line Road Coal Tipple.

7.1.7 Identification of Chemicals of Concern: National Guard Trainee

As stated in Section 7.1.4, the Resident Receptor is evaluated as a first step and, if COCs are identified, the NGT is evaluated. Because two COCs were identified for the Resident Receptor, an evaluation of COCs for the NGT was performed.

For the NGT evaluation, soil samples were aggregated into surface soil (0-4 ft) and subsurface soil (4-7 ft), which represents the exposure intervals for the NGT. However, surface soil ISM samples were collected from 0 to 1 ft bgs and from 1 to 4 ft bgs; therefore, a weighted average was used because the depths for samples collected represented 1 ft (0-1ft interval) and 3 ft (1-4 ft interval) of the depth interval evaluated (0-4 ft).

Subsurface soil samples for the NGT evaluation consisted of ISM soil samples collected from 4 to 7 ft bgs. The average of all data collected between the 4-7 ft depth intervals was used to calculate the EPC for subsurface soil. The aggregation of these data and EPC calculations are provided in Appendix I, Tables I-1 through I-3.

The evaluations of COCs in surface soil and subsurface soil, by area, for the NGT are provided in Appendix I, Tables I-10 through I-15. The COC evaluation includes a comparison of the selected FWCUG to the EPC. The COC evaluation for NGT surface soil (0-4 ft) also included an SOR assessment because there were multiple carcinogens and non-carcinogens that affect the same target organ. For non-carcinogens, the EPC was compared to the target HQ FWCUG. For carcinogens, the EPC was compared to the target risk FWCUG.

For the NGT receptor, COCs were identified as follows:

- Surface Soil

  - Manganese at the North Line Road Coal Tipple only.
  - No COCs were identified at the Sand Creek Coal Tipple or Building U-16 Boiler House.

- Subsurface Soil

  - No COCs were identified in any exposure area (North Line Road Coal Tipple, Sand Creek Coal Tipple, or Building U-16 Boiler House).

Manganese
The EPC for manganese in North Line Road Coal Tipple surface soil is 1,023 mg/kg. This EPC is below the manganese BSV of 1,450 for surface soil. Therefore, based of the weight-of-evidence manganese can be eliminated as a COC in surface soil for the NGT.

7.1.8 Risk Characterization

The following discussion provides a characterization of risk posed to the Resident Receptor and NGT based on the COCs identified in surface soil, subsurface soil. Tables 7-12 and 7-13 present a summary of the associated risks and HQs calculated for arsenic, benzo(a)pyrene, and manganese.

Two COCs, arsenic and benzo(a)pyrene, were identified for the Resident Receptor for surface soil at the North Line Road Coal Tipple. No COCs were identified in the subsurface soil.

One COC, manganese, was identified for the NGT in surface soil at the North Line Road Coal Tipple. No COCs were retained for subsurface soil. No COCs contribute to cancer risk for the NGT.

North Line Road Coal Tipple

Arsenic, benzo(a)pyrene, and manganese were identified as COCs for surface soil. The total excess lifetime cancer risk (ELCR) for the Resident Receptor (9×10^{-5}) exceeded the Ohio EPA risk criterion of 10^{-5}, but was within the USEPA acceptable risk range of from 10^{-4} to 10^{-6}, and the hazard index for Resident Receptor is below the USEPA threshold value of 1. Furthermore, the weight-of-evidence shows that all COCs can be eliminated from further evaluation for Resident Receptor and NGT. Therefore, No Further Action is achieved for North Line Road Coal Tipple surface soil.
No COCs were identified in subsurface soil for the Resident Receptor. Therefore, No Further Action is obtained for North Line Road Coal Tipple subsurface soil.

Sand Creek Coal Tipple

No COCs were identified in surface or subsurface soil for the Resident Receptor in this exposure area. Therefore, No Further Action is obtained for Sand Creek Coal Tipple surface soil and subsurface soil.

Building U-16 Boiler House

No COCs were identified for surface or subsurface soil for the Resident Receptor in this exposure area. Therefore, No Further Action is obtained for Building U-16 Boiler House surface soil and subsurface soil.

7.1.9 Uncertainty

Uncertainty is inherent to risk assessment and can be introduced at every step of the process and, because risk assessment is a complex process, the impact of uncertainty should be discussed. Variability is the variation in physical and biological processes and should not be confused with uncertainty. Uncertainty is the lack of knowledge of the true value or variation of a particular variable. Uncertainty can be reduced by the gathering of information; however, it can likely never be eliminated where variability would not change by including additional information. Common uncertainties in risks assessment that apply to CC RVAAP-73 Facility-Wide Coal Storage include:

- Assumptions for intake rates, exposure duration, and exposure frequencies are upper bound estimates that are very conservative.

- Laboratory animals are used to determine carcinogenicity in humans; however, there are many sources of uncertainty in the dose-response evaluation such as:

  - Interspecies (animal-to-human) extrapolation that, in the absence of quantitative pharmacokinetic, dosimetric, or mechanistic data, is usually based on consideration of interspecies differences in basal metabolic rate.

  - Intraspecies or individual variation. Laboratory animals are very similar in age and genotype so that intragroup biological variation is minimal; however, the human population may reflect wide heterogeneity, including unusual sensitivity to the COPC. This includes toxicity data from human occupational exposure that are is biased toward a healthy population rather than a population that is unusually sensitive.

- The linearized multi-stage model is based on a non-threshold assumption of carcinogenesis. However, a large body of evidence suggests that epigenetic carcinogens, as well as many genotoxic carcinogens, have a threshold below which they are non-carcinogenic (USEPA 1996b); therefore, the use of the linearized multistage model is ultraconservative for chemicals that exhibit a threshold for carcinogenicity.

- The estimation of an RfD uses an effect level because this estimation is predicated on the assumption of a threshold below which adverse effects are not expected. Therefore, an additional uncertainty factor is usually applied to estimate a no-effect level.

- Additional uncertainty arises from estimation of an RfD for chronic exposure from less-than-chronic data. Unless empirical data indicate that effects do not worsen with increasing duration of exposure, an additional uncertainty factor is applied to the no-effect level in the less than chronic study.

- The USEPA (1989) risk assessment guidelines advocate the use of the one-hit model to estimate risk. However, there is uncertainty associated with the one-hit model and with other risk models because most studies of carcinogenic effects provide limited dose-response information for risk estimation (International Commission for Radiological Protection 1991). This effort to identify potential uncertainties associated with each step of the risk assessment is not intended to discredit the calculated results, but to point out that risks are calculated for hypothetical receptors under a definite, strict method. Refinements of sampling plans, analytical techniques, data statistical evaluation, exposure assessment models and parameters, hazard evaluation, dose-response assessment, and risk characterization could reduce these uncertainties.

- Soil is the only medium evaluated in the risk assessments. As described in Chapter 5, there is no complete transport pathway from AOC surface soil to the closest surface water bodies; thus, there are no SRCs for surface water and sediment. This conclusion is supported by the 2003 Facility-Wide Biological and Water Quality Study (USACE 2005a), which demonstrated that analytes detected in Sand Creek were below criteria protective of Warmwater Habitat aquatic life use and that conditions of fish and benthic communities ranged from good to exceptional. Furthermore, surface water and sediment sampling conducted in 2013 failed to identify contaminants in Sand Creek that could be attributable to historical coal storage at the AOC.

- EPCs were calculated for COPCs using concentrations within the surface soil and subsurface soil depth intervals associated with each receptor. This process consisted of calculating the average (arithmetic mean) of ISM and vertical composite samples. ISM samples consist of 30-50 aliquots of soil collected from random locations within a DU and combined into a single ISM sample. The ISM analytical result provides an estimate of the average concentration for a DU. In contrast, composite samples provide concentrations at various intervals at a single point. Combining ISM data with composite data to calculate an average could introduce uncertainty because samples from single points are mathematically given equal importance as ISM data (themselves representative of average conditions) and skew the calculation toward discrete samples and outliers. However, the level of uncertainty decreases with increasing sample size. At CC RVAAP-73 Facility-Wide Coal Storage, there are 24 surface and subsurface soil ISMs and 3 vertical composite samples, suggesting that this uncertainty has been limited, and the true mean has been reasonably estimated.

7.1.10 Human Health Risk Assessment Conclusions

The HHRA performed for CC RVAAP-73 Facility-Wide Coal Storage evaluated potential risk to the Resident Receptor from potential exposure to surface (0-1 ft) and subsurface soils (1-13 ft). Additionally, potential risks were assessed to the NGT to assist in qualitatively evaluating any COCs identified for the Resident Receptor for the Unrestricted (Residential) Land Use.

COCs were identified for North Line Road Coal Tipple surface soil, but were eliminated based on the weight-of-evidence discussion in Section 7.1.8. No COCs were identified in North Line Road Coal Tipple subsurface soil for the Resident Receptor. No COCs were identified for Sand Creek Coal Tipple surface soil or subsurface soil for the Resident Receptor. No COCs were identified for Building U-16 Boiler House surface soil and subsurface soil Resident Receptor. Therefore, No Further Action is obtained for CC RVAAP-73 Facility-Wide Coal Storage surface soil and subsurface soil.

7.2 ECOLOGICAL RISK ASSESSMENT

The purpose of this ERA is to evaluate the potential for chemical constituents detected in surface soil (0-1 ft) at CC RVAAP-73 Facility-Wide Coal Storage to adversely affect ecological receptors. The ERA is conducted following the Unified Approach, the Facility-Wide Ecological Risk Assessment Work Plan (USACE 2003), and the Ohio EPA's 2010 ERA Guidelines. The Unified Approach was developed collaboratively by the USACE and SAIC, and was approved by the Ohio EPA in 2011. The Unified Approach meets the requirements of Ohio EPA and USACE ERA guidance, while following the accepted methods established for the facility as presented the Facility-Wide ERA Work Plan and those of the Ohio EPA. The Unified Approach draws upon elements from, but does not strictly follow, ERA guidance documents including:

- Ohio EPA Division of Environmental Response and Revitalization (DERR) *Ecological Risk Assessment Guidance Document* (Ohio EPA-DERR 2008)

- USEPA *Ecological Risk Assessment Guidance for Superfund* (USEPA 1997)

- USACE *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010b).

7.2.1 Scope and Objective

This ERA satisfies the requirements of a qualitative Level I Scoping ERA (Section 7.2.1) and Level II Screening ERA (Section 7.2.2). The results of this ERA were used to reach a scientific management decision point, selected as the appropriate recommendation from one of the following:

- Continue the ERA process and conduct a Level III Baseline ERA

- Proceed with remediation of CC RVAAP-73 Facility-Wide Coal Storage through development and implementation of a remediation plan

- Ecological risk at CC RVAAP-73 Facility-Wide Coal Storage is negligible, and no further action is obtained.

7.2.2 Level I: Scoping Level Ecological Risk Assessment

This section presents the Level I Scoping ERA. The Level I ERA evaluated if past releases have occurred, if there is the potential for current contamination, and if there are important ecological resources at or near CC RVAAP-73 Facility-Wide Coal Storage.

The Level I ERA considered the following two questions:

1. *Are current or past releases suspected at CC RVAAP-73 Facility-Wide Coal Storage?* Yes; the historical storage of coal at CC RVAAP-73 Facility-Wide Coal Storage may have resulted in releases at the AOC.

2. *Are important ecological resources present at or in the locality of CC RVAAP-73 Facility-Wide Coal Storage?* Yes; important ecological resources, defined in the Guidance for Conducting ERAs (Ohio EPA-DERR 2008) and Technical Document for ERA: Process for Developing Management Goals (United States Army Biological Technical Assistance Group 2005), were identified in the locality of CC RVAAP-73 Facility-Wide Coal Storage.

As described below, the Level I ERA found that both releases and important ecological resources are present; therefore, the risk assessment process proceeds to a Level II Screening ERA (Section 7.2.2).

7.2.2.1 CC RVAAP-73 Facility-Wide Coal Storage Description and Land Use

CC RVAAP-73 Facility-Wide Coal Storage consists of the following three areas where coal was historically stored at the former RVAAP:

- North Line Road Coal Tipple
- Sand Creek Coal Tipple
- Building U-16 Boiler House.

As described previously in Chapter 2, these areas are small (2.01 acres in aggregate), non-contiguous, and spread out across the facility. The Building U-16 Boiler House and North Line Road Coal Tipple are located in the northwestern portion of the property, and the Sand Creek Coal Tipple is located in the north-central portion of the facility.

7.2.2.2 Evidence of Historical Chemical Contamination

No previous ERAs have been conducted for the CC RVAAP-73 Facility-Wide Coal Storage; therefore, chemicals of potential ecological concern (COPECs) have not historically been identified. CC RVAAP-73 Facility-Wide Coal Storage consists of three separate areas where coal was historically stored. Chemical constituents may have been introduced to CC RVAAP-73 Facility-Wide Coal Storage surface soil that was directly in contact with coal.

7.2.2.3 Ecological Significance

This section presents the management goals for the facility, characterizes environmental conditions at CC RVAAP-73 Facility-Wide Coal Storage, and determines if there are ecological significant resources on the AOC. Ecological significance is defined as the presence of important ecological resources at or in the locality of CC RVAAP-73 Facility-Wide Coal Storage that are subject to COPEC exposure (USEPA 1996c). The presence or absence of ecologically important places is determined by comparing the environmental conditions and characteristics of CC RVAAP-73 Facility-Wide Coal Storage to those of the important places and resources as identified in the Unified Approach and presented in the final checklist (Table 7-14). Considering that each exposure area is small (the combined area is 2.01 acres) and considering that the exposure areas are noncontiguous and spread out across the facility, they are not expected to provide unique or valuable ecological resources.

7.2.2.4 Management Goals

The OHARNG monitors and maintains ecological conditions and resources at the facility to maintain or enhance the integrity of the property's natural resources and ecosystem. The OHARNG's Management Goals for meeting this requirement are published in the Integrated Natural Resources Management Plan (INRMP) (AMEC 2008) and are as follows:

- ***GOAL 1***—Manage natural resources in a manner that is compatible with and supports the military mission while complying with applicable federal and state laws and Army regulations and policies.

- ***GOAL 2***—Maintain and foster positive working relationships with the United States Fish and Wildlife Service; the Ohio Division of Natural Resources (ODNR) Division of Wildlife; and other federal, state, and local natural resources management agencies and organizations for the benefit of the military mission, the natural resources being managed, and the citizens of Ohio and the nation.

- ***GOAL 3***—Monitor the condition of the natural resources and the implied impacts from training and the natural resources management program on the natural resources at the facility.

- ***GOAL 4***—Protect and maintain populations of rare plant and animal species on the facility in compliance with federal and state laws and regulations.

- ***GOAL 5***—Sustain usable training lands and native natural resources by managing non-native and invasive species, vegetation and plant communities, and nuisance wildlife species.

