Final
Site Inspection Report
CC RVAAP-83 Former Buildings 1031 and 1039
Revision 0

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

June 15, 2015

Contract No. W912QR-04-D-0039
Delivery Order: 0004

Prepared for:

US Army Corps of Engineers®

United States Army Corps of Engineers
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14. ABSTRACT
This Site Inspection (SI) report documents the SI activities conducted at CC RVAAP-83 Former Buildings 1031 and 1039 at the former Ravenna Army Ammunition Plant in Portage and Trumbull counties, Ohio. The purpose of the SI was to determine the presence or absence of contamination and whether the Former Buildings 1031 and 1039 Area of Concern (AOC) warrented further investigation pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The sampling completed for this SI indicates that there is no contamination present at the Former Buildings 1031 and 1039 AOC that would warrant further investigation. This SI report recommends No Further Action.

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Environmental Chemical Corporation has completed the *Final Site Inspection Report CC RVAAP-83 Former Buildings 1031 and 1039, Revision 0 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 includes review of 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.

June 5, 2015

Michael Goydas, P.G. — Date
Senior Hydrogeologist

June 8, 2015

Debra MacDonald, P.E., PMP — Date
Project Manager

June 9, 2015

Kim Bigelow — Date
Technical Writer

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OhioEPA

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

July 29, 2015

Re: **US Army Ravenna Ammunition Plt RVAAP**
Remediation Response
Project records
Remedial Response
Portage County
267000859212

Mr. Mark Leeper, P.G., MBA
Restoration/Cleanup Program Manager
ARNG Directorate
111 S. George Mason Dr.
Arlington, VA 22204

Subject: Ohio EPA's Review of Final Site Inspection Report, CC-RVAAP-83 Former Buildings 1031 and 1039, Project No. 267-000859-212

Dear Mr. Leeper:

The Ohio Environmental Protection Agency (Ohio EPA), Northeast District Office (NEDO) has reviewed the Final Site Inspection Report for CC-RVAAP-83 Former Buildings 1031 and 1039, dated June 15, 2015. The document was prepared by ECC under contract no. W912QR-04-D-0039.

Ohio EPA has reviewed the response to comments and the report and has no further comments. The document is approved.

If you have any questions or concerns related to this review or would like to schedule a meeting or conference call, please free feel to contact me at (330) 963-1170.

Sincerely,

Edward D'Amato
Project Coordinator
Ohio EPA - Division of Environmental Response and Revitalization

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LIST OF ACRONYMS AND ABBREVIATIONS

ºF	Degrees Fahrenheit
µg/kg	Microgram(s) per kilogram
amsl	Above mean sea level
AOC	Area of concern
beta-BHC	beta-Hexachlorocylohexane
bgs	Below ground surface
BKG	Background
CC	Army Environmental Compliance-Related Cleanup Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	Centimeter
CR	Compliance Restoration
DDD	p,p'-Dichlorodiphenyldichloroethane.
DDE	p,p'-Dichlorodiphenyldichloroethylene.
DDT	1,1,1-Trichloro-2,2-di(4-chlorophenyl)ethane.
delta-BHC	Delta-hexachlorocyclohexane
DI	Deionized
DRO	Diesel range organic
DSB	Deep soil boring
DU	Decision Unit
ECC	Environmental Chemical Corporation
EQM	Environmental Quality Management, Inc.
ER	Equipment rinsate
FD	Field duplicate
ft	Feet (foot)
FWCUG	Facility-Wide Cleanup Goal
FWSAP	Facility-Wide Sampling and Analysis Plan
gpm	Gallon(s) per minute
GRO	Gasoline range organic
HMX	Cyclotetramethylene tetranitramine
HRR	Historical Records Review
ID	Identification
IDW	Investigation-derived waste
ISM	Incremental sampling methodology

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

J	Estimated
km	Kilometer
LES	Lakeshore Engineering Services, Inc.
m	Meter
MgA	Mahoning Silt Loam, 0-2 percent Slopes
MgB	Mahoning Silt Loam, 2-6 percent Slopes
mg/kg	Milligram(s) per kilogram
MS	Matrix spike
MSD	Matrix spike duplicate
MTBE	Methyl-tert-butyl ether
NA	Not applicable
ND	Non-detect
NFA	No Further Action
No.	Number
NS	Not sampled
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PID	Photoionization detector
QA	Quality assurance
QC	Quality control
RDX	Cyclotrimethylene trinitramine
RI	Remedial Investigation
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SB	Soil boring
SI	Site Inspection
SIM	Selective ion monitoring
SRC	Site-related chemical
SVOC	Semivolatile organic compound

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TAL	Target Analyte List
TB	Trip blank
TCR	Target Cancer Risk
THQ	Target Hazard Quotient
TNT	2,4,6-Trinitrotoluene
TPH	Total petroleum hydrocarbon
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
WOE	Weight-of-evidence

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EXECUTIVE SUMMARY

Environmental Chemical Corporation (ECC) has been contracted by the United States Army Corps of Engineers (USACE)–Louisville District to complete a Site Inspection (SI) at the Compliance Restoration (CR) Site CC (Army Environmental Compliance-Related Cleanup Program) RVAAP-83 Former Buildings 1031 and 1039 at the former Ravenna Army Ammunition Plant (RVAAP), in Portage and Trumbull counties, Ohio. This SI was completed under Contract Number (No.) W912QR-04-D-0039, Delivery Order No. 0004, Modification No. 1.

This SI was completed in accordance with the *Final Site Inspection and Remedial Investigation Work Plan at Compliance Restoration Sites (Revision 0), Ravenna Army Ammunition Plant, Ravenna, Ohio* (ECC 2012a), and the United States Environmental Protection Agency's (USEPA) *Interim Final Guidance for Performing Site Inspections under CERCLA* (USEPA 1992).

CC RVAAP-83 is one area of concern (AOC) that is comprised of two sites: (1) Former Building 1031 and (2) Former Building 1039. Former Building 1031 was utilized as a hospital and Former Building 1039 was used as a laboratory. Based on the Historical Records Review (HRR) findings, during the laboratory operations, Building 1039 contained and operated a photography laboratory, a chemistry laboratory, and a medical x-ray facility. The photo laboratory was used for large-scale photo development activities until its closure in the early 1970s.

- Former Building 1031 received a no additional investigation determination as a result of the findings of the *Historical Records Review Report for CC-RVAAP-71 Barn No. 5 Petroleum Release and CC-RVAAP-83 Former Buildings 1031 and 1039 Revision 1, Ravenna Army Ammunition Plant, Ravenna, Ohio* (ECC 2012b). No additional investigation activities were required at Building 1031 and, therefore, it is not included in this SI Report.

- Former Building 1039 was determined to require further investigation as a result of the findings of the HRR (ECC 2012b) due to the historical practices conducted within the former laboratory building.

This SI at CC RVAAP-83 was conducted to assess the potential contamination specifically related to the former sump and associated piping identified at Former Building 1039. Since the sump was located beneath the subsurface, the environmental media evaluated in this SI included only subsurface soil. No surface soil was collected as part of this SI. Sediment and surface water are not present at this AOC and, therefore, no samples were collected of this media. Groundwater samples were not collected as groundwater is being evaluated on a facility-wide basis under RVAAP-66 Facility-Wide Groundwater.

The primary objective of this SI was to determine the presence of potential contamination in soil at the AOC. In order to determine potential contamination, the following steps were included as part of this SI:

- Collect soil samples for laboratory analysis at CC RVAAP-83.
- Identify whether Site-Related Chemicals (SRCs) are present in the soil at the AOC. SRCs are identified following the process outlined in the Facility-Wide Human Health Cleanup Goals document (SAIC 2010).
- Compare the maximum reported concentrations of the SRCs to the most stringent Resident Receptor Facility-Wide Cleanup Goals (FWCUGs), between the adult and the child receptor, using the Target Cancer Risk (TCR) level of 10^{-6} and the Target Hazard Quotient (THQ) for non-carcinogenic risks of THQ = 0.1. For the purposes of this SI, potential contamination at CC RVAAP-83 is defined by an exceedance of the most stringent Resident Receptor FWCUG.
- Complete a weight-of-evidence (WOE) approach to further evaluate the SRCs reported at concentrations exceeding the most stringent Resident Receptor FWCUG using the TCR level of 10^{-6} or the THQ for non-carcinogenic risks at THQ = 0.1.
- Provide a recommendation for either further investigation under the Comprehensive Environmental Response, Compensation, and Liability Act, in the form of a Remedial Investigation, if potential contamination has been identified, or NFA if no potential contamination has been identified at this AOC.

The soil sampling conducted at CC RVAAP-83 was within a relatively small area, approximately 870 square feet (ft), which corresponds to the suspected location of the former sump and the associated piping. The subsurface soil samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), Target Analyte List (TAL) metals, explosives, and propellants. VOCs were collected as discrete samples.

The following subsurface soil samples were collected during this SI:

- Three horizontal subsurface soil incremental sampling methodology (ISM) samples were collected at depths of 1-4, 4-7, and 7-10 ft below ground surface (bgs).
- Eight vertical ISM subsurface samples were collected at depths of 4-10 ft bgs.
- One subsurface soil sample was collected as a composite sample between 7 and 13 ft bgs to characterize the soil to 13 ft bgs.

The analytical results from the SI samples were used to determine if potential contamination was present by first identifying the SRCs. Per the *RVAAP's Facility-Wide Human Health Risk Assessment Manual* (USACE 2005), a chemical detected at a concentration greater than the established background value, is not an essential nutrient, and has not been screened out through a frequency of detection evaluation, is identified as an SRC. An SRC may, or may not be, related to the former operations at the site. The resulting maximum detected concentration of each SRC identified in this SI was compared to the most stringent FWCUG for the Resident Receptor (between the adult and child receptors) using the TCR level of 10^{-6} or the THQ for non-carcinogenic risks of THQ = 0.1 for each SRC to determine the presence of potential contamination.

The SRCs that exceeded the most stringent value (between adult and child receptors) Resident Receptor FWCUG, using a TCR level of 10^{-6} or the THQ = 0.1 for non-carcinogenic risks, were then evaluated using a WOE approach. The WOE evaluation considers the SRCs that exceed their Resident Receptor FWCUGs, as described above, to determine if the chemical should be identified as potential contamination.

The SI results of the subsurface soil sampling conducted at Former Building 1039 at CC RVAAP-83 are summarized as follows:

- A total of 19 SVOCs including polycyclic aromatic hydrocarbon compounds, 1 pesticide delta-hexachlorocyclohexane, and 4 metals (antimony, beryllium, cadmium, and lead) were identified as SRCs in the subsurface soil samples.
- No VOCs, SVOCs, metals, explosives, propellants, polychlorinated biphenyls, or pesticides were detected at concentrations exceeding their respective Resident Receptor FWCUGs in the subsurface soil samples collected.
- Therefore, no potential contaminants were identified in the subsurface soil collected at Former Building 1039 at CC RVAAP-83.

The conclusions of this SI conducted at Former Building 1039 at CC RVAAP-83 are as follows:

- No potential contaminants were identified in the subsurface soil sampled at this AOC.
- The results of this SI indicate that the subsurface soil is not contaminated; therefore, soil is not a source of groundwater contamination at this AOC.

The results of this SI indicate that No Further Action (NFA) is warranted for soil at Former Building 1039 at CC RVAAP-83. Since no additional investigation was previously granted at the Former Building 1031 hospital building, the entire AOC, consisting of both former buildings sites, at CC RVAAP-83 is recommended for NFA.

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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 Site Inspection (SI) for Compliance Restoration (CR) Site CC (Army Environmental Compliance-Related Cleanup Program) RVAAP-83 Former Buildings 1031 and 1039 at the former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull counties, Ohio. The location of the former RVAAP is provided in Figure 1-1 and the location of the CR sites at the facility is shown in Figure 1-2. The SI was completed and this document was prepared under Contract Number (No.) W912QR-04-D-0039, Delivery Order No. 0004, Modification No. 1.

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 RVAAP* (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 Oil and Hazardous Substances Pollution Contingency Plan to complete this SI for area of concern (AOC) CC RVAAP-83. The location of CC RVAAP-83 is shown on Figure 1-3.

The SI for CC RVAAP-83 was conducted in accordance with the United States Environmental Protection Agency's (USEPA) *Interim Final Guidance for Performing Site Inspections under CERCLA* (USEPA 1992). The work described in this SI Report was conducted in accordance with the *Final Site Inspection and Remedial Investigation Work Plan Addendum at Compliance Restoration Sites CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039, Revision 1, Ravenna Army Ammunition Plant, Ravenna, Ohio* (ECC 2013).

This SI includes the following components:

- Site descriptions and operational histories
- Waste characteristics and management practices
- Summary of field investigation and pre-mobilization activities
- Summary of the analytical data and results of the field investigation activities
- Determination of Site-Related Chemicals (SRCs)
- Comparison of SRC maximum concentrations to the most stringent Resident Receptor Facility-Wide Cleanup Goals (FWCUGs)
- A weight-of-evidence (WOE) evaluation of the SRCs to determine if potential contamination is present

- Evaluation of the exposure pathways for surface soil, subsurface soil, air, surface water, and groundwater
- Conclusions
- References

1.1 PURPOSE AND SCOPE

ECC is submitting this SI report to the Army in accordance with the Performance Work Statement, Multiple Award Remediation 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 RVAAP, Ravenna, Ohio (Figures 1-1 and 1-2). The Delivery Order was issued by the USACE–Louisville District on August 15, 2011.

Environmental work at the former RVAAP under the Installation Restoration Program began in 1989, with 32 environmental AOCs. The United States Army Center for Health Promotion and Preventive Medicine collected environmental samples at each AOC and performed a Relative Risk Site Evaluation, which prioritized each AOC into one of three groups: low, medium, and high priorities. Environmental restoration work has proceeded primarily by addressing the highest priority sites first. In 1998, the number of environmental AOCs was increased from 32 to 51. Relative risk rankings were conducted to further prioritize those additional environmental AOCs. Since 1998, new environmental AOCs have been added.

This SI discusses one of these AOCs, CC RVAAP-83, which is comprised of two sites: Former Building 1031 and Former Building 1039. Former Building 1031 was utilized as a hospital and Former Building 1039 was used as a laboratory. Former Building 1031 received a No Further Action (NFA) determination as a result of the findings of the *Final Historical Records Review Report for CC-RVAAP-71 Barn No. 5 Petroleum Release and CC-RVAAP-83 Former Buildings 1031 and 1039 Revision 1, Ravenna Army Ammunition Plant, Ravenna, Ohio* (ECC 2012b). No additional investigation activities were required at Building 1031 and, therefore, it is not included in this SI Report. Former Building 1039 was determined to require further investigation as a result of the findings of the Historical Records Review (HRR) (ECC 2012b) due to the historical practices conducted within the former laboratory building.

Historical information available for CC RVAAP-83 is presented in the *Final Historical Records Review Report for CC-RVAAP-71 Barn No. 5 Petroleum Release and CC-RVAAP-83 Former Buildings 1031 and 1039 Revision 1, Ravenna Army Ammunition Plant, Ravena, Ohio* (ECC 2012b). The HRR followed the USEPA guidance document that establishes the minimum requirements for conducting an Abbreviated Preliminary Assessment, as outlined in *Improving Site Assessment: Abbreviated Preliminary Assessments* (USEPA 1999).

1.2 FACILITY DESCRIPTION

The facility, consisting of 21,683 acres, is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (km) (3 miles) east/northeast of the city of

Ravenna and approximately 1.6 km (1 mile) northwest of the city of Newton Falls. The facility, previously known as the RVAAP, was formerly used as a load, assemble, and pack facility for munitions production. As of September 2013, administrative accountability for the entire acreage of the facility has been transferred to the 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.

1.3 DEMOGRAPHY AND LAND USE

The facility consists of 21,683 acres in northeastern Ohio, approximately 37 km (23 miles) east-northeast of Akron and 30 miles (48.3 km) west-northwest of Youngstown. The facility occupies east-central Portage County and southwestern Trumbull County. 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.

The facility is licensed to the OHARNG for use as a military training site. Training and related activities at Camp Ravenna include field operations and bivouac training, convoy training, equipment maintenance, C-130 aircraft drop zone operations, helicopter operations, and storage of heavy equipment.

1.4 FACILITY ENVIRONMENTAL SETTING

This section describes the physical features, topography, geology, hydrogeology, and environmental characteristics of the facility. The environmental setting specific to CC RVAAP-83 Former Buildings 1031 and 1039 is included in Chapter 6.

1.4.1 Physiographic Setting

The facility is located within the Southern New York Section of the Appalachian Plateaus physiographic province (United States Geological Survey 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 surficial deposits (e.g., sand, gravel, and finer-grained outwash deposits). As a result of glacial activity, old stream drainage patterns were disrupted in many locales, and extensive wetland areas developed.

1.4.2 Surface Features and Topography

The topography of the facility is gently undulating with an overall decrease in ground surface 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. The average surface elevation for CC RVAAP-77 is 1,025 ft amsl. 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.

1.4.3 Soil and Geology

1.4.3.1 Regional Geology

The regional geology at the facility consists of horizontal to gently dipping bedrock strata of Mississippian and Pennsylvanian-age overlain by unconsolidated glacial deposits of varying thicknesses. The unconsolidated surficial deposits and bedrock geology are described in the following subsections.

1.4.3.2 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 1-4). Unconsolidated glacial deposits vary considerably in thickness across the facility, from non-existent in some of the eastern portions of the facility to an estimated 150 ft (46 meters [m]) in the south-central portion.

Thin surface glacial deposits 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 Load Line 1 and the Erie Burning Grounds (USACE 2001).

Where glacial sediments remain, their distribution and character indicate their origin as a ground moraine. These tills consist of laterally discontinuous assemblages of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments. Lacustrine sediment from bodies of glacial-age standing water has also been encountered in the form of deposits of uniform light gray silt greater than 50 ft thick in some areas (USACE 2001).

Soil at 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 1978). Much of the native soil was disturbed during construction activities in former production and operational areas of the facility.

Several soil types are present at the facility, as shown in Figure 1-5 and Figure 1-6. The primary soil type present at CC RVAAP-83 is shown in Figure 1-7 and summarized in Table 1-1.

Table 1-1: Soil Type at Former Building 1039, CC RVAAP-83

Soil Series Classification	Parent Material	Geographic Setting	Slope Percent	Drainage	Surface Runoff	Permeability
Mahoning silt loams (MgA and MgB)	Silty clay loam or clay loam glacial till, generally where bedrock is greater than 6 feet below ground surface.	Gently sloping highland areas	0-2 and 2-6	Poorly drained	Rapid and seasonal wetness	Low

1.4.3.3 Bedrock Geology

The Sharon Sandstone Member, informally referred to as the Sharon Conglomerate, of the Pennsylvanian Pottsville Formation, is the primary bedrock beneath the facility (Figure 1-8). 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 (Winslow and White 1966).

In the western portion of the facility, the upper members of the Pottsville Formation, including the Sharon Member, Connoquennissing Sandstone Member, Mercer Member, and uppermost Homewood Sandstone Member, are present (Figure 1-8). The regional dip of the Pottsville Formation measured in the west portion of the facility is between 1.5 and 3.5 m per 1.6 km (5-11.5 ft per mile) to the south.

The Sharon Member 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 has also 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 color.

1.4.4 Hydrogeology

1.4.4.1 Regional Hydrogeology

Sand and gravel aquifers are present in the buried valley and outwash deposits in Portage County, as described in the *Phase I Remedial Investigation Report for High Priority AOCs at the RVAAP, Ravenna, Ohio* (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 extent and continuity of these aquifers are unknown. Recharge of these units is derived from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at the facility have not been delineated. The regional potentiometric surface at the facility for unconsolidated surficial deposits and bedrock is presented in Figures 1-9 and 1-10, respectively (Environmental Quality Management, Inc. [EQM] 2014).

The thickness of unconsolidated surficial deposits at the facility ranges from thin to absent in the eastern and northeastern portion of the facility to an estimated 150 ft (46 m) in the central portion of the facility. The water table (Figure 1-9) is encountered within the unconsolidated zone in many areas of the facility. Because of the heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns are difficult to determine. Laterally, most groundwater flow in the surficial deposits likely follows topographic contours and stream drainage patterns (Figure 1-9), with preferential flow along pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeability than surrounding clay or silt-rich material. Aquifer recharge from precipitation likely occurs via infiltration along root zones, desiccation cracks, and partings within the soil column.

Beneath the facility, the principal bedrock aquifer is within the Sharon Sandstone Conglomerate Unit (referred to as the Sharon Conglomerate Aquifer) (Figure 1-11). Depending on overburden thickness, the Sharon Conglomerate aquifer ranges from an unconfined to a leaky artesian aquifer hydraulically. According to one source, yields from onsite supply wells completed within the Sharon Conglomerate range from 30 to 400 gallons per minute (gpm) (United States Army Toxic and Hazardous Materials Agency 1978). Yields of 5-200 gpm have also been reported for onsite bedrock wells completed in the Sharon Conglomerate (Kammer 1982).

Other, less important, local bedrock aquifers include the Homewood Sandstone (Figure 1-10), which is generally thinner and only capable of well yields less than 10 gpm, and the Connoquennissing Sandstone. Wells completed in the Connoquennissing Sandstone in Portage County yield from 5 to 100 gpm, but are typically less productive than the Sharon Conglomerate due to lower permeability in the sandstone.

In general, the hydraulic gradient in the Sharon Conglomerate aquifer results in a regional eastward flow of groundwater (Figure 1-11) that appears to be more uniform than flow directions in unconsolidated deposits (Figure 1-9) because local surface topography influences the latter. Due to the lack of well data in the western portion of the facility, general flow patterns are difficult to discern. For much of the eastern half of the facility, hydraulic head elevations in bedrock are higher than those in overlying unconsolidated deposits, indicating an upward vertical hydraulic gradient. These data suggest there is a confining layer separating the two aquifers in some areas. In the far eastern area, there is little difference in the head elevations, suggesting a hydraulic connection exists between the two.

1.4.4.2 Groundwater Usage and Domestic Water Supply

The former RVAAP historically used groundwater for both domestic and industrial supplies. Groundwater utilized at the former RVAAP during past operations was obtained from production wells located throughout the facility, with most 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 original groundwater production wells remains in use by the OHARNG. This well, located in the former

Administration Area, is not used as a potable water source, but supplies non-potable water for sanitary purposes for active-use buildings on the facility.

In addition, as of 2011, the OHARNG has installed two bedrock aquifer production wells at the facility. These two OHARNG supply wells were completed in the Sharon Conglomerate near Buildings 1067 and 1068 within the former Administration Area. There is also one inactive non-potable supply well just south of Winklepeck Burning Grounds along the east side of George Road, which was formerly used to supply water for environmental restoration activities.

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, most groundwater use in the area surrounding the facility is for domestic and livestock supply, with the Sharon Conglomerate acting as the major producing aquifer in the area. The Connoquennissing Sandstone Member and Homewood Sandstone Member also provide limited groundwater supplies, primarily to the western half of the facility. Unconsolidated deposits can also be an important source of groundwater. Many of the domestic wells and small public water supplies located near the facility obtain sustainable quantities of water from wells completed in unconsolidated, surficial deposits.

In the unconsolidated aquifer, groundwater flows predominantly eastward; however, the unconsolidated zone shows numerous local flow variations influenced by topography and drainage patterns (Figure 1-9). The local variations in flow direction suggest the following: (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.

Local groundwater within and surrounding the facility contains proportionately high levels of iron, manganese, and naturally occurring carbonate compounds. As such, it is classified as "hard" water. Hard water has an associated metallic taste that can be unpalatable if not properly treated for human consumption (OHARNG 2008).

1.4.4.3 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 north to south, before flowing into the Michael J. Kirwan Reservoir south of State Route 5 (Figure 1-1). The west branch flows out of the reservoir and parallels the southern 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.

The three primary watercourses that drain the facility are as follows (Figure 1-3):

- 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 miles (36 square km), 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 miles (4.3 km) to its confluence with Eagle Creek. The drainage area of the south fork of Eagle Creek is 26.2 square miles (67.8 square km), 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 square miles (28.5 square km), flows in a southerly direction through the facility, and converges with the west branch of the Mahoning River south of the facility (USACE 2001).

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 at the facility 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 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.

1.4.5 Climate

The general climate of the area where the facility is located is continental and 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, presented below, were obtained from available National Weather Service records for the 30-year period of record from 1981 to 2010 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-links#wind*) for the available 66-year period of record from 1930 through 1996.

Average annual rainfall in the area is 38.86 inches (98.7 cm), with the highest monthly average occurring in July (4.31 inches [10.9 cm]) and the lowest monthly average occurring in February (2.15 inches [5.46 cm]). Average annual snowfall totals approximately 63.4 inches (161.0 cm) with the highest monthly average occurring in January (17.1 inches [43.43 cm]). Due to the influence of lake-effect snowfall events associated with Lake Erie, located approximately 35 miles (56.3 km) northwest of the facility, snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the area is 49.3 degrees Fahrenheit (ºF), with an average daily high temperature of 59.0ºF and an average daily low temperature of 39.7ºF. The record high temperature of 100ºF occurred in July 1988, and the record low temperature of -22ºF occurred in January 1994. The prevailing wind direction at the former RVAAP is from the west-southwest, with the highest average wind speed occurring in January (12 miles [19.3 km] per hour) and the lowest average wind speed occurring in August (7 miles [11.3 km] per hour). As per the National Climatic Data Center, 20 storm events (category Thunderstorm Wind) were reported between January 1, 1996 and July 31, 2013 *(http://tinyurl.com/k2kn47o).* The area is susceptible to tornadoes; minor structural damage to several buildings on facility property occurred as the result of a tornado in 1985.

1.5 REPORT ORGANIZATION

This SI Report is organized into the following sections:

- ***Chapter 1 (Introduction)***—Provides an overview of the purpose and scope of this SI, a general facility description, demography, and land use of the facility. This section provides an overview of the environmental setting at the facility.

- ***Chapter 2 (Site Description and Operational History)***—Provides the site description and land use history of the site. The physical property characteristics, military operations, and a summary of past investigations are included.

- ***Chapter 3 (Historical Operations)***—Summarizes the historical operations, investigations, and removal actions at the AOC.

- ***Chapter 4 (Field Investigation)***—Addresses the scope of activities performed under this SI. This section discusses sampling rationale for placement of environmental media sampling locations, field activity procedures, laboratory methods, and protocols. Included in this section are descriptions of the pre-mobilization activities and field sampling methodologies for subsurface soil incremental sampling methodology (ISM) sampling. Deviations from the work plan are outlined. Site surveying and collection and characterization of investigation-derived wastes (IDW) generated during this SI are discussed.

- ***Chapter 5 (Data Evaluation and Summary of Analytical Results)***—Provides the data evaluation process used for this SI, a summary of subsurface soil sampling results, and a presentation of the comparison of the maximum reported concentrations of SRCs to the most stringent Resident Receptor FWCUGs to identify the presence of potential contamination. The results of the WOE evaluation are provided in this section, as well as a discussion of the IDW characterization results.

- ***Chapter 6 (Exposure Pathways)***—Summarizes physical conditions, and hydrological and hydrogeological settings; and provides conclusions for the exposure pathways identified for soil, air, surface water, and groundwater.

- ***Chapter 7 (Summary and Conclusions)***—Summarizes findings and conclusions of this SI.

- ***Chapter 8 (References)***—Lists references used for this report.