- ***GOAL 6***—Manage wildlife resources in a manner compatible with the military mission and within the limits of the natural habitat.

- ***GOAL 7***—Manage the whitetail deer population in a manner that minimizes impacts on the military mission, is ecologically sustainable, provides for public hunting, and is in accordance with Army regulations and State law.

- ***GOAL 8***—Manage forest resources to the benefit of the military mission, to perpetuate the ecosystem functions, to support regional ecosystem needs, and for the production of forest products.

- ***GOAL 9***—Manage wetlands and other surface waters in accordance applicable federal, state, and local regulations and to protect water quality and ecological function while facilitating the military mission.

- *GOAL 10*—Manage soil to maintain productivity and prevent and repair erosion in accordance with State and federal laws and regulations so that the facility can support doctrinally required military training in perpetuity.
- *GOAL 11*—Manage cultural resources on the facility in accordance with state and federal laws and regulations while implementing the natural resources management program.

- *GOAL 12*—Develop, maintain, and manage data regarding natural resources at the facility through the use of Geographic Information System for efficient data storage, retrieval, analysis, and presentation.

7.2.2.5 Important Places and Resources

Ecological importance means that a place or resource exhibits a unique, special, or otherwise important attribute of great value. Important ecological places and resources, as identified in the Unified Approach, include, but are not limited to:

- Wetlands
- Terrestrial areas used for breeding by large or dense aggregations of animals
- Habitat known to be used by state or federally-listed threatened, endangered, or special concern species
- State land designated for wildlife or game management
- Locally important ecological places
- State parks.

Environmental conditions and characteristics of CC RVAAP-73 Facility-Wide Coal Storage are presented below to determine if ecologically important places or resources are present. Terrestrial resources are presented first, followed by aquatic resources.

7.2.2.6 Terrestrial Resources

The terrestrial portion of CC RVAAP-73 Facility-Wide Coal Storage consists of three separate areas where coal was historically stored:

- The North Line Road Coal Tipple is approximately 1.22 acres. No buildings are associated with this location. The area is generally flat, unpaved, and partially vegetated with low shrubs. The surrounding area is wooded.

- The Sand Creek Coal Tipple area is approximately 0.65 acres. The tipple is at the base of the former rail spur, and covered by woody/shrub vegetation. Sand Creek runs adjacent to the Sand Creek Coal Tipple area to the south and east.

- The Building U-16 Boiler House area is approximately 0.14 acres. The boiler house has been demolished, and the area has been graded. The surface of the area is covered mainly with grasses and small shrubs. A rail line exists just north of the area.

Detailed information about the habitats associated with these three areas is presented below.

Habitat Descriptions and Species

Numerous plant community and wildlife studies have been conducted at facility dating back to 1993 (AMEC 2008). Plant communities have been mapped for the entire facility property including CC RVAAP-73 Facility-Wide Coal Storage (Figure 7-1), using two classification systems:

- Anderson's Classification Scheme (Anderson 1982) in 1993 (ODNR-Division of Natural Areas and Preserves [DNAP] 1993)

- The Federal Geographic Data Committee (FGDC) Vegetation Classification Standard (National Spatial Data Infrastructure 1997) in 1999 (SAIC 1999).

The FGDC Vegetation Classification Standard is the approved standard for vegetation classification on federal land. Plant communities in and around CC RVAAP-73 Facility-Wide Coal Storage were mapped using the FGDC Vegetation Classification Standard (Figure 7-1).

North Line Road Coal Tipple

- Dry early-successional herbaceous field (HU1)

- Willow (*Salix spp.*) Saturated Shrubland Alliance (SL4)

- Red maple (*Acer rubrum*) successional forest (FU4)

- Pin oak (*Quercus palustris*) – swamp white oak (*Quercus bicolor*) Seasonally Flooded Forest Alliance (FL4)

- Flooded Forest Alliance (FL1).

Sand Creek Coal Tipple

- Dry early-successional herbaceous field (HU1)

- Red maple (*Acer rubrum*) successional forest (FU4)

- Mixed cold-deciduous successional forest (FU5)

- American beech (*Fagus grandifolia*) – Sugar maple (*Acer saccharum*) – Tulip tree (*Liriodendron tulipifera*) Forest Alliance (FU1).

Building U-16 Boiler House

- Dry late-successional cold-deciduous shrubland (SU2)
- Dry mid-successional cold-deciduous shrubland (SU1)
- Mixed cold-deciduous successional forest (FU5)
- Willow (*Salix spp*.) Saturated Shrubland Alliance (SL4).

Overall, vegetation in the various areas of CC RVAAP-73 Facility-Wide Coal Storage is sparse and disturbed by historical use. Dry early-successional herbaceous field (HU1) and dry late-to-mid successional cold-deciduous shrub land (SU1 and SU2) were identified as the predominant plant communities.

Detailed descriptions and additional information on the vegetation classifications are presented in the INRMP (AMEC 2008) and the Vegetation Communities Planning Level Survey for the Ravenna Training and Logistics Site (AMEC 2006). The Vascular Plant Flora of the Ravenna Arsenal (ODNR-DNAP 2000) conducted during the 1998 growing season (May through October) and Spring 1999.

The updated INRMP includes summaries of all the wildlife survey work conducted at the facility (AMEC 2008). Wildlife observed at the facility includes:

- Thirty-five species of mammals including 11 species of bats

- Two hundred and fourteen species of birds including 117 species of birds are known to or are considered likely to nest on facility property

- Thirty-four species of amphibians and reptiles, including salamanders, toads, frogs, snakes, lizards, and turtles (AMEC 2008).

Wildlife studies have not been conducted specifically for CC RVAAP-73 Facility-Wide Coal Storage. However, with its mix of herbaceous fields, shrubland, maintained grass land, and forest edge habitats, CC RVAAP-73 Facility-Wide Coal Storage provides habitat for a variety of wildlife species. CC RVAAP-73 Facility-Wide Coal Storage provides foraging habitat for birds as well as habitat for small mammals including, mice and voles, shrews, and moles that would typically occur in these habitats. Larger mammals occurring on the facility including white-tailed deer, raccoons, woodchucks, and eastern fox squirrels may also use CC RVAAP-73 Facility-Wide Coal Storage habitats, but only transiently. While these receptors may use part of the Facility-Wide Coal Storage, considering the small size of the individual, noncontiguous exposure areas, the AOC is unlikely to support most of these receptors on a population or community level.

Threatened, Endangered, and Other Rare Species

Terrestrial portions of CC RVAAP-73 Facility-Wide Coal Storage have not been surveyed for federal- or state-listed species nor have there been any reported sightings of listed species. On the facility, there are no known occurrences of federally listed rare, threatened, and endangered species (AMEC 2008). There are, however, occurrences of state-listed species that have been identified. The state status of animal and plant species is determined by the ODNR Division of Wildlife and the ODNR Division of Natural Areas and Preserves, respectively. Listed species fall into one of the following five designations: endangered, threatened, special concern, special interest, and potentially threatened. Table 7-15 presents all state-listed species observed at the facility, which may potentially occur at CC RVAAP-73 Facility-Wide Coal Storage or its vicinity.

Other Terrestrial Resources

The INRMP provides additional detailed information about species and habitat surveys at the facility (AMEC 2008). There are no other reported surveys of terrestrial plant communities and wildlife at CC RVAAP-73 Facility-Wide Coal Storage beyond those summarized in the INRMP and discussed above.

7.2.2.7 Aquatic Resources

As described in Chapter 5, there is no complete transport pathway from the Facility-Wide Coal Storage surface soil to the nearest surface water body (Sand Creek) and, thus, there are no SRCs for surface water and sediment. This conclusion is supported by the 2003 Facility-Wide Biological and Water Quality Study (USACE 2005a), which demonstrated that analytes detected in Sand Creek were below criteria protective of Warmwater Habitat aquatic life use and that conditions of fish and benthic communities ranged from good to exceptional. Furthermore, surface water and sediment sampling conducted in 2013 failed to identify contaminants in Sand Creek that could be attributable to SRCs at the AOC.

7.2.2.8 Ecosystem and Landscape Roles and Relationships

To fully assess the potential ecological risks at an AOC, four areas are recommended to be evaluated. Per the Unified Approach and knowing the relationship of the AOC to the ecosystem and landscape roles and relationships, CC RVAAP-73 Facility-Wide Coal Storage, the vicinity of CC RVAAP-73 Facility-Wide Coal Storage, the entire facility property, and the surrounding eco-region of northeastern Ohio help determine the ecological setting, significance, and risks.

CC RVAAP-73 Facility-Wide Coal Storage

CC RVAAP-73 Facility-Wide Coal Storage consists of three fragmented, non-contiguous, areas that, in aggregate, consist of only 2.01 acres. Considering that their locations are spread out and comprise small areas both individually and collectively, they provide low quality habitat that is not expected to support populations of common or individuals of threatened ecological resources.

Vicinity of CC RVAAP-73 Facility-Wide Coal Storage

The herbaceous field and shrub communities that dominate CC RVAAP-73 Facility-Wide Coal Storage are abundant on the facility (Figure 7-1). In addition, habitat in the largely undeveloped vicinity are of better quality than CC RVAAP-73 Facility-Wide Coal Storage habitats, which are segmented and affected by proximity to roads, rail lines, and other developed features and disturbed by historical use. Thus, the type and quality of habitats in CC RVAAP-73 Facility-Wide Coal Storage are, therefore, expected to be of generally lower quality than those in less developed portions of the facility.

The Entire Facility Property

CC RVAAP-73 Facility-Wide Coal Storage (2.01 acres) comprises only 0.001 percent of the total facility property (21,683 acres). The herbaceous field and shrub habitat that dominate CC RVAAP-73 Facility-Wide Coal Storage are common throughout the facility, comprising approximately 3,380 acres of the facility property (AMEC 2008). Thus, the CC RVAAP-73 Facility-Wide Coal Storage habitats represent only a small fraction of the total available habitat at the facility.

The Eco-Region

The upland fields, shrub land, and forest habitats found in CC RVAAP-73 Facility-Wide Coal Storage and its vicinity are in abundance in the surrounding eco-regions. The RVAAP is located in the Erie/Ontario Drift and Lake Plain eco-regions (USEPA 2013) in northeastern Ohio. These eco-regions contain communities of:

- Dry early-successional herbaceous field (HU1)
- Dry mid-successional cold-deciduous shrubland (SU1)
- Red maple successional forest (FU4)
- Mixed cold-deciduous successional forest (FU5)
- Mixed needle-leaved evergreen cold-deciduous forest (MFU2)
- Temporarily flooded forest wetlands (FL1)
- Semi-permanently flooded, herbaceous wetlands (HL4)
- Permanently flooded herbaceous wetlands (HL5).

Many of the habitats found in CC RVAAP-73 Facility-Wide Coal Storage and its vicinity (HU1, SU1, and FU4) are common to the surrounding eco-regions. Therefore, this assessment concludes that there are no known unique resources in CC RVAAP-73 Facility-Wide Coal Storage that cannot be found in the immediate vicinity of CC RVAAP-73 Facility-Wide Coal Storage, the facility, and the surrounding eco-region of northeastern Ohio.

7.2.2.9 Summary and Recommendations of Scoping Level Ecological Risk Assessment

The CC RVAAP-73 Facility-Wide Coal Storage represents only a small fraction of the total habitat available at the facility. The AOC does not contain any unique habitats, and generally contains habitat of lower quality than the less developed portions of the facility. Due to its small size and non-contiguous individual exposure areas, it likely supports few potential ecological receptors, especially at the population or community level. The potential presence of these few species satisfies the condition of the existence of an important ecological resource, and SRCs were identified at the CC RVAAP-73 Facility-Wide Coal Storage. Per the Unified Approach, contamination is present and important ecological resources may also be present at CC RVAAP-73 Facility-Wide Coal Storage, therefore, this ERA was proceeded to a Level II Screening ERA.

7.2.3 Level II: Screening Level Ecological Risk Assessment

The Level II Screening Level ERA follows the Unified Approach and guidance documents listed in Section 7.2.1. This section:

- Presents the generic Ecological CSM (Section 7.2.3.1)
- Identifies habitats and species including generic receptors (Section 7.2.3.2)
- Identifies procedures used to identify COPECs (Section 7.2.3.3)
- Selects COPECs (Section 7.2.3.4 through Section 7.2.3.6)
- Conducts refinements steps for evaluating COPECs (Step 3A in the ERA process) (Section 7.2.3.7)
- Provides consideration of effects on COPECs from human health-driven remediation (Section 7.2.3.8)
- Considers uncertainties and mitigations (Section 7.2.3.9)
- Provides a summary and recommendations for the Level II: Screening Level ERA (7.2.3.10).

7.2.3.1 Generic Ecological Conceptual Site Model

The generic ecological CSM identifies the relationship between historical chemical releases to source media and ecological receptors. The ecological CSM for CC RVAAP-73 Facility-Wide Coal Storage was developed using the available information and serves as a framework for evaluating ecological exposure and risk. The ecological CSM is depicted in Figure 7-2 and described below.

Potential Sources

Contaminants found at CC RVAAP-73 Facility-Wide Coal Storage may have originated from historical storage of coal and from historical rail and heavy equipment operations associated with moving the coal to and from CC RVAAP-73 Facility-Wide Coal Storage (Section 7.2.1.2).

Transport Mechanisms

Chemicals from the sources may have migrated via the following transport mechanisms:

- Erosion and subsequent deposition in surface soil
- Bioaccumulation in biota (i.e., prey items).

Exposure Media

Ecological receptors (i.e., plants and animals) may be exposed to chemicals in surface soil (0-1 ft), and biota (i.e., prey items). Ecological receptors are not typically exposed to subsurface soil or groundwater; therefore, those media are not evaluated in this Level II ERA. Exposure to air is not evaluated in this Level II ERA as volatiles in outdoor air rapidly disperse resulting in negligible exposures, and because there are no sources of volatiles associated with coal storage.

Exposure Routes

Exposure routes through which ecological receptors may be exposed to chemicals in exposure media include:

- Direct/dermal contact with surface soil
- Dietary ingestion of biota (e.g., prey items) exposed to surface soil
- Incidental ingestion of surface soil.

Ecological Receptors

The following generic ecological receptors are likely present in the terrestrial habitats of CC RVAAP-73 Facility-Wide Coal Storage and are selected for evaluation in this ERA:

- Terrestrial plants
- Soil invertebrates
- Birds
- Mammals.

7.2.3.2 Habitats and Species (Including Generic Receptors)

CC RVAAP-73 Facility-Wide Coal Storage provides low quality habitat. Due to its small size and non-contiguous individual exposure areas, it likely supports few potential ecological receptors, especially at the population or community level.