Report appendices contain the summarized investigation data as follows:

- Appendix A – Historical Aerial Photographs

- Appendix B – Field Activity Forms

- Appendix C – Boring Logs

- Appendix D – Data Verification Report

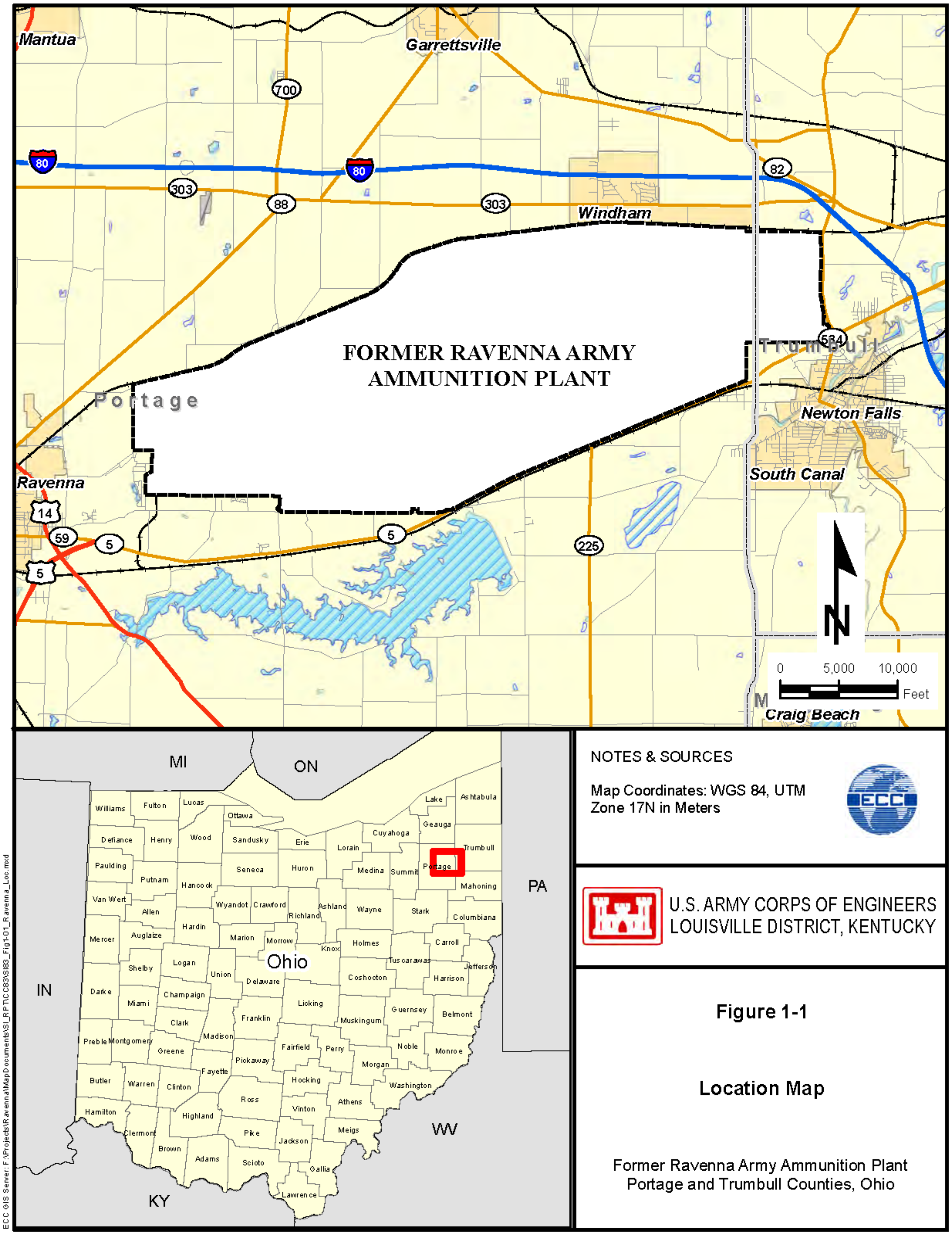
- Appendix E – Laboratory Analytical Results, Laboratory Data, and Chain of Custody Forms

- Appendix F – Data Validation Report

- Appendix G – IDW Disposal Letter Report

- Appendix H – Site Photographs

- Appendix I – Regulatory Correspondence and Comment Response Table



NOTES & SOURCES

Map Coordinates: WGS 84, UTM Zone 17N in Meters

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Figure 1-1

Location Map

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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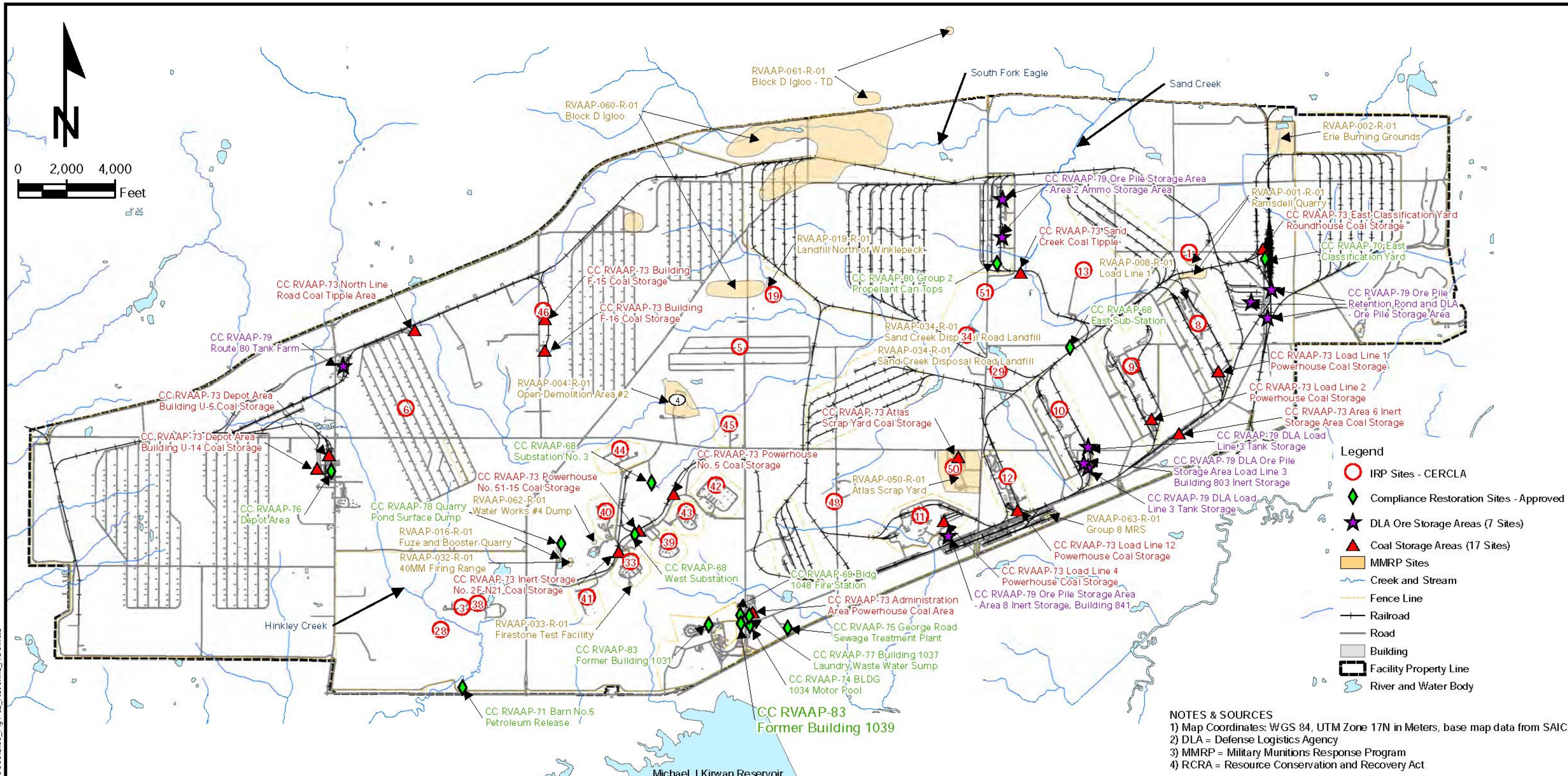

IRP SITES - CERCLA

1	CC RVAAP-01	Ramsdell Quarry Landfill
3	CC RVAAP-03	Open Demolition Area #1
5	CC RVAAP-05	Winklepeck Burning Grounds
6	CC RVAAP-06	C Block Quarry
8	CC RVAAP-08	Load Line 1
9	CC RVAAP-09	Load Line 2
10	CC RVAAP-10	Load Line 3
11	CC RVAAP-11	Load Line 4
12	CC RVAAP-12	Load Line 12
13	CC RVAAP-13	Building 1200 - Dilution\Settling Pond
19	CC RVAAP-19	Landfill North of Winklepeck Burning Grounds
28	CC RVAAP-28	Mustard Agent Burial Site
29	CC RVAAP-29	Upper and Lower Cobbs Ponds
33	CC RVAAP-33	Load Line 6
34	CC RVAAP-34	Sand Creek Disposal Road Landfill
38	CC RVAAP-38	NACA Test Area
39	CC RVAAP-39	Load Line 5
40	CC RVAAP-40	Load Line 7
41	CC RVAAP-41	Load Line 8
42	CC RVAAP-42	Load Line 9
43	CC RVAAP-43	Load Line 10
44	CC RVAAP-44	Load Line 11
45	CC RVAAP-45	Wet Storage Area
46	CC RVAAP-46	Building F-15 and F-16
48	CC RVAAP-48	Anchor Test Area
50	CC RVAAP-50	Atlas Scrap Yard
51	CC RVAAP-51	Dump Along Paris Windham Rd.
	CC RVAAP-66	Facility-Wide Groundwater
	CC RVAAP-67	Facility-Wide Sewer

COMPLIANCE RESTORATION SITES (13 SITES)

CC RVAAP-68	Electronic Substations (E, W, No.3)
CC RVAAP-69	Former Building 1048 Fire Station
CC RVAAP-70	East Classification 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 Propelant Can Tops
CC RVAAP-83	Former Building 1031 and 1039

MMRP SITES (14 SITES)

RVAAP-001-R-01	DLA Ore Storage Sites
RVAAP-002-R-01	Erie Burning Grounds MRS
RVAAP-004-R-01	Open Demolition Area #2 MRS
RVAAP-008-R-01	Load Line 1M RS
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

4	CC RVAAP-04	Open Demolition Area #2

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Figure 1-2

Location of Compliance Restoration Sites

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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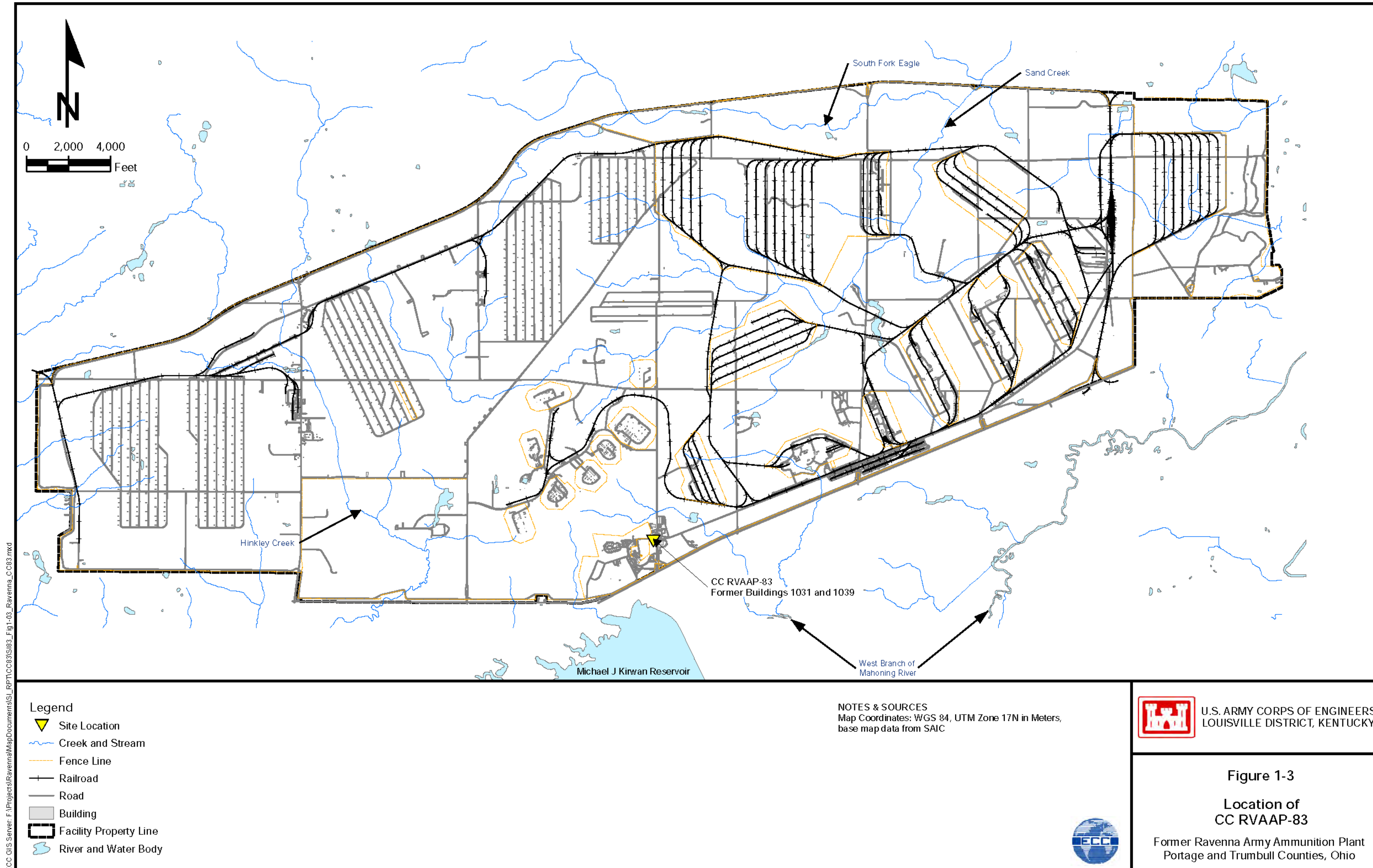

Figure 1-3

Location of
CC RVAAP-83

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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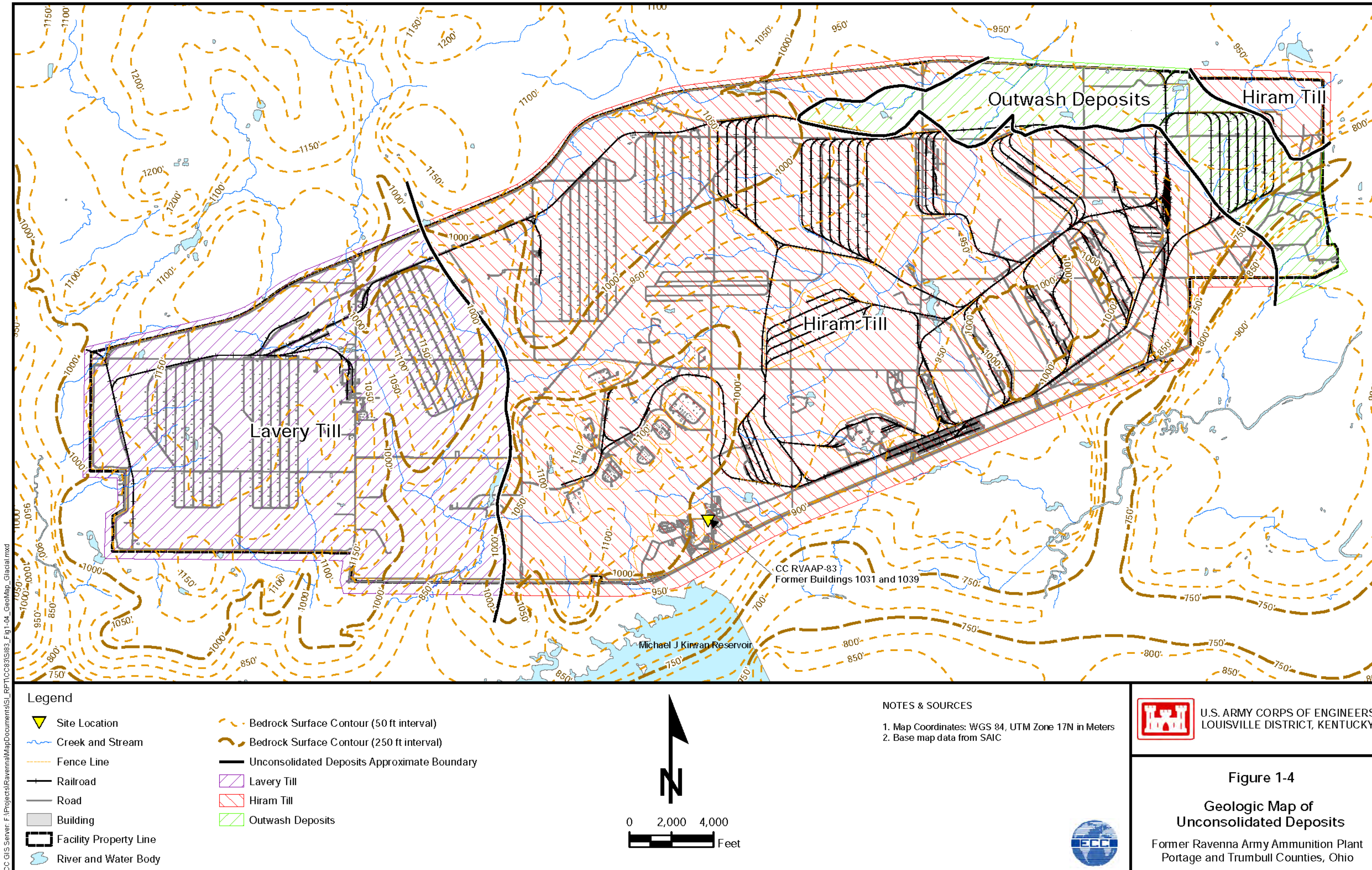
Outwash Deposits
Hiram Till
Hiram Till
Lavery Till
CC RVAAP-83
Former Buildings 1031 and 1039
Michael J Kirwan Reservoir
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
River and Water Body
Bedrock Surface Contour (50 ft interval)
Bedrock Surface Contour (250 ft interval)
Unconsolidated Deposits Approximate Boundary
Lavery Till
Hiram Till
Outwash Deposits
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
U.S. ARMY CORPS OF ENGINEERS
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Figure 1-4
Geologic Map of Unconsolidated Deposits
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
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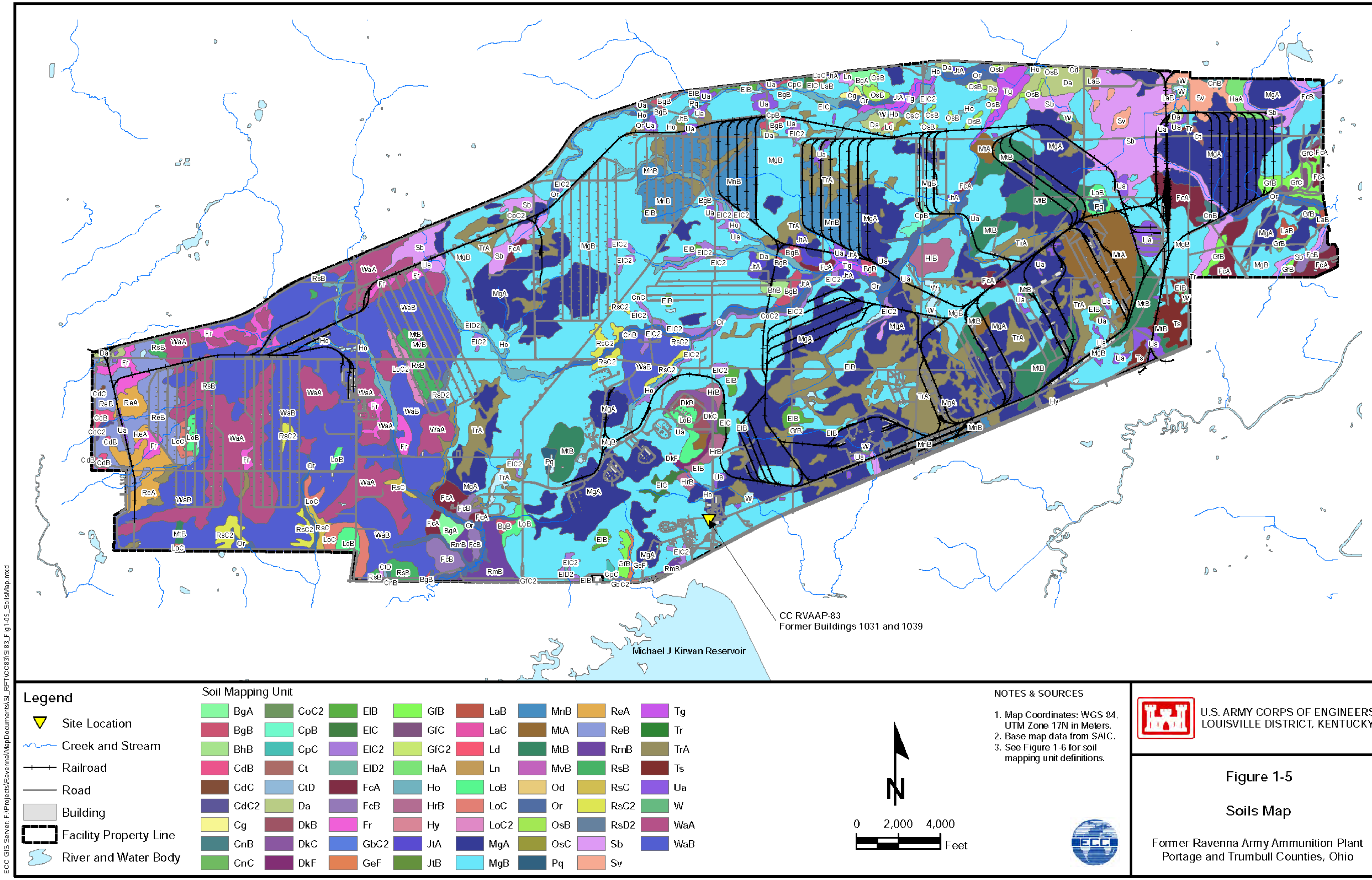

Figure 1-5

Soils Map

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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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
- EIB, Ellsworth silt loam, 2-6% slopes
- EIC, Ellsworth silt loam, 6-12% slopes
- EIC2, Ellsworth silt loam, 6-12% slopes, moderately eroded
- EID2, 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 1-5 for soils map.

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Figure 1-6

Description of
Soil Mapping Units

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

ECC GIS Server: F:\Projects\Ravenna\MapDocuments\SI_RPT\CC83\SI83_Fig1-06_SoilsMapLegend.mxd

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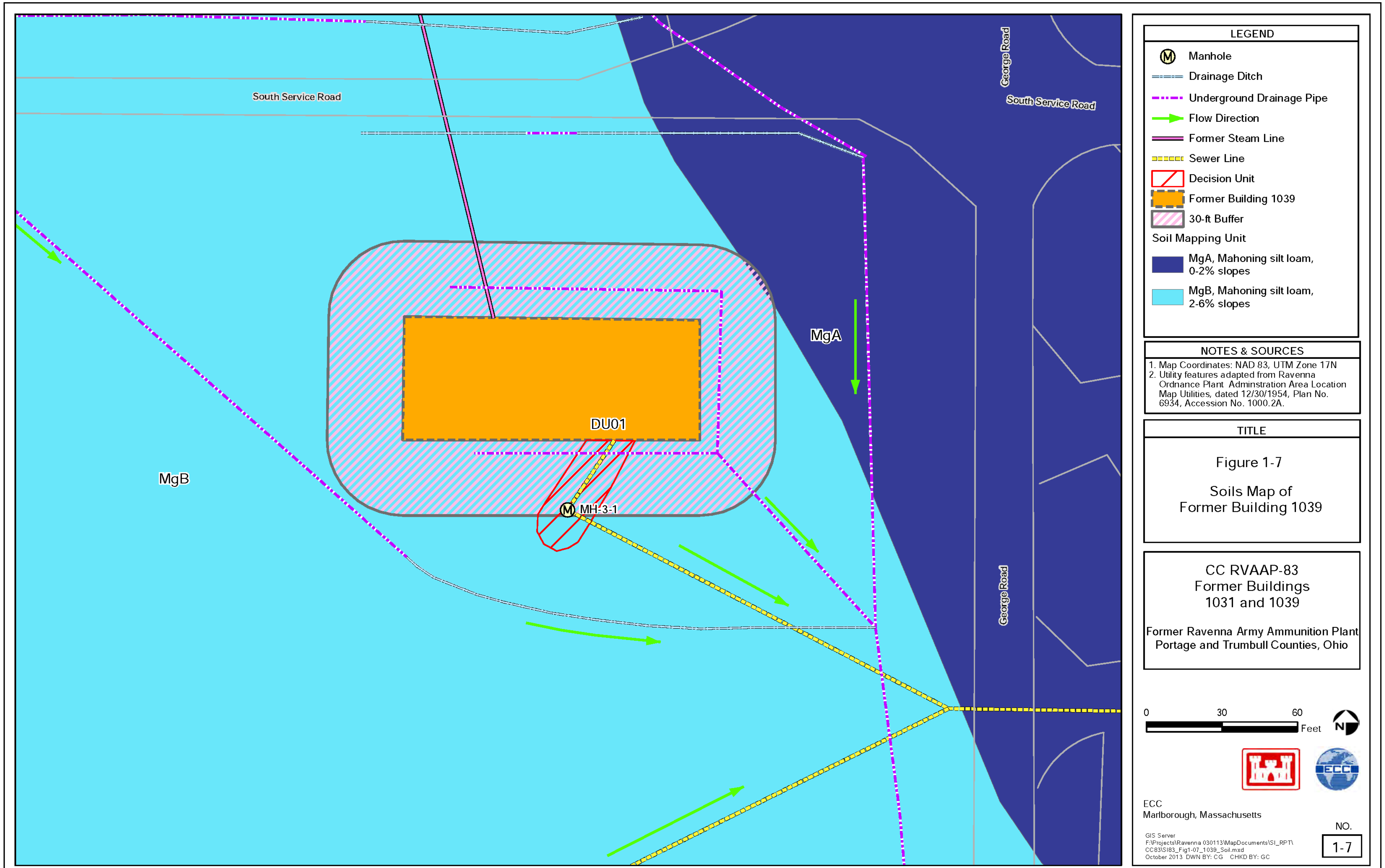
South Service Road
George Road
South Service Road
MgA
MgB
DU01
MH-3-1
George Road
LEGEND
Manhole
Drainage Ditch
Underground Drainage Pipe
Flow Direction
Former Steam Line
Sewer Line
Decision Unit
Former Building 1039
30-ft Buffer
Soil Mapping Unit
MgA, Mahoning silt loam, 0-2% slopes
MgB, Mahoning silt loam, 2-6% slopes
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N
2. Utility features adapted from Ravenna Ordnance Plant Adminstration Area Location Map Utilities, dated 12/30/1954, Plan No. 6934, Accession No. 1000.2A.
TITLE
Figure 1-7
Soils Map of Former Building 1039
CC RVAAP-83 Former Buildings 1031 and 1039
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0 30 60 Feet
N
ECC
Marlborough, Massachusetts
NO.
1-7