This Level II ERA does not identify specific ecological receptors, but instead uses generic receptors, and evaluates risk using Ecological Screening Values (ESVs) as toxicity metrics. ESVs are intended to represent conservative estimates of toxicity to be protective of multiple generic receptors, including plants, microorganisms, and animals.

7.2.3.3 Procedure to Identify Chemicals of Potential Ecological Concern

COPECs are identified in this Level II ERA following a multi-step selection process that includes:

- Data selection
- Comparison to BSVs and sediment reference values
- Selection of ESVs
- Comparison of MDCs to ESVs.

Data Selection

This Level II ERA uses surface soil (0-1 ft) data collected in November 2012 and March and April 2013 in support of the RI. Sample locations are shown on Figures 5-1 through 5-12. Evaluation of data usability is presented in Chapter 5. Surface soil samples used in the ERA are presented in Table 7-16.

Surface soil data used in this Level II ERA were collected in CC RVAAP-73 Facility-Wide Coal Storage using ISM, a structured sampling method that is intended to provide a reasonably unbiased mean estimate of chemical concentrations within a given area. One ISM sample was collected at each of the three distinct terrestrial areas of CC RVAAP-73 Facility-Wide Coal Storage. One additional QA/QC duplicate ISM surface soil sample was collected at the Sand Creek Coal Tipple. Thus, a total of 4 soil samples were considered in the ERA.

This Level II ERA conservatively assumes that terrestrial receptors are continually exposed to CC RVAAP-73 Facility-Wide Coal Storage media with no accounting for the actual home range of individual terrestrial receptors, migration, or winter dormancy. Only surface soil samples collected from the top 1 ft of soil are used in this ERA, as the majority of ecological receptors would only be exposed to soils to this depth. Soil from deeper intervals is generally considered outside the biologically active zone for plants and soil invertebrates (Brady & Weil 2001).

Comparison to Background

Chemicals detected in CC RVAAP-73 Facility-Wide Coal Storage surface soil are compared to BSVs to determine if their concentrations are site-related (Table 7-17). Chemicals detected in surface soil were eliminated from further consideration in this Level II ERA where MDCs were less than BSVs. BSVs are not available for VOCs, SVOCs, and explosive compounds.

Analytes detected in that are known to be persistent, bioaccumulative, and toxic (PBT) compounds, as described in Ohio EPA-DERR guidance (Ohio EPA-DERR 2008), are retained for further evaluation regardless of the results of the media evaluation. The Ohio EPA-DERR guidance identifies chemicals that are PBT and also notes that chemicals with an octanol-water partition coefficient (Log K_{ow}) of 3.0 or greater are also likely bioaccumulative. Analytes specifically listed in the guidance, as well as analytes detected in AOC surface soil with a Log K_{ow} greater than 3.0 are identified as COPECs, except where MDCs are less than ESVs developed to be protective of bioaccumulative effects.

Ecological Screening Value Selection

ESVs are selected using the media-specific Ohio EPA-DERR screening hierarchy.

Soil Ecological Screening Values

The following Ohio EPA-DERR screening hierarchy was used to select ESVs for surface soil, with sources presented in the preferred order of selection:

1. USEPA Ecological Soil Screening Levels (USEPA 2005)
2. Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al. 1997)
3. USEPA Region 5 Ecological Screening Levels (USEPA 2003).

Comparison of Maximum Detected Concentration to Ecological Screening Values

COPECs were selected by comparing MDCs of chemicals retained (following the BSV comparison) to ESVs. MDCs were used to provide a conservative estimate of the concentration of a given chemical in CC RVAAP-73 Facility-Wide Coal Storage surface soil. The ratio of the MDC to the ESV is also referred to as an HQ and is calculated using the following equation:

$$HQ = \frac{MDC}{ESV} \qquad \text{(Equation 2)}$$

An HQ ≤1.0 indicates that a chemical is present in the AOC media at concentrations that are unlikely to result in adverse ecological affects and can be eliminated from further evaluation. An HQ >1.0 does not necessarily indicate that a chemical is present at concentrations that would result in adverse ecological affects, only that it is present at a concentration greater than the conservative ESV. Chemicals with HQs >1.0 were selected as COPECs and were retained for further evaluation. Analytes with HQs ≤1.0 that are known PBT compounds were retained as COPECs where ESVs are not protective of bioaccumulation effects.

HQs were not calculated for essential nutrients. Essential nutrients are chemical elements that are required by most organisms, naturally present in the environment in high concentrations, and generally considered to be innocuous. Calcium, iron, magnesium, potassium, and sodium are considered essential nutrients and were, therefore, eliminated from further consideration in this Level II ERA. The COPECs identified in this ERA are summarized below in Sections 7.2.3.4 through Section 7.2.3.6.

7.2.3.4 Soil Chemicals of Potential Ecological Concern

Thirteen metals (excluding essential nutrients) were detected at concentrations exceeding their respective BSV and 2 VOCs, 17 SVOCs, and 1 explosive compound were detected in surface soil samples in CC RVAAP-73 Facility-Wide Coal Storage (Table 7-17). Seven metals, 2 VOCs, and 17 SVOCs were eliminated from further evaluation because their MDCs were less than ESVs. Following the screening, 6 metals, 1 SVOC, and 1 explosive compound were identified as COPECs in surface soil and retained for further evaluation:

- Arsenic
- Cadmium
- Manganese

- Selenium
- Thallium
- Zinc
- Dibenzofuran
- Tetryl.

7.2.3.5 Step 3A: Refinement of Soil Chemicals of Potential Ecological Concern

The purpose of Step 3A is to refine the list of COPECs to determine if:

1. There are final COPECs requiring further evaluation in Level III ERA or remediation to protect ecological receptors; or

2. COPECs can be eliminated from further consideration.

This evaluation is adapted from the USEPA Step 3A, outlined in the ERA Guidance for Superfund: Process for Designing and Conducting ERAs (USEPA 1997) and Risk Assessment Handbook Volume II: Environmental Evaluation (USACE 2010b). The eight total COPECs are further refined in Step 3A.

Metals

It was conservatively assumed in the ERA that receptors would be limited to within the boundaries of CC RVAAP-73 Facility-Wide Coal Storage. However, CC RVAAP-73 Facility-Wide Coal Storage accounts for only 0.009 percent of the total terrestrial area of the facility. Populations of birds and mammals would forage and nest across a much larger range, and communities of plants and soil invertebrates would also occur across a much larger area than that of the CC RVAAP-73 Facility-wide Coal Storage. Even individuals of state-listed species are unlikely to be restricted to such a small area. Also, as explained above, the AOC does not provide any unique habitat and is of lesser quality than other less developed parts of the facility.

Considering the uncertainties associated with conservative exposure assumptions (Section 7.2.3.7), HQs presented in Table 7-17 greatly overestimate ecological risk. Therefore, risks from metals in CC RVAAP-73 Facility-Wide Coal Storage surface soil were further refined by calculating HQs based on the average concentration (herein referred to as the “average HQ”). Average concentrations provide more realistic estimates of concentrations to which populations of ecological receptors would be exposed to over time and across the spatial extent of CC RVAAP-73 Facility-Wide Coal Storage. Although CC RVAAP-73 Facility-Wide Coal Storage is not a contiguous area, habitats are consistent in the three distinct terrestrial exposure areas of CC RVAAP-73 Facility-Wide Coal Storage. It is, therefore, appropriate to consider CC RVAAP-73 Facility-Wide Coal Storage as a single unit for the purpose of characterizing risk to ecological receptors.

Table 7-18 presents average HQs for metals identified as COPECs in CC RVAAP-73 Facility-Wide Coal Storage surface soil. Average HQs are <1 for arsenic, cadmium, and thallium. Average HQs are <10 for lead (1.6), manganese (3.4), selenium (1.7), and zinc (1.5).

Considering other conservative assumptions (100 percent bioavailability and receptors using CC RVAAP-73 Facility-Wide Coal Storage 100 percent of the time), risk to communities and populations of commons species, and to individual species of special concern, is likely negligible, and these surface soil metals can be eliminated from further review.

Dibenzofuran

Dibenzofuran was detected in CC RVAAP-73 Facility-Wide Coal Storage surface soil and retained as a COPEC for further evaluation because no screening benchmark was available in the Ohio EPA-DERR screening hierarchy. Dibenzofuran was detected in 3 of 4 surface soil samples with an MDC of 2,500 µg/kg and an average concentration of 698 µg/kg. The Los Alamos National Laboratory [LANL] Eco-RISK Database (LANL 2014) presents a minimum no-effect benchmark (6,100 µg/kg) and low-effect benchmarks (61,000 µg/kg) for dibenzofuran based on values for effects on generic plant receptors. Considering that the MDC of dibenzofuran is an order of magnitude lower than the LANL low-effect minimum ecological screening value, risk to communities and populations of commons species, and to individual species of special concern, is likely negligible, and dibenzofuran can be eliminated from further review.

Tetryl

Tetryl was detected in CC RVAAP-73 Facility-Wide Coal Storage surface soil and retained as a COPEC for further evaluation as no screening benchmark was available in the Ohio EPA-DERR screening hierarchy. Tetryl was detected in one surface soil sample at a concentration of 24 µg/kg. The LANL Eco-RISK Database presents minimum no-effect (990 µg/kg) and low-effect benchmarks (47,000 µg/kg) for tetryl based on values for effects on mammalian receptors. Considering that the MDC of tetryl is an order of magnitude lower than the LANL minimum ecological screening values, risk to communities and populations of commons species, and to individual species of special concern, is likely negligible, and tetryl can be eliminated from further review.

7.2.3.6 Consideration of the Results from the Human Health Risk Assessment

No COCs were identified in North Line Road Coal Tipple surface or subsurface soil for the Resident Receptor. A few chemicals exceeded screening values, but were eliminated based on the weight-of-evidence discussion in Section 7.1.8. No COCs were identified for Sand Creek Coal Tipple surface or subsurface soil for the Resident Receptor. No COCs were identified for Building U-16 Boiler House surface soil and subsurface soil Resident Receptor.

Therefore, No Further Action is obtained for CC RVAAP-73 Facility-Wide Coal Storage surface and subsurface soil based on human health.

7.2.3.7 Uncertainties and Mitigations

The initial risk screening conducted in the Level II Screening ERA incorporated numerous assumptions and uncertainties that tend to overestimate risk including:

- That ecological receptors are exposed to COPEC in exposure units all of the time with no accounting for home range, habitat suitability, or temporal use (e.g., migration or hibernation)

- That ecological receptors are exposed to MDCs of COPECs in ISM samples from among all the terrestrial exposure units at all times

- That ecological receptors are exposed to average concentrations from among all the terrestrial exposure units at all times

- The use of ESVs, which are highly conservative and do not take into account bioavailability in the environment or the attenuation and degradation of chemicals in the environment.

These uncertainties are considered in the Step 3A refinement presented in Section 7.2.3.5.

7.2.3.8 Summary and Recommendations Ecological Risk Assessment

COPECs were identified using the MDCs of analytes detected in surface soil. The MDCs were compared to BSVs and conservative ecological screening benchmarks for generic receptors. The list of COPECs was subsequently refined on a COPEC-by-COPEC basis. Considering the small individual and collective size (2.01 acres), and the low quality habitat, and taking into account uncertainties addressed in Section 7.2.3.7, it is unlikely that exposure to surface soil would adversely affect communities or populations of common ecological receptors or individuals of state-listed species in CC RVAAP-73 Facility-Wide Coal Storage.

7.2.4 Conclusions

No further investigation (e.g., Level III Baseline ERA) or removal action is considered necessary for CC RVAAP-73 Facility-Wide Coal Storage for the protection of ecological receptors.

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Table 7-1: Samples Included in the Human Health Risk Assessment

Location ID	Field Sample ID	Sample Date	Sample Depth (ft bgs)	Exposure Area	Medium
73-SCCT-DU1-SB	073SB-0016M-0001-SO	3/28/2013	1-4	SCCT	Subsurface Soil
73-SCCT-DU1-SB	073SB-0019M-0001-SO	3/28/2013	4-7	SCCT	Subsurface Soil
73-SCCT-DU1-SB1	073SB-0020M-0001-SO	3/28/2013	1-7	SCCT	Subsurface Soil
73-SCCT-DU1-SB2	073SB-0021M-0001-SO	3/28/2013	1-7	SCCT	Subsurface Soil
73-SCCT-DU1-SB3	073SB-0022M-0001-SO	3/28/2013	1-7	SCCT	Subsurface Soil
73-SCCT-DU1-SB4	073SB-0023M-0001-SO	3/28/2013	1-7	SCCT	Subsurface Soil
73-SCCT-DU1-SB5	073SB-0024M-0001-SO	3/28/2013	1-7	SCCT	Subsurface Soil
73-NLCT-DU1-SB	073SB-0025M-0001-SO	3/27/2013	1-4	NLCT	Subsurface Soil
73-NLCT-DU1-SB	073SB-0026M-0001-SO	3/27/2013	4-7	NLCT	Subsurface Soil
73-NLCT-DU1-SB1	073SB-0027M-0001-SO	3/27/2013	1-7	NLCT	Subsurface Soil
73-NLCT-DU1-SB2	073SB-0029M-0001-SO	3/27/2013	1-7	NLCT	Subsurface Soil
73-NLCT-DU1-SB3	073SB-0030M-0001-SO	3/27/2013	1-7	NLCT	Subsurface Soil
73-NLCT-DU1-SB4	073SB-0031M-0001-SO	3/27/2013	1-7	NLCT	Subsurface Soil
73-NLCT-DU1-SB5	073SB-0032M-0001-SO	3/27/2013	1-7	NLCT	Subsurface Soil
73-NLCT-DU1-SB5	073SB-0033-0001-SO	3/27/2013	7-13	NLCT	Subsurface Soil
73-U16-DU1-SB	073SB-0036M-0001-SO	4/1/2013	1-4	U16	Subsurface Soil
73-U16-DU1-SB	073SB-0037M-0001-SO	4/1/2013	4-7	U16	Subsurface Soil
73-U16-DU1-SB1	073SB-0038M-0001-SO	4/1/2013	1-7	U16	Subsurface Soil
73-U16-DU1-SB2	073SB-0040M-0001-SO	4/1/2013	1-7	U16	Subsurface Soil
73-U16-DU1-SB3	073SB-0041M-0001-SO	4/1/2013	1-7	U16	Subsurface Soil
73-U16-DU1-SB4	073SB-0042M-0001-SO	4/1/2013	1-7	U16	Subsurface Soil
73-U16-DU1-SB5	073SB-0043M-0001-SO	4/1/2013	1-7	U16	Subsurface Soil
73-U16-DU1-SB5	073SB-0044-0001-SO	4/1/2013	7-13	U16	Subsurface Soil
73-SCCT-DU1-SB5	073SB-0067-0001-SO	3/28/2013	7-13	SCCT	Subsurface Soil
73-SCCT-DU1-SS	073SS-0002M-0001-SO	11/8/2012	0-1	SCCT	Surface Soil
73-NLCT-DU1-SS	073SS-0005M-0001-SO	11/8/2012	0-1	NLCT	Surface Soil
73-U16-DU1-SS	073SS-0035M-0001-SO	4/1/2013	0-1	U16	Surface Soil

Notes:
bgs = Below ground surface.
ft = Feet.
ID = Identification.
NLCT = North Line Road Coal Tipple.
SCCT = Sand Creek Coal Tipple.
U16 = Bld. U-16 Boiler House.