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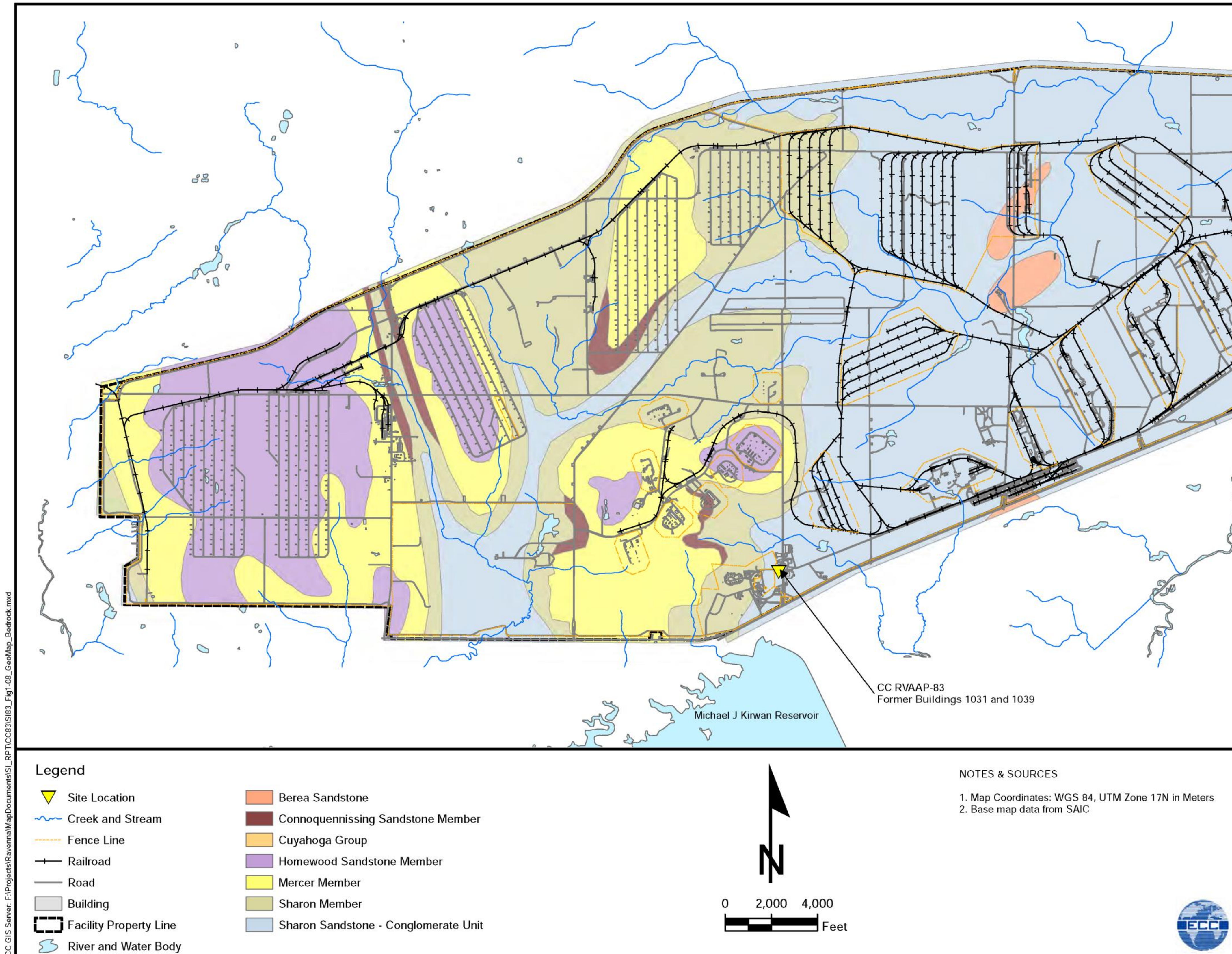

Figure 1-8

Geologic Bedrock Map and Stratigraphic Description of Units

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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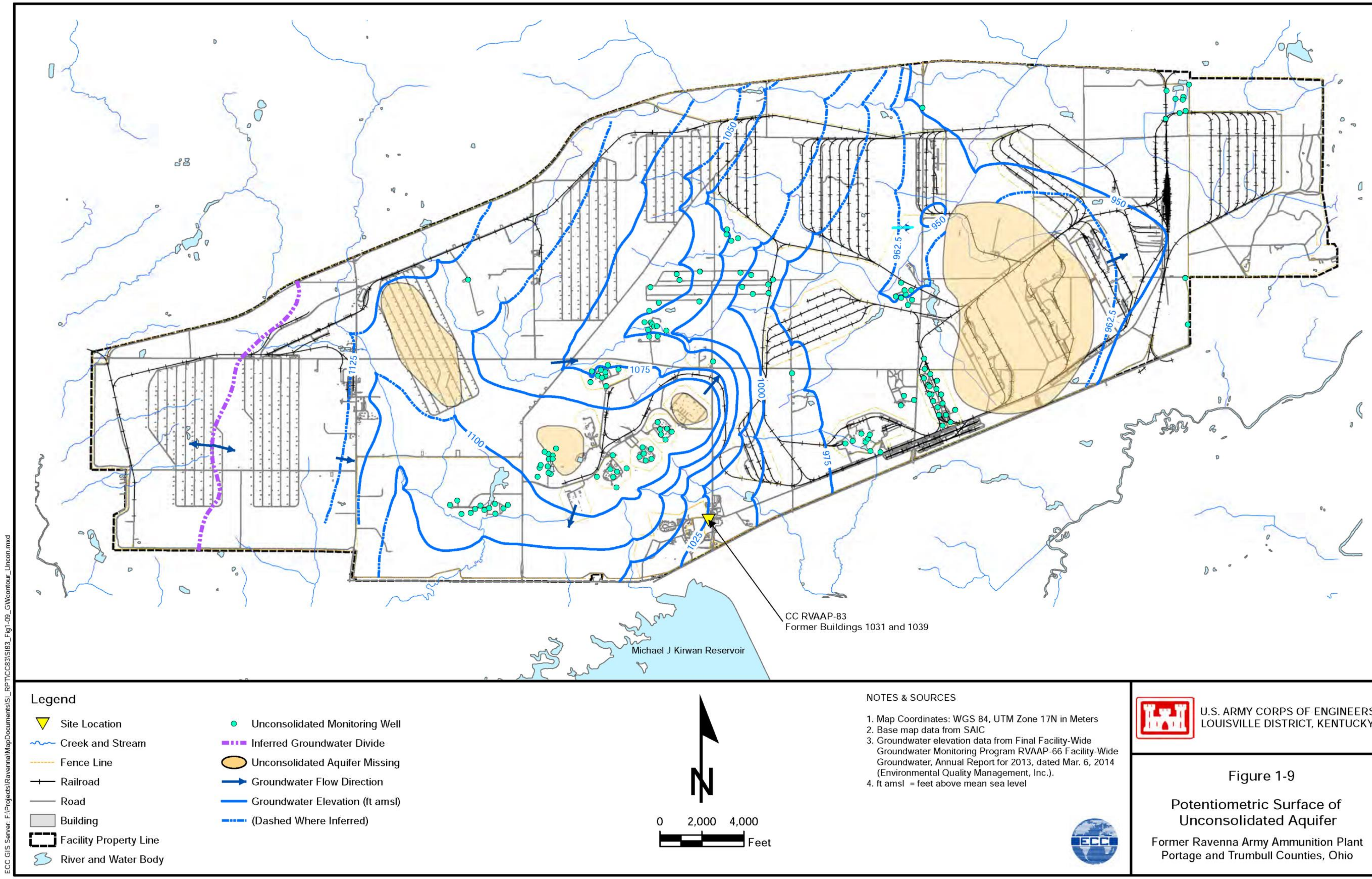

Figure 1-9
Potentiometric Surface of Unconsolidated Aquifer
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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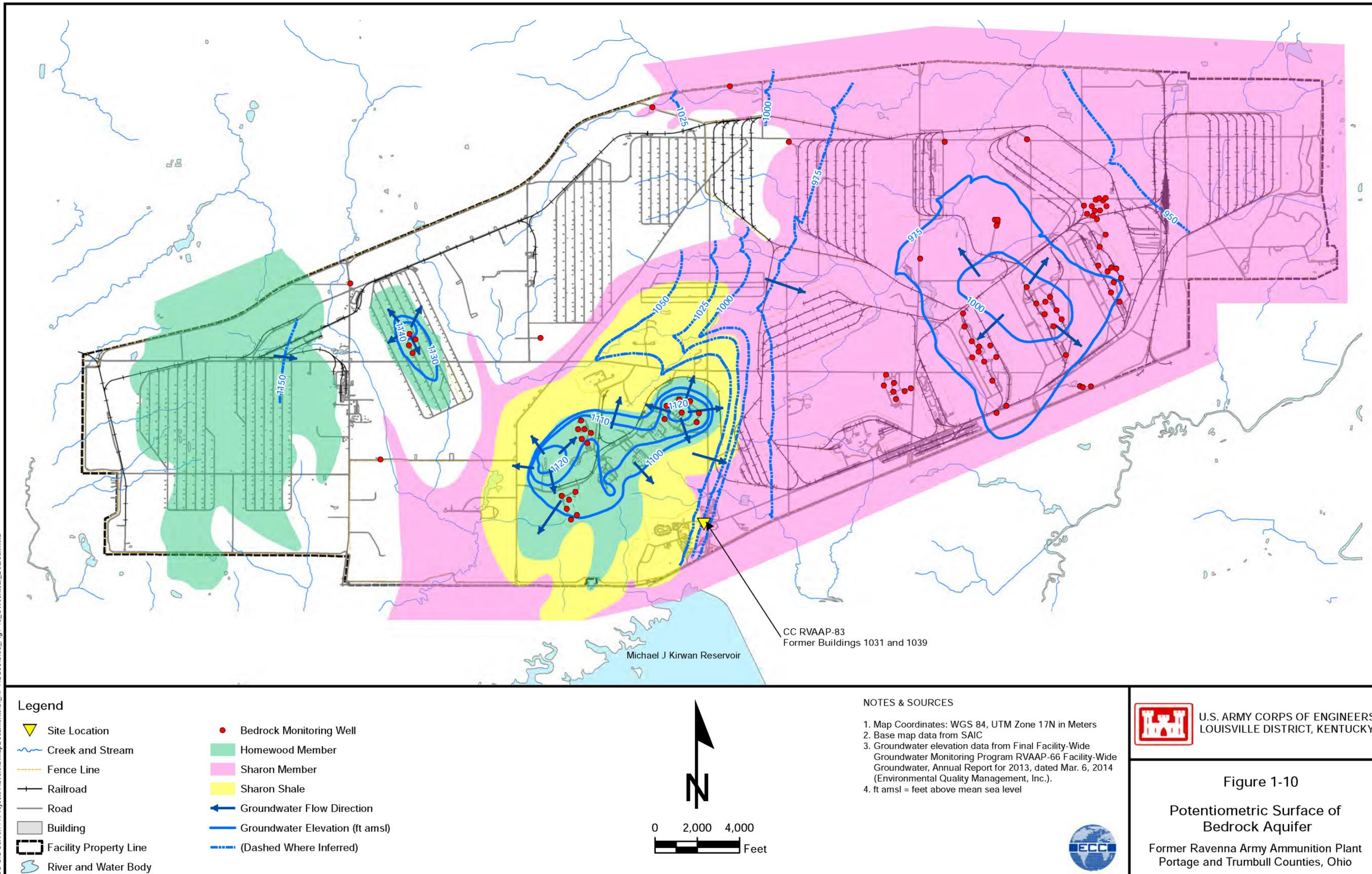

ECC GIS Server: F:\Projects\Ravenna\MapDocuments\SI_RPT\CC83\SI83_Fig1-10_GWcontour_Bedrock.mxd

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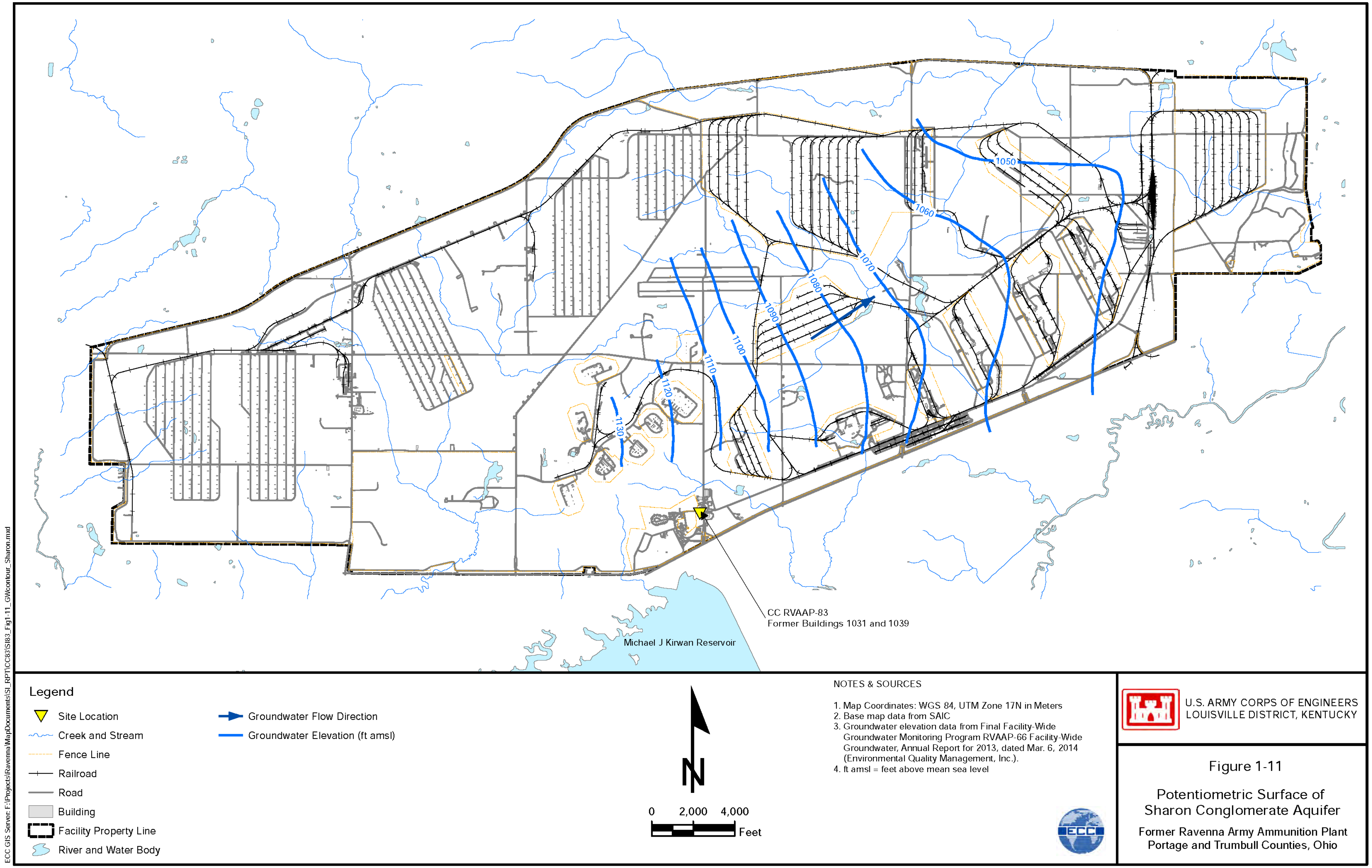
1050
1060
1070
1080
1090
1100
1110
1120
1130
CC RVAAP-83
Former Buildings 1031 and 1039
Michael J Kirwan Reservoir
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
River and Water Body
Groundwater Flow Direction
Groundwater Elevation (ft amsl)
N
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters
2. Base map data from SAIC
3. Groundwater elevation data from Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater, Annual Report for 2013, dated Mar. 6, 2014 (Environmental Quality Management, Inc.).
4. ft amsl = feet above mean sea level
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT, KENTUCKY
Figure 1-11
Potentiometric Surface of
Sharon Conglomerate Aquifer
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
ECC GIS Server: F:\Projects\Ravenna\MapDocuments\SI_RPT\CC83\SI83_Fig1-11_GWcontour_Sharon.mxd

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2. SITE DESCRIPTION AND OPERATIONAL HISTORY

2.1 SITE DESCRIPTION

The CR site CC RVAAP-83 is located in the former Administration Area of the installation, which is centered in the southern central portion of the facility. The Former Building 1039 footprint is located at the southwest corner of the intersection of South Service Road and George Road (Figure 2-1). Nearby buildings include Building 1037 (office space) and Building 1034 (maintenance equipment storage).