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Table 7-2: Chemicals of Potential Concern for Surface Soil, North Line Road Coal Tipple

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal[(a)]	Screening Value Source [(b)]	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-NLCT-DU1-SS
Field Sample ID:								**073SS-0005M-0001-SO**
Lab Sample ID:								**240-17422-8**
Sample Date:								**11/8/2012**
Sample Depth:								**0-1**
Metals								
Arsenic	mg/kg	15.4	0.425	RR AC	28	Yes	Yes	28
Barium	mg/kg	88.4	351	NGT	160	Yes	No	160
Beryllium	mg/kg	0.88	16	RRSL	3.3	Yes	No	3.3
Cadmium	mg/kg	0	6.41	RR CN	0.61	Yes	No	0.61 J
Manganese	mg/kg	1,450	35.1	NGT	1,900	Yes	Yes	1.900
Nickel	mg/kg	21.1	155	RR CN	24	Yes	No	24
Selenium	mg/kg	1.4	39	RRSL	2.3	Yes	No	2.3 J
Zinc	mg/kg	61.8	2,321	RR CN	99	Yes	No	99
Semivolatile Organic Compounds								
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	9.1	Yes	No	9.1
Acenaphthene	mg/kg	NB	340	RRSL	0.24	Yes	No	0.24
Acenaphthylene	mg/kg	NB	1,700	RRSL**	0.16	Yes	No	0.16
Anthracene	mg/kg	NB	1,700	RRSL	0.30	Yes	No	0.3
Benzo(a)anthracene	mg/kg	NB	0.221	RR AC	0.73	Yes	Yes	0.73
Benzo(a)pyrene	mg/kg	NB	0.022	RR AC	0.57	Yes	Yes	0.57
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR AC	0.67	Yes	Yes	0.67
Benzo(g,h,i)perylene	mg/kg	NB	122	RR CN*	0.16	Yes	No	0.16
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR AC	0.19	Yes	No	0.19
Chrysene	mg/kg	NB	22.1	RR AC	1.0	Yes	No	1
Dibenzofuran	mg/kg	NB	15.3	RR CN	2.5	Yes	No	2.5
Fluoranthene	mg/kg	NB	163	RR CN	0.86	Yes	No	0.86
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR AC	0.14	Yes	No	0.14
Naphthalene	mg/kg	NB	122	RR CN	4.6	Yes	No	4.6
Phenanthrene	mg/kg	NB	1,700	RRSL**	5.5	Yes	No	5.5
Pyrene	mg/kg	NB	122	RR CN	1.0	Yes	No	1

Table 7-2: Chemicals of Potential Concern for Surface Soil, North Coal Line Tipple (continued)

Notes:
a. Most stringent screening value from available sources.
b. Source of Screening Values:
NGT = National Guard Trainee (Lower of HQ = 0.1 and ELCR of 1×10^{-6})
RR AC = Residential Receptor (Adult) (Cancer ELCR of 1×10^{-6}).
RR CN = Residential Receptor (Child) (Non-cancer HQ = 0.1) (*) = Pyrene used as a surrogate.
RRSL = Residential RSL (Lower of HQ = 0.1 and ELCR of 1×10^{-6}) (**) = Anthracene was used as a surrogate phenanthrene.
Yellow shading indicates analyte is a COPC.
COPC = Chemical of potential concern.
ELCR = Excess Lifetime Cancer Risk.
HQ = Hazard quotient.
ID = Identification.
J = Estimated: the result reported between the Detection Limit and the Limit of Quantitation.
mg/kg = Milligrams per kilogram.
NB = No background.
SRC = Site-related chemical.

Table 7-3: Chemicals of Potential Concern for Subsurface Soil, North Line Road Coal Tipple

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal[(a)]	Screening Value Source [(b)]	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-NLCT-DU1-SB		73-NLCT-DU1-SB1	
Field Sample ID:								**073SB-0025M-0001-SO**	**073SB-0026M-0001-SO**	**073SB-0027M-0001-SO**	**073SB-0028M-0001-SO**
Lab Sample ID:								**240-22562-1**	**240-22562-2**	**240-22562-3**	**240-22562-4**
Sample Date:								**3/27/2013**	**3/27/2013**	**3/27/2013**	**3/27/2013**
Sample Depth:								**1-4**	**4-7**	**1-7**	**1-7**
Metals											
Beryllium	mg/kg	0.88	16	RRSL	0.97	Yes	No	0.72	0.44	0.97	0.84
Cadmium	mg/kg	0	6.41	RR CN	0.26	Yes	No	0.2	0.23	0.25	0.25
Silver	mg/kg	0	38.6	RR CN	0.041	Yes	No	0.03 J	0.041 J	0.035 J	0.038 J
Volatile Organic Compounds											
Carbon Disulfide	mg/kg	NB	82	RRSL	0.0029	Yes	No	NR	NR	NR	NR
Semivolatile Organic Compounds											
1,4-Dichlorobenzene	mg/kg	NB	2.4	RRSL	0.022	Yes	No	ND	0.021 J	ND	ND
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	0.14	Yes	No	0.14	0.024	0.068	0.067
Benzo(a)anthracene	mg/kg	NB	0.221	RR AC	0.048	Yes	No	ND	ND	0.048	0.027 J
Benzo(a)pyrene	mg/kg	NB	0.022	RR AC	0.049	Yes	Yes	ND	ND	0.049	0.033 J
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR AC	0.11	Yes	No	ND	0.0068	0.11	0.072
Benzo(g,h,i)perylene	mg/kg	NB	122	RRCN*	0.041	Yes	No	ND	0.0073	0.041	0.032 J
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR AC	0.03	Yes	No	ND	ND	0.03 J	0.02 J
Chrysene	mg/kg	NB	22.1	RR AC	0.088	Yes	No	ND	ND	0.088	0.06
Dibenzofuran	mg/kg	NB	15.3	RR CN	0.022	Yes	No	ND	0.0092 J	0.022 J	0.022 J
Fluoranthene	mg/kg	NB	163	RR CN	0.098	Yes	No	0.065 J	0.0042 J	0.098	0.066
Fluorene	mg/kg	NB	243	RR CN	0.0073	Yes	No	ND	0.0073	ND	ND
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR AC	0.033	Yes	No	ND	ND	0.033	0.023 J
Isophorone	mg/kg	NB	510	RRSL	0.031	Yes	No	ND	0.031 J	ND	ND
Naphthalene	mg/kg	NB	122	RR CN	0.055	Yes	No	ND	0.02	0.055	0.054
Phenanthrene	mg/kg	NB	1700	RRSL**	0.18	Yes	No	0.18	0.017	0.064	0.064
Pyrene	mg/kg	NB	122	RR CN	0.08	Yes	No	0.07	0.0043 J	0.08	0.055
Explosives											
2,4-Dinitrotoluene	mg/kg	NB	0.753	RR AC	0.01	Yes	No	NR	NR	NR	NR
Tetryl	mg/kg	NB	12	RRSL	0.01	Yes	No	NR	NR	NR	NR

Table 7-3: Contaminants of Potential Concern for Subsurface Soil, North Line Road Coal Tipple (continued)

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal (a)	Screening Value Source (b)	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-NLCT-DU1-SB2	73-NLCT-DU1-SB3	73-NLCT-DU1-SB4	73-NLCT-DU1-SB5	
Field Sample ID:								073SB-0029M-0001-SO	073SB-0030M-0001-SO	073SB-0031M-0001-SO	073SB-0032M-0001-SO	073SB-0033-0001-SO
Lab Sample ID:								240-22562-5	240-22562-6	240-22562-7	240-22562-8	240-22562-9
Sample Date:								3/27/2013	3/27/2013	3/27/2013	3/27/2013	3/27/2013
Sample Depth:								1-7	1-7	1-7	1-7	7-13
Metals												
Beryllium	mg/kg	0.88	16	RRSL	0.97	Yes	No	0.46	0.31	0.45	0.68	0.25
Cadmium	mg/kg	0	6.41	RR CN	0.26	Yes	No	0.26	0.13	0.16	0.2	0.088 J
Silver	mg/kg	0	38.6	RR CN	0.041	Yes	No	0.04 J	0.021 J	0.035 J	0.032 J	0.024 J
Volatile Organic Compounds												
Carbon Disulfide	mg/kg	NB	82	RRSL	0.0029	Yes	No	NR	NR	0.0029 J	NR	NR
Semivolatile Organic Compounds												
1,4-Dichlorobenzene	mg/kg	NB	2.4	RRSL	0.022	Yes	No	0.022 J	ND	ND	ND	ND
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	0.14	Yes	No	0.012	0.014	0.018	0.089	0.014
Benzo(a)anthracene	mg/kg	NB	0.221	RR AC	0.048	Yes	No	ND	ND	ND	ND	ND
Benzo(a)pyrene	mg/kg	NB	0.022	RR AC	0.049	Yes	Yes	ND	ND	ND	ND	0.0049 J
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR AC	0.11	Yes	No	0.006 J	0.0049 J	0.0051 J	ND	0.016
Benzo(g,h,i)perylene	mg/kg	NB	122	RRCN*	0.041	Yes	No	0.0087	0.0047 J	ND	ND	0.033
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR AC	0.03	Yes	No	ND	ND	ND	ND	ND
Chrysene	mg/kg	NB	22.1	RR AC	0.088	Yes	No	ND	ND	0.0051 J	ND	0.012
Dibenzofuran	mg/kg	NB	15.3	RR CN	0.022	Yes	No	0.0035 J	0.0043 J	0.0069 J	ND	0.0043 J
Fluoranthene	mg/kg	NB	163	RR CN	0.098	Yes	No	0.0043 J	ND	0.0057 J	0.069	0.0067 J
Fluorene	mg/kg	NB	243	RR CN	0.0073	Yes	No	ND	ND	ND	ND	ND
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR AC	0.033	Yes	No	ND	ND	ND	ND	0.0082
Isophorone	mg/kg	NB	510	RRSL	0.031	Yes	No	ND	ND	ND	ND	ND
Naphthalene	mg/kg	NB	122	RR CN	0.055	Yes	No	0.011	0.013	0.012	ND	0.0054 J
Phenanthrene	mg/kg	NB	1,700	RRSL**	0.18	Yes	No	0.0083	0.0089	ND	ND	0.016
Pyrene	mg/kg	NB	122	RR CN	0.08	Yes	No	0.0064 J	ND	0.0045 J	0.055 J	0.014
Explosives												
2,4-Dinitrotoluene	mg/kg	NB	0.753	RR AC	0.01	Yes	No	NR	NR	0.01	NR	NR
Tetryl	mg/kg	NB	12	RRSL	0.01	Yes	No	NR	NR	0.01	NR	NR

Notes:
a. Most stringent screening value from available sources.
b. Source of Screening Values:
NGT = National Guard Trainee (Lower of HQ = 0.1 and ELCR of 1×10^{-6})
RR AC = Residential Receptor (Adult) (Cancer ELCR of 1×10^{-6}).
RR CN = Residential Receptor (Child) (Non-cancer HQ = 0.1) (*) = Pyrene used as a surrogate.
RRSL = Residential RSL (Lower of HQ = 0.1 and ELCR of 1×10^{-6}) (**) = Anthracene was used as a surrogate phenanthrene.
Yellow shading indicates analyte is a COPC.
COPC = Chemical of potential concern.
ELCR = Excess Lifetime Cancer Risk.
HQ = Hazard quotient.
ID = Identification.
J = Estimated: the result reported between the Detection Limit and the Limit of Quantitation.
mg/kg = Milligrams per kilogram.
NB = No background.
NR = Not reported.
SRC = Site-related chemical.

Table 7-4: Chemicals of Potential Concern for Surface Soil, Sand Creek Coal Tipple

		Background Screening Value	Facility-Wide Cleanup Goal [(a)]	Screening Value Source [(b)]	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No		
Location ID:								**73-SCCT-DU1-SS**	
Field Sample ID:								**073SS-0002M-0001-SO**	**073SS-0003M-0001-SO**
Lab Sample ID:								**240-17422-5**	**240-17422-6**
Sample Date:								**11/8/2012**	**11/8/2012**
Sample Depth:								**0-1**	**0-1**
Metals									
Cadmium	mg/kg	0	6.41	RR CN	0.22	Yes	No	0.22	0.21
Chromium (as CrVI)	mg/kg	NB	1.64	NGT	19	Yes	Yes	19	17
Nickel	mg/kg	21.1	155	RR CN	22	Yes	No	22	22
Silver	mg/kg	0	38.6	RR CN	0.44	Yes	No	0.38	0.44
Thallium	mg/kg	0	0.612	RR CN	0.11	Yes	No	ND	0.11 J
Zinc	mg/kg	61.8	2321	RR CN	64	Yes	No	64	64
Volatile Organic Compounds									
Carbon Disulfide	mg/kg	NB	82	RRSL	0.0013	Yes	No	ND	0.0013 J
Semivolatile Organic Compounds									
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	0.09	Yes	No	0.09	0.062
Acenaphthylene	mg/kg	NB	1,700	RRSL**	0.007	Yes	No	ND	0.0066 J
Anthracene	mg/kg	NB	1,700	RRSL	0.016	Yes	No	ND	0.016
Benzo(a)anthracene	mg/kg	NB	0.221	RR AC	0.057	Yes	No	0.052	0.057
Benzo(a)pyrene	mg/kg	NB	0.022	RR AC	0.087	Yes	Yes	0.087	0.065
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR AC	0.12	Yes	No	0.12	0.11
Benzo(g,h,i)perylene	mg/kg	NB	122	RR CN*	0.047	Yes	No	0.029	0.047
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR AC	0.029	Yes	No	0.026 J	0.029
Chrysene	mg/kg	NB	22.1	RR AC	0.080	Yes	No	0.08	0.071
Dibenzofuran	mg/kg	NB	15.3	RR CN	0.023	Yes	No	0.023 J	0.015 J
Fluoranthene	mg/kg	NB	163	RR CN	0.120	Yes	No	0.099	0.12
Fluorene	mg/kg	NB	243	RR CN	0.009	Yes	No	ND	0.0085
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR AC	0.054	Yes	No	0.054 J	0.046
Naphthalene	mg/kg	NB	122	RR CN	0.063	Yes	No	0.063	0.049
Phenanthrene	mg/kg	NB	1,700	RRSL**	0.071	Yes	No	0.061	0.071
Pyrene	mg/kg	NB	122	RR CN	0.088	Yes	No	0.078	0.088
Explosives									
Tetryl	mg/kg	NB	12	RRSL	0.024	Yes	No	ND	0.024 J

Notes:
a. Most stringent screening value from available sources.
b. Source of Screening Values:
NGT = National Guard Trainee (Lower of HQ = 0.1 and ELCR of 1×10^{-6})
RR AC = Residential Receptor (Adult) (Cancer ELCR of 1×10^{-6}).
RR CN = Residential Receptor (Child) (Non-cancer HQ = 0.1) (*) = Pyrene used as a surrogate.
RRSL = Residential RSL (Lower of HQ = 0.1 and ELCR of 1×10^{-6}) (**) = Anthracene was used as surrogate phenanthrene.
Yellow shading indicates analyte is a COPC.
COPC = Chemical of potential concern.
ELCR = Excess Lifetime Cancer Risk.
HQ = Hazard quotient.
ID = Identification.
J = Estimated: the result reported between the Detection Limit and the Limit of Quantitation.
mg/kg = Milligrams per kilogram.
NB = No background.
ND = Not detected.
SRC = Site-related chemical.

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Table 7-5: Chemicals of Potential Concern for Subsurface Soil, Sand Creek Coal Tipple

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal [(a)]	Screening Value Source [(b)]	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-SCCT-DU1-SB		
Field Sample ID:								073SB-0016M-0001-SO	073SB-0017M-0001-SO	073SB-0019M-0001-SO
Lab Sample ID:								240-22648-1	240-22648-2	240-22648-3
Sample Date:								3/28/2013	3/28/2013	3/28/2013
Sample Depth:								1-4	1-4	4-7
Metals										
Cadmium	mg/kg	0	6.41	RR CN	0.2	Yes	No	0.2 J+	0.19	0.12
Silver	mg/kg	0	38.6	RR CN	0.4	Yes	No	0.24	0.23	0.021 J
Semivolatile Organic Compounds										
1,4-Dichlorobenzene	mg/kg	NB	2.4	RRSL	0.035	Yes	No	0.028 J	0.024 J	0.021 J
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	0.06	Yes	No	0.06	0.036	0.012
Acenaphthylene	mg/kg	NB	1,700	RRSL**	0.0094	Yes	No	0.0094	0.0048 J	ND
Anthracene	mg/kg	NB	1,700	RRSL	0.025	Yes	No	0.016	0.025	ND
Benzo(a)anthracene	mg/kg	NB	0.221	RR AC	0.077	Yes	No	0.077	0.07	ND
Benzo(a)pyrene	mg/kg	NB	0.022	RR AC	0.062	Yes	Yes	0.062	0.058	ND
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR AC	0.11	Yes	No	0.11	0.085	ND
Benzo(g,h,i)perylene	mg/kg	NB	122	RR CN*	0.038	Yes	No	0.038	0.032	ND
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR AC	0.031	Yes	No	0.027	0.031	ND
Benzyl alcohol	mg/kg	NB	610	RRSL	0.13	Yes	No	ND	0.037 J	ND
Chrysene	mg/kg	NB	22.1	RR AC	0.077	Yes	No	0.077	0.067	ND
Dibenzofuran	mg/kg	NB	15.3	RR CN	0.014	Yes	No	0.014 J	0.011 J	ND
Fluoranthene	mg/kg	NB	163	RR CN	0.15	Yes	No	0.13	0.15	ND
Fluorene	mg/kg	NB	243	RR CN	0.0096	Yes	No	0.0059 J	0.0096	ND
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR AC	0.033	Yes	No	0.033	0.031	ND
Isophorone	mg/kg	NB	510	RRSL	0.023	Yes	No	0.018 J	0.023 J	ND
Naphthalene	mg/kg	NB	122	RR CN	0.051	Yes	No	0.051	0.034	0.012
Phenanthrene	mg/kg	NB	1,700	RRSL**	0.087	Yes	No	0.062	0.087	0.0077
Pyrene	mg/kg	NB	122	RR CN	0.12	Yes	No	0.1	0.12	0.0039 J

Table 7-5: Chemicals of Potential Concern for Subsurface, Soil Sand Creek Coal Tipple (continued)

	Location ID:	Background Screening Value	Facility-Wide Cleanup Goal [(a)]	Screening Value Source [(b)]	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-SCCT-DU1-SB1	73-SCCT-DU1-SB2	73-SCCT-DU1-SB3
	Field Sample ID:							**073SB-0020M-0001-SO**	**073SB-0021M-0001-SO**	**073SB-0022M-0001-SO**
	Lab Sample ID:							**240-22648-4**	**240-22648-5**	**240-22648-6**
	Sample Date:							**3/28/2013**	**3/28/2013**	**3/28/2013**
	Sample Depth:							**1-7**	**1-7**	**1-7**
Metals										
Cadmium	mg/kg	0	6.41	RR CN	0.2	Yes	No	0.14	0.14	0.12
Silver	mg/kg	0	38.6	RR CN	0.4	Yes	No	0.033 J	0.027 J	0.041 J
Semivolatile Organic Compounds										
1,4-Dichlorobenzene	mg/kg	NB	2.4	RRSL	0.035	Yes	No	0.02 J	0.023 J	ND
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	0.06	Yes	No	0.022	0.024	0.017
Acenaphthylene	mg/kg	NB	1,700	RRSL**	0.0094	Yes	No	ND	ND	ND
Anthracene	mg/kg	NB	1,700	RRSL	0.025	Yes	No	ND	ND	ND
Benzo(a)anthracene	mg/kg	NB	0.221	RR AC	0.077	Yes	No	0.013	0.0091	0.0072
Benzo(a)pyrene	mg/kg	NB	0.022	RR AC	0.062	Yes	Yes	0.014	0.007	ND
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR AC	0.11	Yes	No	0.018	0.014	0.0077
Benzo(g,h,i)perylene	mg/kg	NB	122	RR CN*	0.038	Yes	No	0.01	0.0064 J	0.0054 J
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR AC	0.031	Yes	No	0.0085	0.0045 J	ND
Benzyl alcohol	mg/kg	NB	610	RRSL	0.13	Yes	No	0.13 J	ND	ND
Chrysene	mg/kg	NB	22.1	RR AC	0.077	Yes	No	0.015	0.01	0.0061 J
Dibenzofuran	mg/kg	NB	15.3	RR CN	0.014	Yes	No	0.0084 J	0.0065 J	0.005 J
Fluoranthene	mg/kg	NB	163	RR CN	0.15	Yes	No	0.025	0.016	0.0087
Fluorene	mg/kg	NB	243	RR CN	0.0096	Yes	No	0.0044 J	ND	ND
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR AC	0.033	Yes	No	0.0081	0.0062 J	ND
Isophorone	mg/kg	NB	510	RRSL	0.023	Yes	No	0.016 J	0.019 J	ND
Naphthalene	mg/kg	NB	122	RR CN	0.051	Yes	No	0.022	0.023	0.014
Phenanthrene	mg/kg	NB	1,700	RRSL**	0.087	Yes	No	0.019	0.017	0.013
Pyrene	mg/kg	NB	122	RR CN	0.12	Yes	No	0.022	0.013	0.009

Table 7-5: Chemicals of Potential Concern Subsurface Soil Sand Creek Coal Tipple (continued)

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal (a)	Screening Value Source (b)	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-SCCT-DU1-SB4	73-SCCT-DU1-SB5	
Field Sample ID:								**073SB-0023M-0001-SO**	**073SB-0024M-0001-SO**	**073SB-0067-0001-SO**
Lab Sample ID:								**240-22648-7**	**240-22648-8**	**240-22648-9**
Sample Date:								**3/28/2013**	**3/28/2013**	**3/28/2013**
Sample Depth:								**1-7**	**1-7**	**7-13**
Metals										
Cadmium	mg/kg	0	6.41	RR CN	0.2	Yes	No	0.2	0.18	0.093 J
Silver	mg/kg	0	38.6	RR CN	0.4	Yes	No	0.38	0.074 J	0.016 J
Semivolatile Organic Compounds										
1,4-Dichlorobenzene	mg/kg	NB	2.4	RRSL	0.035	Yes	No	0.035 J	0.024 J	ND
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	0.06	Yes	No	0.024	0.028	ND
Acenaphthylene	mg/kg	NB	1,700	RRSL**	0.0094	Yes	No	0.0033 J	0.0046 J	ND
Anthracene	mg/kg	NB	1,700	RRSL	0.025	Yes	No	ND	0.0045 J	ND
Benzo(a)anthracene	mg/kg	NB	0.221	RR AC	0.077	Yes	No	0.016	0.014	ND
Benzo(a)pyrene	mg/kg	NB	0.022	RR AC	0.062	Yes	Yes	0.015	0.013	ND
Benzo(b)fluoranthene	mg/kg	NB	0.221	RR AC	0.11	Yes	No	0.022	0.028	ND
Benzo(g,h,i)perylene	mg/kg	NB	122	RR CN*	0.038	Yes	No	0.015	0.014	ND
Benzo(k)fluoranthene	mg/kg	NB	2.21	RR AC	0.031	Yes	No	0.011	0.0083	ND
Benzyl alcohol	mg/kg	NB	610	RRSL	0.13	Yes	No	0.034 J	ND	0.08 J
Chrysene	mg/kg	NB	22.1	RR AC	0.077	Yes	No	0.029	0.021	ND
Dibenzofuran	mg/kg	NB	15.3	RR CN	0.014	Yes	No	0.012 J	0.0085 J	ND
Fluoranthene	mg/kg	NB	163	RR CN	0.15	Yes	No	0.031	0.025	ND
Fluorene	mg/kg	NB	243	RR CN	0.0096	Yes	No	0.006 J	0.0045 J	ND
Indeno(1,2,3-c,d)pyrene	mg/kg	NB	0.221	RR AC	0.033	Yes	No	0.0088	0.011	ND
Isophorone	mg/kg	NB	510	RRSL	0.023	Yes	No	0.013 J	0.014 J	ND
Naphthalene	mg/kg	NB	122	RR CN	0.051	Yes	No	0.02	0.026	ND
Phenanthrene	mg/kg	NB	1,700	RRSL**	0.087	Yes	No	0.031	0.026	ND
Pyrene	mg/kg	NB	122	RR CN	0.12	Yes	No	0.031	0.022	ND

Notes:
a. Most stringent screening value from available sources.
b. Source of Screening Values:
NGT = National Guard Trainee (Lower of HQ = 0.1 and ELCR of 1×10^{-6})
RR AC = Residential Receptor (Adult) (Cancer ELCR of 1×10^{-6}).
RR CN = Residential Receptor (Child) (Non-cancer HQ = 0.1) (*) = Pyrene used as a surrogate.
RRSL = Residential RSL (Lower of HQ = 0.1 and ELCR of 1×10^{-6}) (**) = Anthracene was used as a surrogate phenanthrene.
Yellow shading indicates analyte is a COPC.
COPC = Chemical of potential concern.
ELCR = Excess Lifetime Cancer Risk.
HQ = Hazard quotient.
ID = Identification.
J = Estimated: the result reported between the Detection Limit and the Limit of Quantitation.
mg/kg = Milligrams per kilogram.
ND = Not detected.
NB = No background.
SRC = Site-related chemical.

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Table 7-6: Chemicals of Potential Concern for Surface Soil, Building U-16 Boiler House

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal [(a)]	Screening Value Source [(b)]	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-U16-DU1-SS
Field Sample ID:								073SS-0035M-0001-SO
Lab Sample ID:								240-22663-11
Sample Date:								4/1/2013
Sample Depth:								0-1
Metals								
Cadmium	mg/kg	0	6.41	RR CN	0.18	Yes	No	0.18
Cobalt	mg/kg	10.4	7.03	NGT	11.0	Yes	Yes	11
Copper	mg/kg	17.7	311	RR CN	19	Yes	No	19
Nickel	mg/kg	21.1	155	RR CN	22	Yes	No	22
Silver	mg/kg	0	38.6	RR CN	0.029	Yes	No	0.029 J
Thallium	mg/kg	0	0.612	RR CN	0.16	Yes	No	0.16
Semivolatile Organic Compounds								
2-Methylnaphthalene	mg/kg	NB	30.6	RR CN	0.036	Yes	No	0.036 J
Naphthalene	mg/kg	NB	122	RR CN	0.034	Yes	No	0.034 J

Notes:
a. Most stringent screening value from available sources.
b. Source of Screening Values:
NGT = National Guard Trainee (Lower of HQ = 0.1 and ELCR of 1×10^{-6})
RR CN = Residential Receptor (Child) (Non-cancer HQ = 0.1)
Yellow shading indicates analyte is a COPC.
COPC = Chemical of potential concern.
ELCR = Excess Lifetime Cancer Risk.
HQ = Hazard quotient.
ID = Identification.
J = Estimated: the result reported between the Detection Limit and the Limit of Quantitation.
mg/kg = Milligrams per kilogram.
NB = No background.
SRC = Site-related chemical.