CC RVAAP-83 is defined as the footprint of the former one-story laboratory building and a 30-ft buffer area around the perimeter of the building footprint. The building footprint of this building is approximately 6,100 square ft.

The laboratory building was demolished in 2006 and 2007. The demolition contractor, prior to demolishing the building, removed all laboratory equipment, removed and disposed of all asbestos containing panels, inspected the building interior for explosive residues, conducted Exspray testing, and flashed the building drain lines with detonation cord to eliminate explosive residue from the drain lines. After these pre-demolition activities were completed, the building was demolished and the scrap metal, wood, and brick were sorted and shipped offsite for disposal. The building footprint was backfilled with clean soil, graded, and seeded as part of the demolition activities. The surrounding area is grass-covered and no water bodies are present on the site.

2.2 LAND USE AND HISTORY

Former Building 1039 was built in 1942, and was utilized as a laboratory and photo laboratory. Quality assurance (QA)/quality control (QC) samples from load lines were analyzed in this former laboratory. The structure contained three powder test rooms for the routine analyses of lead azide, mercury fulminate, and percussion element mixes. During operations, the building contained and operated a photography laboratory, a chemistry laboratory, and a medical x-ray facility. The photo laboratory was historically used for large-scale photo development activities until its closure in the early 1970s.

Former Building 1039 was used extensively during World War II, and again during the Korean War; however, there was a limited amount of activity in this building during the Vietnam War. Between wars, the use of the laboratory was halted. During these times, the laboratory was demilitarized and remained dormant. Former Building 1039 was closed in 1972.

Based on interviews with facility personnel conducted in 2011 by ECC during the HRR (ECC 2012b), a sump was reported to have once existed on the south exterior wall of the Former Building 1039 laboratory. The sump was used to collect discharge from the building to settle out contaminants prior to discharge to the George Road Sewage Treatment Plant. The sump was reported to have been constructed of lead-lined concrete approximately 6 ft in depth with dimensions of 6 ft by 6 ft. The sump was filled with sawdust to absorb the collected contaminants and settled material.

Design drawings for Building 1039 were examined during the HRR. Drawings depicted features including plumbing, heating, lighting, intended room use, roofing, foundation, and landscaping. However, none of the drawings verified the existence of a sump nor included details regarding the sump at Former Building 1039 described by interviewees (ECC 2011a, 2011b).

Historical photographs taken between 1937 and 2009 were also examined during the HRR (Appendix O of the HRR) (ECC 2012b). The historical aerial photographs were analyzed to identify potential effects of the building use, the relationship between the site and the surrounding areas, and the chronological development of the site. The former laboratory building (Building 1039) is not present on the 1937 or 1940 aerial photographs and first appears on the 1950 aerial photograph. The building exterior remained unchanged during this time period, with no evidence of any major additions or alterations. The building is not present in the 2009 aerials as demolition of Former Building 1039 took place during 2006 and 2007. Appendix A contains historical aerial photographs of the CR site.

The ground surface inside the former building footprint is covered with grass, which was planted as part of site restoration activities after building demolition conducted from 2006 to 2007 by Lakeshore Engineering Services, Inc. (LES) (LES 2007). Following demolition, steel, wood, brick and concrete were sorted and recycled offsite. The basement of the former building was filled with clean soil (LES 2007). The surrounding area is grass covered and no water bodies are present at the site.

The potential contaminants associated with former operations at Building 1039 are chemicals used in the generation of x-ray acid/silver mix solutions; chemicals associated with the analysis of powder test room materials (i.e., lead azide, mercury fulminate); and chemicals used in percussion element mixes; paints, shellac, fuels, tapes, and adhesives (RVAAP 2013).

2.3 PREVIOUS INVESTIGATIONS

In May 2006, LES performed Expray field tests prior to demolition activities at Former Building 1039. Expray is an aerosol-based field test kit for the detection and identification of Group A explosives (e.g., 2,4,6-trinitrotoluene [TNT] and trinitrobenzene), Group B explosives (e.g., cyclotrimethylene trinitramine [RDX] and cyclotetramethylene tetranitramine [HMX]), and compounds containing inorganic nitrates that are used in improvised explosives (e.g., ammonium nitrate/fuel oil). The application of the aerosol to the test area results in a colormetric result. A green colormetric result is considered a negative result. A red colormetric result is considered a positive result. Expray is often used as a pre-blast detection tool. As reported in the Final Completion Report by LES (LES 2007), of the 46 Expray field tests performed at Former Building 1039 in May 2006, there were five separate positive results in the following locations:

- Room 1 (interior) – (HMX/RDX) (1 positive)
- Room 4 (interior) – (TNT) (2 positive)
- Lab Room (interior) – (HMX/RDX) (1 positive)
- Room 9 (interior) – (HMX/RDX) (1 positive)

Expray test results from Former Building 1039 field tests, one negative and two positive, are presented in the Week No. 1 Weekly Report included in the Final Completion Report by LES (LES 2007). The positive results were from a field test performed on the interior basement wall near the ground and a portion of interior wall near a faucet fixture on the first floor. The negative result was from a field test performed on a portion of interior wall in the basement at eye level. The drain lines within Former Building 1039 were cleared of potential explosive residue by explosive flashings by the demolition contractor as part of the demolition activities due to the positive Expray field test results.

The material used for backfill at Former Building 1039 was documented in the LES Final Completion Report. Fourteen loads of backfill material from Load Line 9 were used to backfill the basement of the Former Building 1039 site to within 2 ft of the ground surface. The remaining material used for backfill was reported to be top soil provided from an offsite source that was used to backfill the top 2 ft of the basement area of the former building site. This fill material was sampled and analyzed in February 2007 for the RVAAP Full Analytical Suite prior to being used. The reported results were below the instrument detection limits with the exception of some metals (total of 18) which were below their respective Ohio EPA Generic Direct-Contact Soil Standard Summary criteria (LES 2007). It was documented in the LES Final Completion Report that 14 loads of backfill material from Load Line 9 were used to backfill the basement of the Former Building 1039 site to within 2 ft of the ground surface.

No documented evidence of impact from former and/or current military operations or use of military munitions was discovered during the HRR evaluation at Former Building 1039. Further, no documented evidence of the presence of aboveground storage tanks or underground storage tanks or containerized hazardous, toxic, and radioactive waste at Former Building 1039 was discovered during the HRR (ECC 2012b).

ECC examined design drawings for Former Building 1039 as part of the HRR (ECC 2012b). The drawings did not show the presence of a sump at Former Building 1039. The sump within Building 1039 has been previously described by individuals interviewed in 2011 by ECC (ECC 2012b). Mr. Wolfgang (ECC 2011a) and Mr. McGee (ECC 2011b) provided detailed descriptions of a 6 ft deep, lead-lined concrete sump located along the south exterior wall of Former Building 1039. There are no records documenting the demolition of the reported sump and no drawings were found to confirm the location of the sump. The LES Final Completion Report (LES 2007) does not mention the sump area nor demolition or abandonment of the sump.

The reported sump was described in the HRR as being located along the southern exterior wall of the former building and was reportedly used to collect discharge from the building's floor drains and sink traps, which then discharged to the sewer system. Due to the unknown presence or potential environmental impacts of this sump, additional investigation at Former Building 1039 was recommended in the vicinity of the reported sump area (ECC 2012b).

Aside from the information provided by interviewees, there is no other documented evidence of a sump associated with Building 1039 (ECC 2012b).

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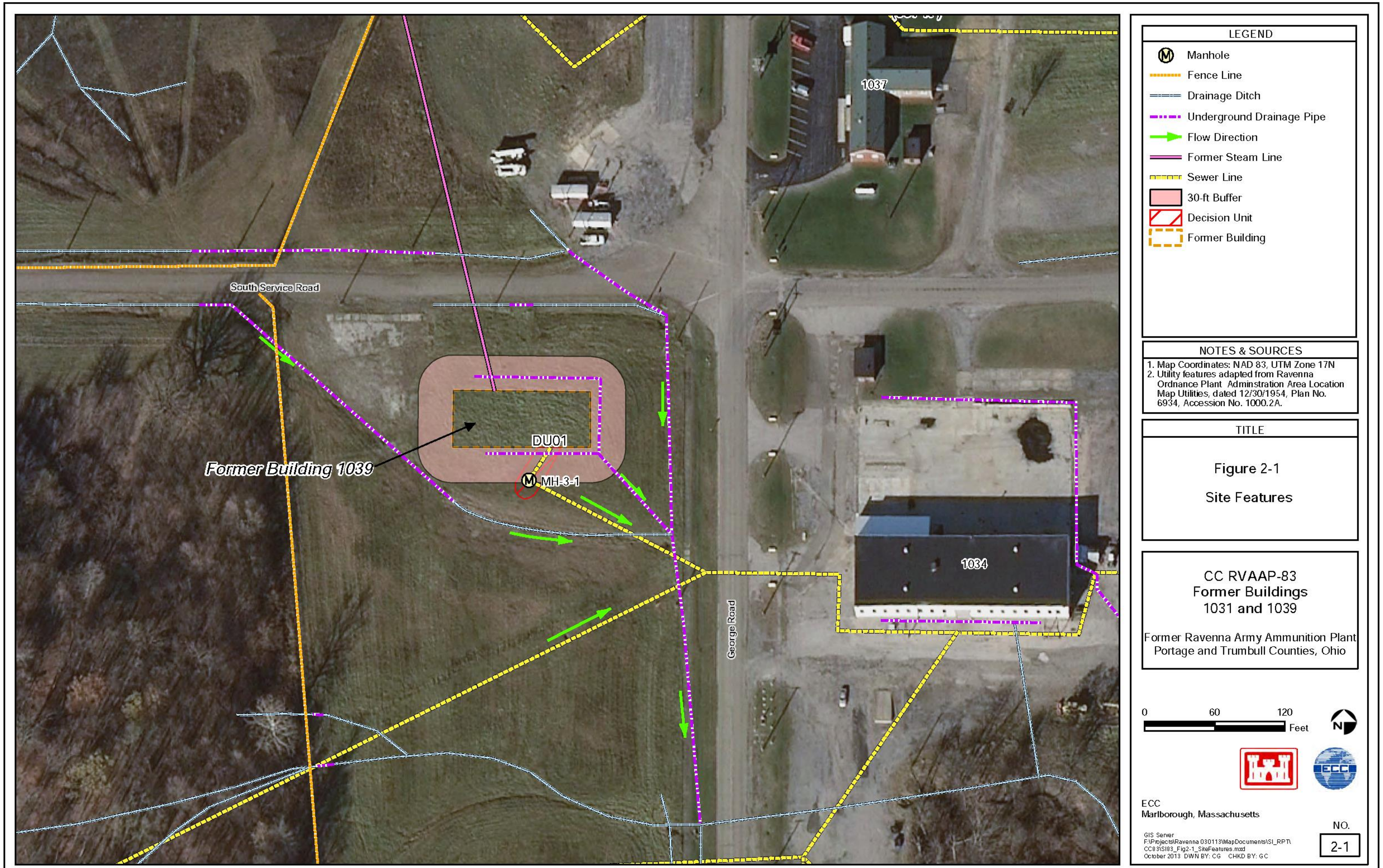
LEGEND
Manhole
Fence Line
Drainage Ditch
Underground Drainage Pipe
Flow Direction
Former Steam Line
Sewer Line
30-ft Buffer
Decision Unit
Former Building
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N
2. Utility features adapted from Ravenna Ordnance Plant Adminstration Area Location Map Utilities, dated 12/30/1954, Plan No. 6934, Accession No. 1000.2A.
TITLE
Figure 2-1
Site Features
CC RVAAP-83
Former Buildings
1031 and 1039
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0
60
120
Feet
N
ECC
Marlborough, Massachusetts
NO.
2-1
1037
South Service Road
Former Building 1039
DU01
MH-3-1
1034
George Road

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3. HISTORICAL OPERATIONS

Based on the findings of the HRR (ECC 2012b), there are no documented releases of hazardous, toxic, or radioactive waste at this CR site. The nature of the former operations conducted within Building 1039 is summarized in Table 3-1, which includes descriptions of potential contaminants associated with these activities.