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Table 7-7: Chemicals of Potential Concern for Subsurface Soil, Building U-16 Boiler House

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal (a)	Screening Value Source (b)	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-U16-DU1-SB		73-U16-DU1-SB1	
Field Sample ID:								073SB-0036M-0001-SO	073SB-0037M-0001-SO	073SB-0038M-0001-SO	073SB-0039M-0001-SO
Lab Sample ID:								240-22663-12	240-22663-13	240-22663-14	240-22663-15
Sample Date:								4/1/2013	4/1/2013	4/1/2013	4/1/2013
Sample Depth:								1-4	4-7	1-7	1-7
Propellants											
Nitrocellulose	mg/kg	NB	18,000,000	RRSL	0.9	Yes	No	NR	NR	NR	NR
Metals											
Cadmium	mg/kg	0	6.41	RR CN	0.3	Yes	No	0.17	0.17	0.19	0.19
Silver	mg/kg	0	38.6	RR CN	0.0	Yes	No	0.024 J	0.03 J	0.022 J	0.021 J
Organochlorine Pesticides											
alpha-BHC (alpha-Hexachlorocyclohexane)	mg/kg	NB	0.077	RRSL	0.0012	Yes	No	NR	NR	NR	NR
p,p'-Dichlrodiphenyldichloroethylene	mg/kg	NB	2.63	RR AC	0.0007	Yes	No	NR	NR	NR	NR

Location ID:		Background Screening Value	Facility-Wide Cleanup Goal (a)	Screening Value Source (b)	Maximum Detected Concentration	SRC - Yes/No	COPC - Yes/No	73-U16-DU1-SB2	73-U16-DU1-SB3	73-U16-DU1-SB4	73-U16-DU1-SB5	
Field Sample ID:								073SB-0040M-0001-SO	073SB-0041M-0001-SO	073SB-0042M-0001-SO	073SB-0043M-0001-SO	073SB-0044-0001-SO
Lab Sample ID:								240-22663-16	240-22663-17	240-22663-18	240-22663-19	240-22663-20
Sample Date:								4/1/2013	4/1/2013	4/1/2013	4/1/2013	4/1/2013
Sample Depth:								1-7	1-7	1-7	1-7	7-13
Propellants												
Nitrocellulose	mg/kg	NB	18,000,000	RRSL	0.9	Yes	No	NR	0.91 J	NR	NR	NR
Metals												
Cadmium	mg/kg	0	6.41	RR CN	0.3	Yes	No	0.12	0.16	0.14	0.16	0.26
Silver	mg/kg	0	38.6	RR CN	0.0	Yes	No	0.017 J	0.029 J	0.027 J	0.023 J	0.028 J
Organochlorine Pesticides (Gas Chromatograph)												
alpha-BHC (alpha-Hexachlorocyclohexane)	mg/kg	NB	0.077	RRSL	0.0012	Yes	No	NR	0.0012 J	NR	NR	NR
p,p'-Dichlrodiphenyldichloroethylene	mg/kg	NB	2.63	RR AC	0.0007	Yes	No	NR	0.00066 J	NR	NR	NR

Notes:
a. Most stringent screening value from available sources.
b. Source of Screening Values:
RR AC = Residential Receptor (Adult) (Cancer ELCR of 1×10^{-6}).
RR CN = Residential Receptor (Child) (Non-cancer HQ = 0.1)
RRSL = Residential RSL (Lower of HQ = 0.1 and ELCR of 1×10^{-6})
Yellow shading indicates analyte is a COPC.
COPC = Chemical of potential concern.
ELCR = Excess Lifetime Cancer Risk.
HQ = Hazard quotient.
ID = Identification.
J = Estimated: the result reported between the Detection Limit and the Limit of Quantitation.
mg/kg = Milligrams per kilogram.
NB = No background.
NR = Not reported (not analyzed for this sample).
SRC = Site-related chemical.

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Table 7-8: Summary of Chemicals of Potential Concern in Surface Soil

Surface Soil (0-1 ft bgs)	**Exposure Areas**		
COPC	**North Line Road Coal Tipple**	**Sand Creek Coal Tipple**	**Building U-16 Boiler House**
Metals			
Arsenic	X	NA	NA
Cobalt	NA	NA	X
Chromium	NA	X	NA
Manganese	X	NA	NA
Semivolatile Organic Compounds			
Benzo(a)pyrene	X	X	NA
Benzo(a)anthracene	X	NA	NA
Benzo(b)fluoranthene	X	NA	NA

Notes:
bgs = Below ground surface.
COPC = Chemical of potential concern.
ft = Feet.
NA = Analyte is not a COPC in the exposure area.
X = Analyte is a COPC in the exposure area.

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Table 7-9: Summary of Chemicals of Potential Concern in Subsurface Soil

Subsurface Soil (>1 ft bgs)	Exposure Areas		
COPC	North Line Road Coal Tipple	Sand Creek Coal Tipple	Building U-16 Boiler House
Semivolatile Organic Compounds			
Benzo(a)pyrene	X	X	NA

Notes:
bgs = Below ground surface.
COPC = Chemical of potential concern.
ft = Feet.
NA = Not applicable.
X = Analyte is a COPC in the exposure area.

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Table 7-10: Facility-Wide Cleanup Goals Corresponding to a Hazard Quotient of 1.0 and Target Risk of 1 × 10^{-5} for the Determination of Chemical of Concern in Surface Soil

CAS Number	COPC	Critical Effect or Target Organ	FWCUG[(a)] (mg/kg)				Background
			National Guard Trainee		Resident Receptor		
			HQ=1.0	TR=10^{-5}	HQ=1.0	TR=10^{-5}	Surface Soil
7440-38-2	Arsenic	Skin	1,140	27.8	20.2	4.25	15.4
56-55-3	Benzo(a)anthracene	NA	--	47.7	--	2.21	0
50-32-8	Benzo(a)pyrene	NA	--	4.77	--	0.22	0
205-99-2	Benzo(b)fluoranthene	NA	--	47.7	--	2.21	0
7440-47-3	Chromium	NOAEL	1,000,000	--	8,1473	--	17.4
7440-48-4	Cobalt	Blood	140	70.3	1,310	8,030	10.4
7439-96-5	Manganese	Nervous System	351	--	2,930	--	1,450

Notes:
a. Resident Receptor FWCUGs are the lower of the Adult of Child values for each COPC and endpoint (non-cancer and cancer). When FWCUGs were not available, Residential Regional Screening Levels are presented.

Dashes (--) indicate no value available.
CAS = Chemical Abstract Service.
COPC = Chemical of potential concern.
FWCUG = Facility-Wide Cleanup Goal.
HQ = Hazard Quotient.
mg/kg = Milligram per kilogram.
NA = Not available.
NOAEL = No observed adverse effect level.
TR = Target Risk.

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Table 7-11: Facility-Wide Cleanup Goals Corresponding to a Hazard Quotient of 1.0 and Target Risk of 1 × 10^{-5} for the Determination of Chemicals of Concern in Subsurface Soil

CAS Number	COPC	Critical Effect or Target Organ	FWCUG[a] (mg/kg)				Background
			National Guard Trainee		Resident Receptor		
			HQ=1.0	TR=10^{-5}	HQ=1.0	TR=10^{-5}	Surface Soil
50-32-8	Benzo(a)pyrene	NA	--	4.77	--	0.22	0

Notes:
a. Resident Receptor FWCUGs are the lower of the Adult of Child values for each COPC and endpoint (non-cancer and cancer). When FWCUGs were not available, Residential Regional Screening Levels are presented for the resident receptor.
Dashes (--) indicate no value available.
CAS = Chemical Abstract Service.
COPC = Chemical of potential concern.
FWCUG = Facility-Wide Cleanup Goal.
HQ = Hazard Quotient.
mg/kg = Milligram per kilogram.
NA = Not available.
TR = Target Risk.

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Table 7-12: Summary of Carcinogenic Risk Values for the Chemicals of Concern Identified in the Human Health Risk Assessment

Exposure Area	Medium	Arsenic	Benzo(a)pyrene	Total
		Resident ELCR	Resident ELCR	Resident ELCR
North Line Road Coal Tipple	Surface Soil	7×10^{-5}	3×10^{-5}	9×10^{-5}
	Subsurface Soil	NA	NA	NA
Sand Creek Coal Tipple	Surface Soil	NA	NA	NA
	Subsurface Soil	NA	NA	NA
Building U-16 Boiler House	Surface Soil	NA	NA	NA
	Subsurface Soil	NA	NA	NA

Notes:
ELCR = Excess Lifetime Cancer Risk.
NA = No carcinogenic chemicals of concern identified for the exposure area.

Table 7-13: Summary of Hazard Quotients for the Chemicals of Concern Identified in the Human Health Risk Assessment

Exposure Area	Medium	Manganese	
		Resident HQ	NGT HQ
North Line Road Coal Tipple	Surface Soil	NA	NA
	Subsurface Soil	NA	3
Sand Creek Coal Tipple	Surface Soil	NA	NA
	Subsurface Soil	NA	NA
Building U-16 Boiler House	Surface Soil	NA	NA
	Subsurface Soil	NA	NA

Notes:
Yellow shading indicates an HQ >1.0.
HQ = Hazard Quotient.
NA = No non-carcinogenic COCs identified in the exposure area.
NGT = National Guard Trainee.

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Table 7-14: Final Checklist of Important Ecological Places and Resources

Resource	USACE List (2005b)	Ohio EPA-DERR List (2008)	At AOC 79	
			Absent	Present
National Park	X	X	X	
Designated Federal Wilderness Area	X	X	X	
National Lakeshore Recreational Area	X	X	X	
Habitat known to be used by Federal designated or proposed threatened or endangered species	X	X	X	
National or State Wildlife Refuge	X	X	X	
Habitat known to be used by state designated threatened or endangered species	X	X	X	
Federally-designated Scenic or Wild River	X	X	X	
State land designated for wildlife or game management	X	X	X	
State-designated Scenic or Wild River	X	X	X	
Wetlands and waters of the State(1)	X	X	X	
National preserve	X	X(4)	X	
State-designated Natural Areas	X	X(4)	X	
Spawning areas critical for the maintenance of fish/shellfish species within river, lake, or coastal tidal waters	X	X(5)	X	
Migratory pathways and feeding areas critical for maintenance of anadromous fish species(2)	X	X(5)	X	
Terrestrial areas used for breeding by large or dense aggregations of animals	X	X(5)	X	
Particular areas, relatively small in size, important to maintenance of unique biotic communities	X	X(5)	X	
Locally important ecological place(3)	X		X	
Critical habitat for Federal designated threatened or endangered species	X		X	
Marine Sanctuary	X		X	
Areas identified under the Coastal Zone Management Act	X		X	
Sensitive Areas identified under the National Estuary Program or Near Coastal Waters Program	X		X	
Critical areas identified under the Clean Lakes Program	X		X	
National Monument	X		X	
National Seashore Recreational Area	X		X	
Unit of Coastal Barrier Resources System	X		X	
Coastal Barrier (undeveloped)	X		X	
Coastal Barrier (partially developed)	X		X	
Administratively Proposed Federal Wilderness Area	X		X	
National river reach designated as Recreational	X		X	
Habitat known to be used by species under review as to its Federal threatened or endangered status	X		X	
State-designated areas for protection or maintenance of aquatic life	X		X	
Fragile landscapes, land sensitive to degradation if vegetative habitat or cover diminishes	X		X	
State, local or private land designated for protection of natural ecosystems		X	X	

Table 7-14: Final Checklist of Important Ecological Places and Resources (continued)

Resource	USACE List (2005b)	Ohio EPA-DERR List (2008)	At Area of Concern 79	
Federal land designated for wildlife or game management		X	X	
Surface water, as that term is used in Chapter 3745-1 of the Ohio Administrative Code		X	X	
Federally-listed or state-listed threatened or endangered species		X	X	
State of Ohio special interest or declining species and its associated habitat		X		X
State Park		X	X	

Notes:

1. For the Ohio EPA-Division of Environmental Response and Revitalization (Ohio EPA-DERR) 2008, as qualified by "regulated under federal law and state of Ohio's water quality laws."
2. Within river reaches or areas in lakes or coastal tidal waters in which fish spend extended periods of time.
3. Identified by the Integrated Natural Resource Management Plan, Base Realignment and Closure Cleanup Plan or Redevelopment Plan, or other official land management plans. The Ohio Army National Guard (Integrated Natural Resources Management Plan [AMEC Environment & Infrastructure, Inc. 2008]) has five special interest areas (important resources) at the facility: mixed mature woods, Hemlock Ravine-Wadsworth Glen, mixed swamp forest, mixed valuable communities, and oak/maple swamp forest. Also, the Ohio Army National Guard recognizes the importance of federal and state-listed threatened and endangered plant and animal species.
4. Ohio EPA does not restrict preserves and natural areas to National or State preserves.
5. Ohio EPA lists "wildlife populations and their associated important nesting areas and food resources, taking into consideration land use and the quality and extent of habitat on and in the vicinity of the site."

Ohio EPA = Ohio Environmental Protection Agency.
USACE = United States Army Corps of Engineers.
X = Designated as important.

Table 7-15: Rare Species Observed at the Ravenna Army Ammunition Plant Property

Group	Common Name	Scientific Name	State Status	Known to Nest or Reside at the RVAAP Property?
Birds	American bittern	*Botaurus lentiginosus*	E	No
	Bald eagle	*Haliaeetus leucocephalus*	E	No
	Dark-eyed junco	*Junco hyemalis*	T	No
	Great egret	*Ardea alba*	SC	No
	Hermit thrush	*Catharus guttatus*	T	No
	Osprey pandion	*haliaetus*	E	No
	Sandhill crane	*Grus Canadensis*	E	No
	Trumpeter swan	*Cygnus buccinator*	E	No
	American wigeon	*Anas americana*	SI	Yes
	Back-throated blue warbler	*Dendroica caerulescens*	SI	Yes
	Barn owl	*Tyto alba*	T	Yes
	Blackburnian warbler	*Dendroica fusca*	SI	Yes
	Blue grosbeak	*Guiraca caerulea*	SI	Yes
	Bobolink	*Dolichonyx oryzivorus*	SC	Yes
	Brown creeper	*Certhia americana*	SI	Yes
	Canada warbler	*Wilsonia canadensis*	SI	Yes
	Cerulean warbler	*Dendroica cerulea*	SC	Yes
	Common moorhen	*Gallinula chloropus*	SC	Yes
	Common snipe	*Gallinago gallinago*	SI	Yes
	Gadwall	*Anas strepera*	SI	Yes
	Golden-crowned kinglet	*Regulus satrapa*	SI	Yes
	Golden-winged warbler	*Vermivora chrysoptera*	E	Yes
	Green-winged teal	*Anas crecca*	SI	Yes
	Henslow's sparrow	*Ammodramus henslowii*	SC	Yes
	Least bittern	*Ixobrychus exilis*	T	Yes
	Least flycatcher	*Empidonax minimus*	T	Yes
	Little blue heron	*Egretta caerula*	SI	Yes
	Magnolia warbler	*Dendroica magnolia*	SI	Yes
	Marsh wren	*Cistothorus palustris*	SC	Yes
	Mourning warbler	*Oporornis philadelphia*	SI	Yes
	Northern bobwhite	*Colinus virginianus*	SC	Yes
	Northern harrier	*Circus cyaneus*	E	Yes
	Northern shoveler	*Anas clypeata*	SI	Yes
	Northern waterthrush	*Seiurus noveboracensis*	SI	Yes
	Pine siskin	*Carduelis pinus*	SI	Yes
	Prothonotary warbler	*Protonotaria citrea*	SC	Yes
	Purple finch	*Carpodacus purpureus*	SI	Yes
	Red-breasted nuthatch	*Sitta canadensis*	SI	Yes
	Redhead duck	*Aythya americana*	SI	Yes
	Ruddy duck	*Oxyura jamaicensis*	SI	Yes
	Sedge wren	*Cistothorus platensis*	SC	Yes
	Sharp-shinned hawk	*Accipiter striatus*	SC	Yes

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Table 7-15: Rare Species Observed at the Ravenna Army Ammunition Plant Property (continued)

Group	Common Name	Scientific Name	State Status	Known to Nest or Reside at the RVAAP Property?
Birds (continued)	Sora	*Porzana carolina*	SC	Yes
	Virginia rail	*Rallus limicola*	SC	Yes
	Winter wren	*Troglodytes troglodytes*	SI	Yes
	Yellow-bellied sapsucker	*Sphyrapicus varius*	E	Yes
Mammals	Bobcat	*Felis rufus*	E	Yes
	Pygmy shrew	*Sorex hovi*	SC	Yes
	Star-nosed mole	*Condylura cristata*	SC	Yes
	Woodland jumping mouse	*Napaeozapus insignis*	SC	Yes
Mussel	Creek heelsplitter	*Lasmigona compressa*	SC	Yes
Lamprey	Mountain brook lamprey	*Ichthyomyzon greeleyi*	E	Yes
Amphibian	Four-toed salamander	*Hemidactylium scutatum*	SC	Yes
Reptile	Eastern box turtle	*Terrapene carolina*	SC	Yes
Caddisfly	No common name	*Psilotreta indecisa*	T	Yes
Mayfly	No common name	*Stenonema ithica*	SC	Yes
Moth	Graceful underwing	*Catocala gracilis*	E	Yes
	No common name	*Apamea mixta*	SC	Yes
	No common name	*Brachylomia algens*	SC	Yes
Plant (bryophyte)	Lurking leskea	*Plagiothecium latebricola*	T	Yes
	Narrow-necked pohl's moss	*Pohlia elongata var. elongata*	E	Yes
	Tufted moisture-loving moss	*Philonotis fontana var. caespitosa*	E	Yes
Plant (vascular)	American chestnut	*Castanea dentata*	P	Yes
	Arbor vitae	*Thuja occidentalis*	P	Yes
	Butternut	*Juglans cinerea*	P	Yes
	Gray birch	*Betula populifolia*	P	Yes
	Hobblebush	*Viburnum alnifolium*	P	Yes
	Long beech fern	*Phegopteris connectilis*	P	Yes
	Northern rose azalea	*Rhododendron nudiflorum var. roseum*	P	Yes
	Pale sedge	*Carex pallescens*	T	Yes
	Shinning ladies'-tresses	*Spiranthes lucida*	P	Yes
	Simple willow-herb	*Epilobium strictum*	T	Yes
	Straw sedge	*Carex straminea*	P	Yes
	Swamp oats	*Sphenopholis pensylvanica*	P	Yes
	Tall St. John's wort	*Hypercium majus*	P	Yes
	Water avens	*Geum rivale*	P	Yes
	Woodland horsetail	*Equisetum sylvaticum*	T	Yes

Notes:
State Status Designations
E = Endangered.
P = Potentially Threatened (administrative status; not a legal designation).
RVAAP = Ravenna Army Ammunition Plant.
SC = Species of Concern (administrative status; not a legal designation).
SI = Special Interest (administrative status; not a legal designation).
T = Threatened.

Table 7-16: Samples Used in the Ecological Risk Assessment

Medium	Sample Location ID	Sample Type	Purpose	Date	Interval (ft bgs)
Surface Soil	073SS-0002M-0001-SO	ISM	N&E, RA	11/8/2012	0-1
	073SS-0003M-0001-SO	ISM	QC FD	11/8/2012	0-1
	073SS-0005M-0001-SO	ISM	N&E, RA	11/8/2012	0-1
	073SS-0035M-0001-SO	ISM	N&E, RA	4/1/2013	0-1

Notes:
bgs = Below ground surface.
FD = Field duplicate.
ft = Feet.
ID = Identification.
ISM = Incremental Sample Methodology.
N&E = Nature and extent.
QC = Quality control.
RA = Risk assessment.

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Table 7-17: Chemicals of Potential Ecological Concern Selection for Surface Soil

Analyte[a]	Frequency of Detection	Range of Reporting Limits for Non-Detects	Range of Detected Concentrations	BSV	Persistent?[b]	ESV[c]		COPEC?[d]	COPEC Reasoning[e]	Hazard Quotient[f]
Metals (mg/kg)										
Arsenic	4 / 4		9.4 - 28	15.4	No	18	EcoSSL	Yes	MDC > ESV	1.6
Barium	4 / 4		48 - 160	88.4	No	330	EcoSSL	No	MDC ≤ ESV	NC
Beryllium	4 / 4		0.47 - 3.3	0.88	No	21	EcoSSL	No	MDC ≤ ESV	NC
Cadmium	4 / 4		0.18 - 0.61	NB	No	0.36	EcoSSL	Yes	MDC > ESV	1.7
Chromium	4 / 4		13 - 19	17.4	No	26	EcoSSL	No	MDC ≤ ESV	NC
Cobalt	4 / 4		6.8 - 11	10.4	No	13	EcoSSL	No	MDC ≤ ESV	NC
Copper	4 / 4		13 - 19	17.7	No	28	EcoSSL	No	MDC ≤ ESV	NC
Manganese	4 / 4		340 - 1900	1,450	No	220	EcoSSL	Yes	MDC > ESV	8.6
Nickel	4 / 4		22 - 24	21.1	No	38	EcoSSL	No	MDC ≤ ESV	NC
Selenium	4 / 4		0.36 - 2.3	1.4	No	0.52	EcoSSL	Yes	MDC > ESV	4.4
Silver	3 / 4	0.87 - 0.87	0.029 - 0.44	NB	No	4.2	EcoSSL	No	MDC ≤ ESV	NC
Thallium	3 / 4	1.7 - 1.7	0.11 - 0.16	NB	No	1	ORNL - PRG	Yes	MDC > ESV	0.2
Zinc	4 / 4		54 - 99	61.8	No	46	EcoSSL	Yes	MDC > ESV	2.2
Volatile Organic Compounds (µg/kg)										
Carbon disulfide	1 / 2	6.7 - 6.7	1.3 - 1.3	NB	No	94.5	Region 5	No	MDC ≤ ESV	NC
Toluene	1 / 2	7.5 - 7.5	0.52 - 0.52	NB	No	200,000	ORNL - PRG	No	MDC ≤ ESV	NC
Semivolatile Organic Compounds (µg/kg)										
2-Methylnaphthalene	4 / 4		36 - 9100	NB	Yes	29,000	EcoSSL	No	MDC ≤ ESV	NC
Acenaphthene	1 / 4	6.8 - 67	240 - 240	NB	Yes	29,000	EcoSSL	No	MDC ≤ ESV	NC
Acenaphthylene	2 / 4	27 - 67	6.6 - 160	NB	Yes	29,000	EcoSSL	No	MDC ≤ ESV	NC
Anthracene	2 / 4	27 - 67	16 - 300	NB	Yes	29,000	EcoSSL	No	MDC ≤ ESV	NC
Benzo(a)anthracene	3 / 4	67 - 67	52 - 730	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Benzo(a)pyrene	3 / 4	67 - 67	65 - 570	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Benzo(b)fluoranthene	3 / 4	67 - 67	110 - 670	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Benzo(g,h,i)perylene	3 / 4	67 - 67	29 - 160	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Benzo(k)fluoranthene	3 / 4	67 - 67	26 - 190	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Chrysene	3 / 4	67 - 67	71 - 1000	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Dibenzofuran	3 / 4	510 - 510	15 - 2500	NB	Yes	NA	NA	Yes	NSL	NC
Fluoranthene	3 / 4	67 - 67	99 - 860	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Fluorene	1 / 4	27 - 67	8.5 - 8.5	NB	Yes	29,000	EcoSSL	No	MDC ≤ ESV	NC
Indeno(1,2,3-c,d)pyrene	3 / 4	67 - 67	46 - 140	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Naphthalene	4 / 4		34 - 4600	NB	Yes	29,000	EcoSSL	No	MDC ≤ ESV	NC
Phenanthrene	3 / 4	67 - 67	61 - 5500	NB	Yes	29,000	EcoSSL	No	MDC ≤ ESV	NC
Pyrene	3 / 4	67 - 67	78 - 1000	NB	Yes	1,100	EcoSSL	No	MDC ≤ ESV	NC
Explosives (µg/kg)										
Tetryl	1 / 2	250 - 250	24 - 24	NB	No	NA	NA	Yes	NSL	NC

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Table 7-17: Chemicals of Potential Ecological Concern Selection for Surface Soil (continued)

Notes:
a. Only analytes detected in one or more incremental sampling methodology surface soil samples are presented for COPEC selection.
b. Chemical is identified as persistent, bioaccumulative, and toxic (Ohio Environmental Protection Agency-Division of Environmental Remediation and Revitalization 2008) and/or log K_{ow} greater than or equal to 3.
c. ESVs are selected from the Ohio Environmental Protection Agency-Division of Environmental Remediation and Revitalization hierarchy using these sources in the order presented:
- EcoSSL = USEPA Ecological Screening Levels (USEPA 2005).
- ORNL PRG = Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Endpoints (Efroymson et. al 1997).
- USEPA Region 5 Ecological Screening Levels (USEPA 2003).

d. Analytes were retained as COPECs when:
- MDC > ESV = The maximum detected concentration is greater than the background screening value and ecological screening value.
- NSL = No screening level is available.

e. Analytes are eliminated from further review when:
- MDC ≤ BSV = The maximum detected concentration is less than or equal to the background screening value.
- MDC ≤ ESV = The maximum detected concentration is less than or equal to the ecological screening value.

f. Hazard Quotient calculated by dividing the MDC by the ESV.

µg/kg = Micrograms per kilogram.
BSV = Background screening value.
COPEC = Chemical of potential ecological concern.
EcoSSL = Ecological Soil Screening Level.
ESV = Ecological screening value.
MDC = Maximum Detected Concentration.
mg/kg = Milligrams per kilogram.
NA = Not available.
NB = No background.
NC = Not calculated.
NSL = No screening level.
ORNL = Oak Ridge National Laboratory.
PRG = Preliminary Remediation Goal.
USEPA = United States Environmental Protection Agency.

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Table 7-18: Chemicals of Potential Ecological Concern Refinement for Surface Soil

COPEC[a]	Average Concentration[b]	BSV	ESV[c]	Average Hazard Quotient[d]
Metals (mg/kg)				
Arsenic	16	15.4	18	<1
Cadmium	0.30	NB	0.36	<1
Lead	21	26.1	11	1.9
Manganese	692	1,450	220	3.1
Mercury	0.072	0.036	0.00051	142
Selenium	0.88	1.4	0.52	1.7
Thallium	0.28	NB	1	<1
Zinc	78	61.8	46	1.7
Semivolatile Organic Compounds (µg/kg)				
Dibenzofuran	576	NB	NA	NC
Explosives (µg/kg)				
Tetryl	0.075	NB	NA	NC

Notes:

a. Only analytes identified as COPECs in Table 7-17 are presented in this table.
b. The average is calculated as the arithmetic mean for all ISM surface soil samples in AOC 73 using one half of the detection limit for non-detects.
c. ESV selection is shown in Table 7-17.
d. Average Hazard Quotient calculated by dividing the average concentration by the ESV.

µg/kg = Micrograms per kilogram.
BSV = Background Screening Value.
COPEC = Chemical of potential ecological concern.
ESV = Ecological Screening Value.
ISM = Incremental sampling methodology.
mg/kg = Milligrams per kilogram.
SVOC = Semivolatile organic compound.
NA = Not available.
NB = No background.
NC = Not calculated.

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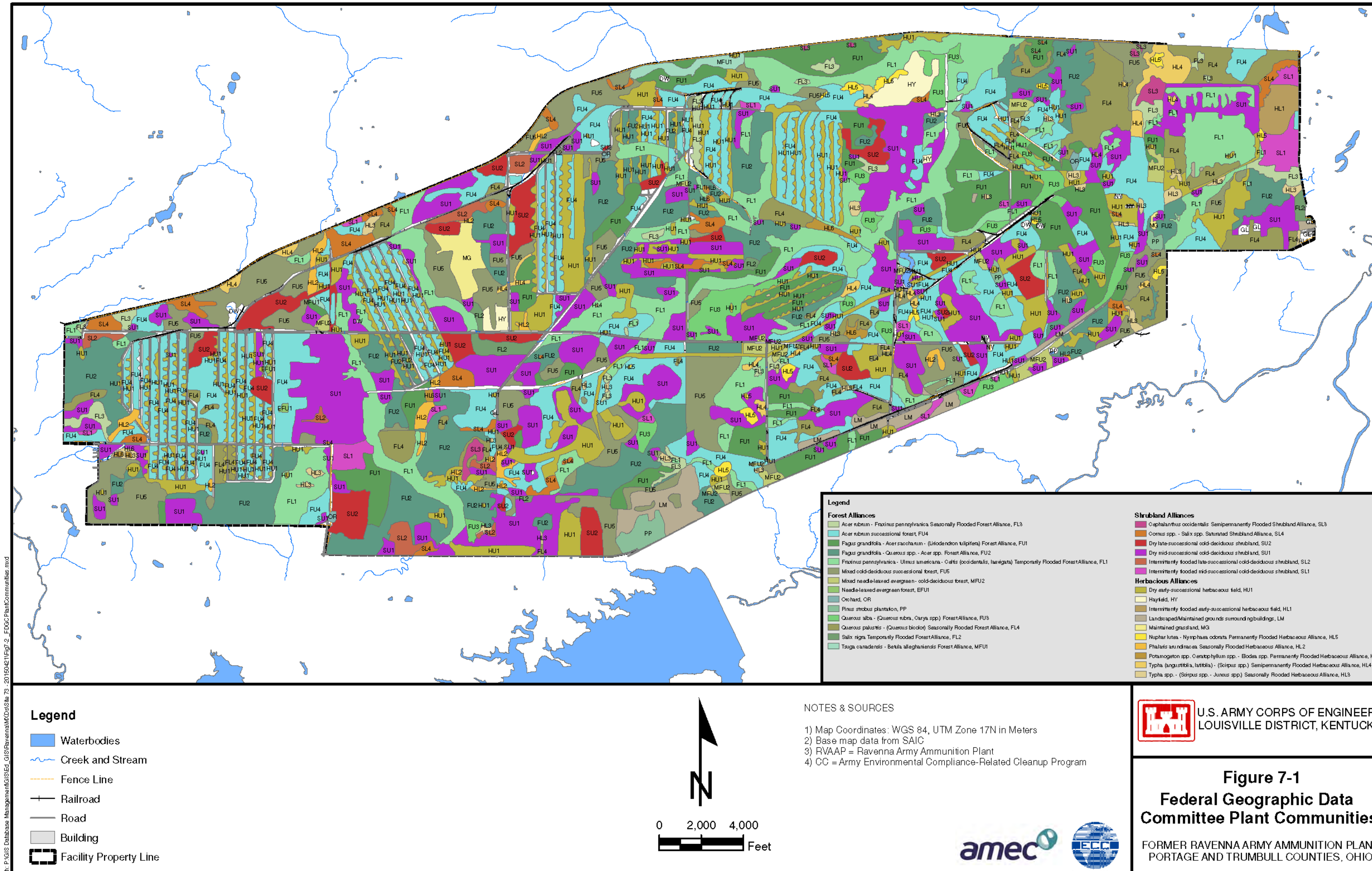