Table 3-1: Summary of Previous Operations, Investigations, and Removal Actions at CC RVAAP-83

Operations	Reported Documentation	Evidence/Description/Potential Contaminants
Past Operations - Former Building 1039		
Operations Involving Hazardous, Toxic, or Radioactive Waste	Yes	– Hazardous material used in quality assurance/quality control testing of samples collected from the load lines and the activity of photo development. – Chemicals related to the former generation of x-ray acid/silver mix solutions and the laboratory analysis of powder test room materials (i.e., lead azide, mercury fulminate), percussion element mixes, paints, shellac, metals, fuels, and tapes or adhesives. – Historical records review interviewees describe the construction and location of a sump associated with the building.
Previous Investigations/Removal Actions – Former Building 1039		
Year Conducted	**Type of Investigation/ Action**	**Findings**
2006/2007	Demolition of Building 1039	– Qualitative positive test results (i.e., Expray testing) for explosive residue on the building interior. Five positive Expray test results that indicated the presence of explosive residues were discovered in 4 rooms. – The drain lines within the building were cleared of potential explosive residue by explosive flashings by the demolition contractor as part of the demolition activities due to the positive Expray field test results. – No mention in the demolition completion report of the demolition or presence of a sump as described by HRR interviewees.
2011	HRR	– The building was heated by steam from Power House #6. – The building was connected to the George Road Treatment System; – No evidence or documentation of a hazardous, toxic, or radioactive release was discovered. – Two interviewees described the existence of a sump to have been located adjacent to the exterior of the southern side of the building. – No evidence or documentation of a sump was discovered. – No documentation of sump demolition was discovered in the *Final Completion Report Munitions Response for the Demolition of Load Lines 5, 7, Building 1039, Transite Removal at Building T-11604 Removal of Remaining Concrete and Miscellaneous Debris at Load Lines 6, 9, and 11* (Lakeshore Engineering Services, Inc. 2007).

Source: Historical Records Review (Environmental Chemical Corporation 2012).

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4. FIELD INVESTIGATION

Work for this SI was conducted in accordance with the *Final Site Inspection and Remedial Investigation Work Plan Addendum at Compliance Restoration Sites CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039, Revision 1, Ravenna Army Ammunition Plant, Ravenna, Ohio* (ECC 2013). The field work was completed following the *Facility-Wide Sampling and Analysis Plan (FWSAP) for Environmental Investigations at the RVAAP, Ravenna, Ohio* (Science Applications International Corporation [SAIC] 2011a) dated February 24, 2011. The subsurface soil samples collected for this SI are presented in Table 4-1.

4.1 SAMPLING RATIONALE

Subsurface soil sampling was conducted at the CC RVAAP-83 to determine the presence of potential contamination associated with Former Building 1039, as described in the Final SI/Remedial Investigation (RI) Work Plan (ECC 2013). The existence of the former sump in Building 1039 is not depicted on any design drawing or visible on aerial photographs of the site. The existence of the former sump has only been mentioned during two interviews conducted as part of the HRR (ECC 2012b). No other documented evidence of the sump's existence was identified during the HRR. The DU location, sampling depths, and soil boring locations were based upon information obtained from the two interviewees' testimonies, and field judgment in consultation with the USACE Project Manager during the SI.

The sampling plan inclusive of the location for the decision unit (DU), sample locations, and analytical suite for the SI at this AOC was based on the following detailed information provided in the HRR (ECC 2012b):

- Two HRR interviewees described the former sump as being constructed of lead-lined concrete, cubic in shape (6 ft wide, 6 ft long, and 6 ft deep), and located adjacent to the exterior southern side of Former Building 1039. The top of the sump was reportedly covered with wood to keep out rainwater. The two HRR interviewees stated the purpose of the sump was to settle out solids prior to wastewater discharging to the sewer system from Former Building 1039.

- Based upon the interviewee testimony and design drawing showing the location of the sanitary sewer line and manhole, the DU was sited between the southern exterior of Former Building 1039 and manhole MH-3-1), sample locations, and analytical suite along the direction of the sewer line.

- The water level in the former sump is unknown; however, at manhole MH-3-1, there was an influent pipe at approximately 7 ft below ground surface (bgs), leading from the outlet of the former sump at an elevation greater than the MH-3-1 influent elevation to allow for gravity induced water flow.

- As the water level in the former sump was below the ground surface and there was no direct discharge to ground surface from the former sump, no surface soil contamination is expected. Therefore, this SI focuses on the subsurface soil at this AOC.

- One DU was defined as the subsurface soil sampling area. The DU was located to encompass a region 10 ft on either side of the sewer line between MH-3-1 and the exterior southern wall of Former Building 1039, as the former sump location was reported by HRR interviewees to be adjacent to the exterior southern wall of Former Building 1039 and to have drained to the sanitary sewer.

- The horizontal and vertical ISM sampling depths were based upon a former sump depth of 6 ft bgs and the manhole MH-3-1influent pipe located 7 ft bgs. Sample depths of 1-4, 4-7, and 7-10 ft bgs were selected as the depths are required to determine the presence or absence of potential contamination attributed to the former sump and associated piping. Additionally, one composite subsurface soil sample was collected from 7 to 13 ft bgs to evaluate the presence or absence of potential contamination to a depth of 13 ft bgs.

Table 4-2 provides the sampling rationale for each sample collected.

4.2 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 providing necessary notifications to the Army, Ohio EPA, and other stakeholders.

ECC personnel mobilized to the facility on August 12, 2013 to conduct a site walk and pre-mark the DU and direct-push boring locations at CC RVAAP-83. The pre-mobilization tasks included the following activities:

- Conducting a site walk
- Delineating the DU
- Locating the soil borings
- Decontaminating the sampling equipment

4.2.1 Site Walk

ECC personnel mobilized to the facility on August 12, 2013 to conduct a site walk to assess current site conditions and to note any potential health and safety hazards that could affect the SI field work.

4.2.2 Soil Sampling Locations

One DU (DU01) was established for the collection of subsurface soil samples for this SI. The DU is located south of the Building 1039 footprint, which is identified by Seibert markers. The DU runs diagonally from the former south exterior wall of Former Building 1039 to manhole MH-3-1, following the sewer line in this area. The original DU location was originally based on information gathered as part of the HRR, including reports of an area where a sump was once located. However, the area of the DU and the proposed direct-push soil boring locations were both revised based on information obtained onsite as detailed in Section 4.3.

A total of eight direct-push soil boring locations were located within DU01 for subsurface soil sample collection. The DU area and soil boring locations are shown on Figure 4-1.

4.2.2 Munitions and Explosives of Concern and Utility Clearance Surveys

Based on HRR findings (ECC 2012b) and documentation from the sump removal project, munitions and explosives of concern clearances were not required or conducted at the Former Building 1039. No documentation of military munitions being historically located or stored onsite was discovered.

ECC met with Vista Sciences Corporation representatives on October 23, 2012. During this meeting, ECC inquired of Mr. James D. McGee, Vista Sciences Corporation Project Manager for the former RVAAP, about utility clearance protocols at the facility. Mr. McGee initially suggested that ECC contact the OHARNG regarding utility clearance. However, after his review of the sites, Mr. McGee reported that any utility located within these areas would either have been removed or, if still in place, inactive and not energized. Active utilities were not encountered during any of the drilling activities conducted at CC RVAAP-83.

4.2.3 Site Clearing Activities

Site clearing activities were not required at the AOC. This AOC is located in an area with low brush, tall grass, and an access road adjacent to the AOC. Therefore, the site was easily accessible by vehicles and drilling equipment.

4.2.4 Site Security

No specific site security was needed at CC RVAAP-83. However, each work day prior to mobilizing to the AOC, Camp Ravenna Range Control was notified that ECC and subcontractor personnel would be working at the AOC.

4.2.5 Equipment Decontamination

Prior to beginning soil sampling, all sampling equipment was decontaminated at a pre-designated area within Building 1036. For this purpose, a 5-square ft piece of plastic sheeting was placed on the concrete floor of the building in the designated decontamination area.

Five-gallon buckets were used to contain brushes, potable water with Alconox® wash, and potable water rinse. Other decontamination fluids consisted of pesticide grade isopropyl alcohol, a 10 percent nitric acid solution, and laboratory supplied deionized (DI) water contained in spray bottles. Following the Alconox® wash with brushes and potable water rinse, sampling equipment was sprayed with isopropyl alcohol, sprayed with the 10 percent nitric acid solution, rinsed with DI water, and then wrapped in aluminum foil. Sufficient sampling equipment was brought to the site each morning to allow for sampling of the DU area without the need to decontaminate equipment. All sampling equipment was decontaminated inside Building 1036 at the end of each work day in preparation for sampling the following day.

Prior to commencing subsurface soil sampling, all direct-push drilling rods and equipment were decontaminated using a high pressure steam cleaner and brushes. A temporary decontamination pad was constructed outside of Building 1036 and lined with plastic sheeting. The drilling equipment was then placed on a temporary steel rack within the decontamination pad, and the equipment was thoroughly cleaned. Following conclusion of subsurface soil sampling, drilling equipment was decontaminated using a high pressure steam cleaner.

During subsurface soil sampling at Former Building 1039, direct-push steel samplers were decontaminated as necessary using 5-gallon buckets, Alconox® wash and brushes, potable water rinse, pesticide grade isopropyl alcohol, a 10 percent nitric acid solution, and laboratory-supplied DI water contained in spray bottles. The decontamination area was set up on plastic sheeting off the northern side of Building 1036.

All decontamination fluids were containerized in a Department of Transportation-approved 55-gallon closed steel drum located within secondary containment inside Building 1036. The drum was labeled with contents, date of initial generation, and contact information.

All sampling equipment was decontaminated in accordance with the procedures outlined in Section 5.6.2.9 of the FWSAP (SAIC 2011b).

4.3 DEVIATIONS FROM THE WORK PLAN

Deviations from the *Final Site Inspection and Remedial Investigation Work Plan Addendum at Compliance Restoration Sites CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039, Revision 1, Ravenna Army Ammunition Plant, Ravenna, Ohio* (ECC 2013) for field work conducted at Former Building 1039 were as follows:

- Adjusted soil boring locations
- Adjusted depth intervals for the vertical subsurface soil ISM sampling
- Additional horizontal subsurface soil ISM sample collected at 7-10 ft bgs

As shown in the *Final Work Plan Addendum* on Figure B.6-1, DU01 is an area along the middle portion of the south side of the Former Building 1039 footprint that extends in a southwest direction to encompass the area immediately surrounding manhole MH-3-1 (ECC 2013). This area covers the suspected location of a former sump (suspected source area) and associated piping between the sump and the manhole (ECC 2012b). No evidence of an influent pipe leading to the manhole from the northwest (toward Former Building 1039) was discovered upon removal of the manhole cover and inspection of the manhole interior. However, there was evidence of one influent pipe accessing the manhole from a northeasterly direction. Based on this additional information, and in consultation with onsite USACE Technical Managers, DU01 was relocated to encompass the area from the manhole to the side of the Former Building 1039 building footprint in a northeasterly direction. The soil boring locations were relocated accordingly to within the revised DU01 area. Figure 4-1 shows the relocated soil borings and area of DU01.

As per the Final Work Plan Addendum (ECC 2013), vertical subsurface soil ISM samples were to have been collected from 1 to 7 ft bgs at each soil boring location at DU1. However, upon measuring the depth of the bottom of the manhole MH-3-1 from the ground surface, it was discovered that the bottom of the manhole (and the influent pipe entering the bottom of the manhole) was measured at 7 ft bgs. Therefore, upon consultation with onsite USACE Technical Managers, it was determined that the 1- to 7-ft bgs interval would not provide representative characterization of the soils potentially impacted by the former sump and associated piping. Therefore, the subsurface soil sampling interval was revised to 4-10 ft bgs so that subsurface soils at depths below the bottom of the manhole and the influent pipe would be collected from each soil boring. An additional horizontal subsurface soil ISM sample was collected from the 7- to 10-ft bgs interval. These subsurface soil sampling locations are shown in Figure 4-1.

4.4 FIELD SAMPLING

All field activities and sampling procedures at Former Building 1039 were performed in accordance with Section 5.0 of the FWSAP (SAIC 2011a) with the exception of the deviations noted above. Field work was comprised of collecting vertical (4-10 ft bgs) and horizontal (1-4, 4-7, and 7-10 ft bgs) subsurface soil samples, as well as an additional soil boring (7-13 ft bgs) sample using ISM at DU01. Surface soils were not sampled since a release from the sump would have potentially only impacted subsurface soils.

Between August 12 and 14, 2013, eight soil borings were advanced to 10 ft bgs at DU01. The locations of the borings are shown on Figure 4-1. Subsurface soil ISM samples (1-4, 4-7, and 4-10 ft bgs) were collected within the DU at each of the boring locations. A deep soil boring (DSB) sample (7-13 ft bgs) was collected at soil boring SB05. A photoionization detector (PID) was used for the measurement of total volatile organic compounds (VOCs) at each boring to facilitate discrete sampling for the purpose of VOC analysis.

The subsurface soil ISM samples and the DSB sample (7-13 ft bgs) were analyzed for the following analytes:

- VOCs using USEPA Method SW-846, 8260C/5035
- Semivolatile organic compounds (SVOCs) using USEPA Method SW-846, 8270D and 8270D selective ion monitoring (SIM)/3550
- Target Analyte List (TAL) Metals using USEPA Method SW-846, 6010C/7471B
- Explosives using USEPA Method SW-846, 8330B
- Propellants using USEPA Methods Nitrocellulose 9056 Modified and Nitroguanidine 8330B

In addition to the above analyses, one vertical subsurface soil ISM sample (4-10 ft bgs) from soil boring SB07 (Sample ID 083SB-0012M-0001-SO) was analyzed for the RVAAP Full Suite analysis, which includes VOCs, SVOCs, TAL metals, pesticides, polychlorinated biphenyls

(PCBs), explosives and propellants, as defined in the Facility-Wide Quality Assurance Project Plan Section 5.4.5 (SAIC 2011b). Table 4-1 presents a sample collection summary for DU01 at Former Building 1039.