Figure 7-1
Federal Geographic Data Committee Plant Communities

FORMER RAVENNA ARMY AMMUNITION PLANT
PORTAGE AND TRUMBULL COUNTIES, OHIO

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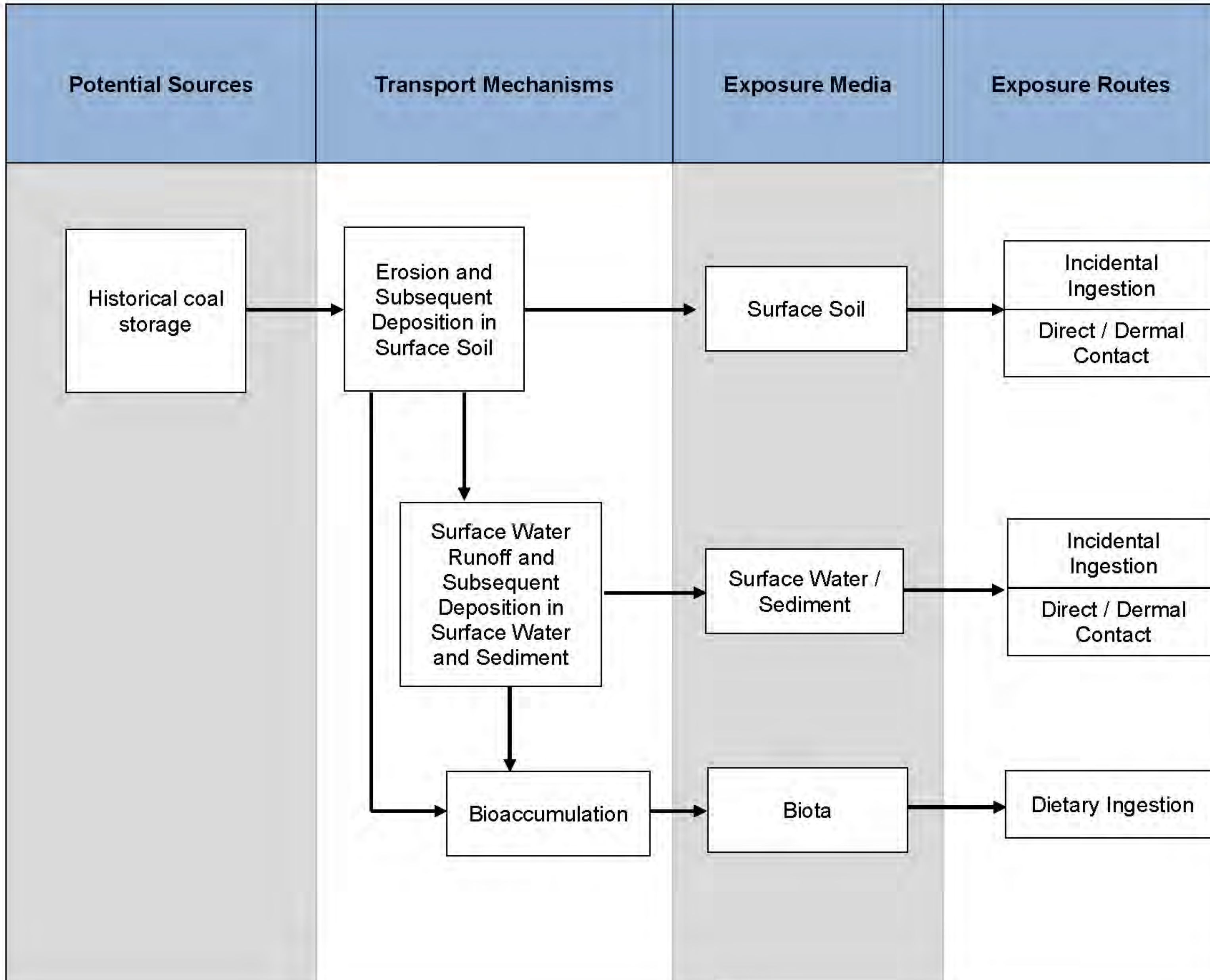

Exposure Media	Exposure Routes	Terrestrial Receptors: Terrestrial Plants	Terrestrial Receptors: Soil Invertebrates	Terrestrial Receptors: Wildlife (Birds and Mammals)	Aquatic Receptors: Aquatic Plants	Aquatic Receptors: Aquatic Invertebrates, Amphibians and Fish	Aquatic Receptors: Wildlife (Birds and Mammals)
Surface Soil	Incidental Ingestion		●	●		●	●
Surface Soil	Direct / Dermal Contact	●	●	●	●	●	●
Surface Water / Sediment	Incidental Ingestion		●	●		●	●
Surface Water / Sediment	Direct / Dermal Contact	●	●	●	●	●	●
Biota	Dietary Ingestion		●	●		●	●

→ Represents a complete exposure pathway
● Complete exposure pathway
○ Incomplete exposure pathway

Prepared by: SFR 3/24/2014
Checked by: TR 3/26/2014

amec

Figure 7-2
Ecological Conceptual Site Model
CC RVAAP-73 Facility-Wide Coal Storage
Former Ravenna Army Ammunition Plant

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8. REMEDIAL INVESTIGATION CONCLUSIONS AND RECOMMENDATIONS

The following sections present the conclusions and recommendations related to the RI conducted for CC RVAAP-73 Facility-Wide Coal Storage AOC.

8.1 SUMMARY OF DATA IN REMEDIAL INVESTIGATION

The data collected during the RI of CC RVAAP-73 Facility-Wide Coal Storage were deemed usable for this report. For surface and subsurface soil, all available ISM and composite samples (with the exception of field duplicates) were included in the data screening to identify SRCs, contaminant nature and extent, contaminant fate and transport, and in risk assessments. Discrete wet sediment and surface water samples (collocated) were collected from Sand Creek, which is near the Sand Creek Coal Tipple and North Line Road Coal Tipple. These sample results were used to confirm that the contaminant transport pathway from surface soil within the AOC to Sand Creek is incomplete.

8.2 SUMMARY OF NATURE AND EXTENT

SRCs were identified in all media evaluated at CC RVAAP-73 Facility-Wide Coal Storage. The majority of SRCs were inorganics followed by SVOCs and VOCs. PCBs were not identified in any of the samples analyzed. Based on the composition of coal, it is unlikely that the relatively low concentrations of these SRCs are due to historical coal storage at the AOC. However, these SRCs were retained to evaluate the risk to downgradient groundwater receptors as well as human and ecological receptors.

- Thirty-two SRCs were identified in surface soil: 13 inorganics, 17 SVOCs, 1 VOC, and 1 explosive

- Twenty-eight SRCs were identified in subsurface soil: 3 inorganics, 19 SVOCs, 1 VOC, 2 explosives, 1 propellant, and 2 organochlorine pesticides.

To delineate the horizontal and vertical extent of contamination, those SRCs identified in surface and subsurface soil were compared with the most stringent of the Resident Receptor FWCUGs at a target risk of 1×10^{-6} and HQ of 0.1. Residential RSLs were used for comparison for those organic compounds without FWCUGs. The majority of SRCs identified had concentrations less than the most stringent FWCUGs.

Surface Soil

SRCs in surface soil with concentrations that exceed the most stringent Resident Receptor FWCUGs were identified at only one former coal storage area, as follows:

- **Inorganics**

  - Arsenic and manganese at the North Line Road Coal Tipple

- **Organics**

    - Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene at the North Line Road Coal Tipple

    - Benzo(a)pyrene at the Sand Creek Coal Tipple.

Subsurface Soil

The SRCs with concentrations that exceed the most stringent Resident Receptor FWCUGs in subsurface soil for each of the three former coal storage areas are as follows:

- **Organics**

    - Benzo(a)pyrene at the North Line Road Coal Tipple
    - Benzo(a)pyrene at the Sand Creek Coal Tipple.

Because arsenic and manganese are not known to be coal constituents, additional sampling beyond the DUs was deemed unnecessary to define the extent of these metals in surface soil at the North Line Road Coal Tipple. Benzo(a)anthracene and benzo(a)pyrene may be present in coal in only trace amounts. These two PAHs were detected at concentrations only slightly greater than their FWCUGs, and their presence in surface soil is likely from anthropogenic sources such as asphalt and tire particles rather than historical coal storage. Benzo(b)fluoranthene is a known constituent in coal; however, if its presence was due to historical coal storage, it would be expected to be detected above the FWCUG at all three coal storage areas, but it was only detected in exceedance of the Resident Receptor FWCUG at the North Line Road Coal Tipple. No SRCs were detected in concentrations exceeding the FWCUGs (or Residential RSLs for those SRCs without FWCUGs) at the Building U-16 Boiler House. For these reasons, additional sampling to define the extent of PAHs beyond the DUs in either surface or subsurface soil was deemed unnecessary.

8.3 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

Soil screening analysis was performed to evaluate the potential risks to groundwater and downgradient receptors from concentrations of SRCs in surface and subsurface soil. Because the three former coal storage areas are not contiguous, this evaluation was conducted separately for each. The downgradient receptor at each area is the nearest surface water body to which groundwater beneath the areas is likely to discharge.

Initially, the MDCs of the SRCs were compared with the generic SSLs to develop the initial CMCOPCs. After the screening, the following initial CMCOPCs were retained.

North Line Road Coal Tipple

- Six metals: arsenic, barium, beryllium, cadmium, manganese, and selenium

- Nine SVOCs: 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, indeno(1,2,3-cd)pyrene, isophorone, naphthalene, and phenanthrene

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- Four SVOCs: benzo(a)anthracene, benzo(b)fluoranthene, isophorone, and naphthalene.

Building U-16 Boiler House

- Two metals: cobalt and thallium
- One organochlorine pesticide: alpha-hexachlorohexane
- One SVOC: naphthalene.

The MDCs of the initial CMCOPCs were then compared with dilution attenuation factor (DAF)-based, site-specific SSLs to further refine the initial CMCOPCs. After this screening, the following were retained as initial CMCOPCs because their reported concentrations in subsurface soil exceeded the site SSLs:

North Line Road Coal Tipple

- Five metals: arsenic, barium, cadmium, manganese, and selenium

- Six SVOCs: 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzofuran, and naphthalene

- One explosive; 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- Three SVOCs: benzo(a)anthracene, benzo(b)fluoranthene, and naphthalene.

Building U-16 Boiler House

- One metal: cobalt

- One organochlorine pesticide: alpha-hexachlorohexane

- One SVOC: naphthalene.

The initial CMCOPCs were further refined by retaining only those that leach through the unsaturated zone to the water table in less than 1,000 years. For each area, the following initial CMCOPCs remained:

North Line Road Coal Tipple

- Three metals: arsenic, barium, and selenium
- Four SVOCs: 2-methylnaphthalene, benzo(a)pyrene, dibenzofuran, and naphthalene
- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- One SVOC: naphthalene.

Building U-16 Boiler House

- One metal: cobalt
- One organochlorine pesticide: alpha-hexachlorohexane.

The last screening was then performed to evaluate and eliminate any initial CMCOPCs from further consideration if more than 1,000 years are required for the chemical to reach the assumed downgradient receptor (i.e., nearest surface water body to which groundwater is likely to discharge). Only two initial CMCOPCs remained after this last screening.

North Line Road Coal Tipple

- One explosive: 2,4-dinitrotoluene.

Sand Creek Coal Tipple

- One SVOC: naphthalene.

If CMCOPCs that remain after the soil screening evaluation have concentrations greater than the most stringent Resident Receptor FWCUGs at 1×10^{-6} and HQ of 0.1 (or RSLs if no FWCUGs are established), the fate and transport evaluation would proceed to include modeling to predict the concentrations of CMCOPCs at the groundwater-surface water interface after leaching and groundwater transport. For this AOC, only 2,4-dinitrotoluene and naphthalene remained as an initial CMCOPC; however, the 2,4-dinitrotoluene MDC of 0.01 mg/kg is an order of magnitude less than its FWCUG of 0.753 mg/kg, and the naphthalene MDC of 0.063 mg/kg is orders of magnitude less than its FWCUG of 122 mg/kg. Therefore, fate and transport modeling was not necessary for this AOC and was not included as part of this RI. Conclusions of the soil screening evaluation are that all of the identified SRCs at this AOC in soil were eliminated as current risks to groundwater.

8.4 SUMMARY AND CONCLUSIONS OF THE RISK ASSESSMENTS

The HHRA performed for CC RVAAP-73 Facility-Wide Coal Storage evaluated potential risk to the Resident Receptor from potential exposure to surface (0-1 ft) and subsurface soils (1-13 ft). Additionally, potential risks were assessed to the NGT to assist in qualitatively evaluating any COCs identified for the Resident Receptor for the Unrestricted (Residential) Land Use.

COCs were identified for North Line Road Coal Tipple surface soil, but were eliminated based on weight-of-evidence. No COCs were identified in North Line Road Coal Tipple subsurface soil for the Resident Receptor. No COCs were identified for Sand Creek Coal Tipple surface soil or subsurface soil for the Resident Receptor. No COCs were identified for Building U-16 Boiler House surface soil and subsurface soil Resident Receptor. Therefore, No Further Action is obtained for CC RVAAP-73 Facility-Wide Coal Storage surface soil and subsurface soil.

The ERA was conducted to evaluate the potential for chemical constituents detected in surface soil to adversely affect ecological receptors. COPECs were identified using the MDCs of analytes detected in surface soil. The MDCs were compared to BSVs and conservative ecological screening benchmarks for generic receptors. The list of COPECs was subsequently refined on a COPEC-by-COPEC basis. Considering the small individual and collective size (2.01 acres), and the low quality habitat, and taking into account uncertainties addressed in Section 7.2.3.7, it is unlikely that exposure to surface soil would adversely affect communities or populations of common ecological receptors or individuals of state-listed species in CC RVAAP-73 Facility-Wide Coal Storage. No further investigation (e.g., Level III Baseline ERA) is considered necessary for CC RVAAP-73 Facility-Wide Coal Storage for the protection of ecological receptors.

8.5 RECOMMENDATIONS OF THE REMEDIAL INVESTIGATION

The RI conducted at CC RVAAP-73 Facility-Wide Coal Storage has adequately characterized surface and subsurface soils contained within this AOC. Based on the results of this RI, which included an evaluation of contamination fate and transport, an HHRA, and an ERA, No Further Action is obtained at CC RVAAP-73 Facility-Wide Coal Storage for soil.

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