Samples collected during the SI were laboratory-analyzed at CT Laboratories, LLC of Baraboo,Wisconsin. Preparation and analyses for chemical parameters were performed according to the methods listed in Table 4-3.

QA split samples were collected separately for the USACE. These samples are identified in Table 4-1. The USACE QA split samples were laboratory-analyzed at Microbac Laboratories, Inc. of Marietta, Ohio. All analytical procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, Department of Defense Quality Systems Manual Version 4.2, USACE–Louisville District analytical QA standards, and specific project goals and requirements.

4.4.1 Subsurface Soil Sampling

Three horizontal subsurface soil ISM samples were collected at DU01: one from the 1- to 4-ft bgs interval, one from the 4- to 7-ft bgs interval, and one from the 7- to 10-ft bgs interval. A vertical ISM sample was collected at each of the eight boring locations from the 4- to 10-ft bgs interval. A DSB sample was collected from one soil boring location at the 7- to 13-ft bgs 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 Section 5.5.2.5.3 of the FWSAP (SAIC 2011a). Samples were collected using 5-ft long stainless steel sampling rods lined with acetate Macro-core® samplers. Each sample was collected using a dedicated liner specific for that interval. The 5-ft stainless steel sampler was advanced twice at each boring location to reach the depth of 10 ft bgs and three times at one boring location to reach the depth of 13 ft bgs. The sampler was then retrieved from the desired depth and the liner removed. The liner was cut open length-wise and the soil was immediately field-screened with a PID. Samples for headspace screening were collected at 2-ft intervals along the entire sampler using stainless steel scoopulas and placed in 8-ounce glass jars. The jars were then capped with aluminum foil and a plastic lid and allowed to warm for approximately 10 minutes. The tip of the PID was then inserted into the jar through the aluminum foil and the reading recorded on the boring log. If elevated readings were noted, a sample was collected and analyzed for VOCs using a disposable Terracore® sampler at that interval. The VOC sample was collected from the DSB sample prior to compositing the sample to avoid the loss of volatiles.

The liner containing the soil was photographed and soil characteristics for each interval were then logged on a soil boring log. A summary of sampling information was logged on the field log forms. Boring logs and field log forms from the site investigation are presented in Appendix C. Photographs are presented in Appendix H.

4.4.1.1 Horizontal Incremental Sampling Methodology Soil Sampling

Subsurface soil was collected at each of the eight borings from the 1- to 4-ft bgs interval to create the depth interval-specific subsurface soil ISM sample. Soil was collected by running a stainless steel scoopula along the length of the liner from 1 to 4 ft to collect a representative sample from each boring. The same procedure was performed for the 4- to 7- and 7- to 10-ft bgs intervals. Sufficient soil was collected from each soil boring sample interval to generate the minimum 1 kilogram of soil required for an ISM sample. All sample containers were labeled and placed in a cooler with ice following collection.

4.4.1.2 Vertical Incremental Sampling Methodology Soil Sampling

Eight vertical subsurface soil ISM samples were collected from the 4- to 10-ft bgs interval. Soil was collected by running a stainless steel scoopula along the length of the liner from 4 to 5 ft and from 5 to 10 ft to collect a representative sample. Sufficient soil was collected from the 4- to 10-ft bgs interval to generate the minimum 1 kilogram of soil required for an ISM sample. All sample containers were labeled and placed in a cooler with ice following collection.

4.4.1.3 Deep Soil Boring Sampling

One DSB was advanced at Former Building 1039 to characterize the subsurface soils to 13 ft bgs. The boring was advanced to a depth of 13 ft bgs and a sample was collected from the 7- to 13-ft bgs interval. The VOC sample was collected prior to collecting the composite sample. Soil for the composite portion of the sample was collected by running a stainless steel scoopula along the length of the liner from 7 to 10 ft and from 10 to 13 ft. The soil was then mixed with a stainless steel spoon in a stainless steel bowl to collect a representative sample. These were collected in accordance with sampling procedures as described in Section 5.5.2.5 in the FWSAP (SAIC 2011a) and as presented in Section 4.2 of Appendix A of the Final Work Plan Addendum (ECC 2013). The sample container was labeled and placed in a cooler with ice following collection. The DSB sample at Former Building 1039 was collected from soil boring SB05.

4.4.2 Field Quality Assurance/Quality Control Sampling Procedures

QC samples were collected in accordance with Section 5.4.7 of the Facility-Wide Field Sampling Plan (SAIC 2011c). Field duplicate samples were collected at a frequency of 10 percent (1 per 10 soil samples). Matrix spike (MS)/matrix spike duplicate (MSD) samples were collected at a frequency of 5 percent (1 per 20 soil samples).

A field duplicate sample was collected at one soil boring location, SB03, at the 4- to 10-ft bgs interval. An MS/MSD sample was collected at one soil boring location, SB02, at the 4- to 10-ft bgs interval. The field duplicate and MS/MSD were derived from the same sampling point as their respective primary samples and using the same sample collection methods. The samples were then submitted for the same analyses as the primary samples (blind to the contract laboratory for the field duplicate sample). One equipment rinsate blank sample was collected from hand tool soil collection equipment. Trip blanks accompanied all shipments containing VOC samples.

QA split samples were collected for USACE at two soil boring locations (SB03 and SB05) and submitted to the USACE contracted laboratory for independent analyses. At these boring locations, the drill rig was offset approximately 6 inches from the initial boring location. The QA split samples were collected from the same subsurface interval as the primary samples and using the same sample collection methods. A vertical subsurface soil ISM QA sample from SB03 was collected at the 4- to 10-ft bgs interval and analyzed for VOCs (including methyl tert-butyl ether [MTBE]), SVOCs, TAL metals, propellants, and explosives. MTBE is not related to the former usage of the AOC but was included in the standard VOC analyte list. The vertical subsurface soil ISM QA sample collected at SB05 was collected from the 4- to 10-ft bgs interval and analyzed for SVOCs, TAL metals, and explosives.

A source water blank sample was collected on March 14, 2013 from the DI water used during direct push equipment decontamination. The source water blank sample was analyzed for TAL metals, explosives, propellants, herbicides, PCBs, pesticides, SVOCs, total petroleum hydrocarbon (TPH) diesel range organics (DRO)/gasoline range organics (GRO), and VOCs. This source water was brought onsite by the drilling subcontractor (Frontz Drilling) and originated from a private well located at the company's facility in Wooster, Ohio. Frontz Drilling has been hired as a drilling subcontractor by previous RVAAP contractors (e.g., SAIC) and has supplied potable water for decontamination purposes during numerous field events. The source water blank sample results are provided in Appendix D. The type and number of QA/QC samples are provided in Table 4-1.

4.5 SURVEYING

Campbell & Associates, Inc., of Akron, Ohio, was subcontracted by ECC to survey all soil boring locations at Former Building 1039. The horizontal coordinates and relative elevations of all sampling locations and the building footprint corners of Former Building 1039 were determined to within 0.3 m (1 ft) and 0.01 m, respectively. Michael McMahon, an employee of Campbell & Associates, Inc. and a licensed surveyor in the state of Ohio, performed the survey. All survey data were reported in North American Datum 1983 Universal Transverse Mercator Zone 17 North, in meters.

4.6 INVESTIGATION-DERIVED WASTE

IDW materials generated during field activities included soil cuttings from subsurface soil sampling and decontamination fluids. All IDW was containerized in Department of Transportation approved 55-gallon drums, properly sealed and labeled, and placed in a designated area within Building 1036. The drum containing IDW fluids was placed on a heavy duty polyethylene secondary containment pallet.

4.6.1 Collection and Containerization

All waste generated during this SI was properly handled, labeled, characterized, and managed in accordance with Section 8.0 of the FWSAP (SAIC 2011a), federal and state of Ohio large quantity generator requirements, and the RVAAP Installation Hazardous Waste Management Plan (Base Realignment and Closure Office 2009).

4.6.2 Characterization for Disposal

Waste disposal characterization samples were collected by ECC personnel on August 15, 2013. Samples were comprised of liquid IDW consisting of decontamination fluids, and solid IDW consisting of soil cuttings. IDW analysis included both liquid and solid Toxicity Characteristic Leaching Procedure, and Reactivity, Corrosivity, and Ignitability analysis.

4.6.3 Transportation and Disposal

On November 27, 2013, Ohio EPA approved the IDW disposal letter report for the transport and disposal of the accumulated IDW generated during this SI. The IDW disposal letter report and Ohio EPA approval are provided in Appendix G. On December 23, 2013, the drummed IDW was transported (under a non-hazardous waste manifest) by Emerald Environmental Services, Inc. and disposed of at Vexor Technology in Medina, Ohio. The manifests are provided in Appendix G.

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Table 4-1: Summary of Samples Collected in August 2013 at CC RVAAP-83

Location	Sample Location/Soil Boring	Sample ID	Matrix	Depth (ft)	Sampling Method	Date	TPH DRO	TPH GRO	VOC/MTBE	VOC	SVOC	TAL Metals	PCB	Pesticides	Explosives	Propellants	Herbicides	Hexavalent Chromium
Subsurface Soil																		
Bldg 1039	DU01	083SB-0015M-0001-SO	SB	7-10	ISM	12-Aug-13					X	X			X	X		
Bldg 1039	DU01	083SB-0015M-0001-SO	SB	7-10	ISM	14-Aug-13			X									
Bldg 1039	DU01	083SB-0001M-0001-SO	SB	1-4	ISM	12-Aug-13					X	X			X	X		
Bldg 1039	DU01	083SB-0001M-0001-SO	SB	1-4	ISM	14-Aug-13			X									
Bldg 1039	DU01	083SB-0002M-0001-SO	SB	4-7	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	DU01	083SB-0002M-0001-SO	SB	4-7	ISM	14-Aug-13			X									
Bldg 1039	SB01	083SB-0003M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB02	083SB-0004M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB02	083SB-0004M-0002-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB03	083SB-0005M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB03	083SB-0006M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB03	083SB-0007M-0001-SO	SB	4-10	ISM	12-Aug-13			X		X	X			X	X		
Bldg 1039	SB04	083SB-0008M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB05	083SB-0009M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB05	083SB-0010M-0001-SO	SB	4-10	ISM	12-Aug-13					X	X			X			
Bldg 1039	SB05	083SB-0014-0001-SO	SB	7-13	Composite	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB06	083SB-0011M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Bldg 1039	SB07	083SB-0012M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X	X	X	X	X		
Bldg 1039	SB08	083SB-0013M-0001-SO	SB	4-10	ISM	12-Aug-13				X	X	X			X	X		
Field Quality Control – Source Water*																		
NA	Source Water (ECC bottled decontamination water)	070-0057-0001-Source Water	QC	Non-dedicated hand sampling tools	NA	12-Dec-12	X	X		X	X	X	X	X	X	X	X	
NA	Source Water (Driller decontamination water)	079-0007-0001-Source Water	QC	Direct-Push Tools	NA	14-Mar-13	X	X		X	X	X	X	X	X	X	X	X
Field Quality Control – Equipment Rinsate*																		
NA	Equipment Rinsate Blank	083SB-0023-0001-ER	QC	Non-dedicated hand sampling tools during sampling event	NA	15-Aug-13		X		X	X	X	X	X	X	X		
Field Quality Control – Trip Blanks*																		
NA	Trip Blank	070-0060-0001-TB	QC	NA	NA	12-Dec-12			X									
NA	Trip Blank	070SB-005-0001-TB	QC	NA	NA	12-Dec-12		X										
NA	Trip Blank	079-0008-0001-TB	QC	NA	NA	14-Mar-13			X									
NA	Trip Blank	079-0009-0001-TB	QC	NA	NA	14-Mar-13		X										
NA	Trip Blank	083SB-0004-0001-TB	QC	NA	NA	15-Aug-13			X									
NA	Trip Blank	083SB-0016-0001-TB	QC	NA	NA	12-Aug-13			X									
NA	Trip Blank	083SB-0017-0001-TB	QA	NA	NA	12-Aug-13			X									
NA	Trip Blank	083SB-0018-0001-TB	QC	NA	NA	12-Aug-13			X									
NA	Trip Blank	083SB-0020-0001-TB	QC	NA	NA	14-Aug-13			X									

Notes:

Field Duplicate	Matrix Spike/Matrix Spike Duplicate	Full Suite	Quality Assurance

Propellants include nitroguanidine, nitrocellulose, and nitroglycerin.

DRO = Diesel Range Organics.
DU = Decision Unit.
ER = Equipment Rinsate.
GRO = Gasoline Range Organics.
ID = Identification.
ISM = Incremental sampling methodology.
MTBE = Methyl tert-butyl ether.
NA = Not applicable.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
SB = Soil Boring.
SVOC = Semivolatile organic compound.
TAL = Target Analyte List.
TB = Trip Blank.
TPH = Total petroleum hydrocarbon.
VOC = Volatile organic compound.

- Programmatic QC samples collected at dates indicated in the table

Table 4-2: Summary of Soil Sampling Rationale, August 2013 at CC RVAAP-83

Sample Type	Depth (ft bgs)	Location (DU/SB)	Sample ID	Date Sampled	Comments/Rationale
ISM	1-4	DU01	083SB-0001M-0001-SO	12-Aug-13	Determine the horizontal presence or absence of potential contamination in subsurface soil.
ISM	4-7	DU01	083SB-0002M-0001-SO	12-Aug-13	Determine the horizontal presence or absence of potential contamination in subsurface soil.
ISM	7-10	DU01	083SB-0015M-0001-SO	12-Aug-13	Determine the horizontal presence or absence of potential contamination in subsurface soil.
ISM	4-10	SB01	083SB-0003M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil.
ISM	4-10	SB02	083SB-0004M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil.
ISM	4-10	SB02	083SB-0004M-0002-SO	12-Aug-13	QC. MS/MSD sample of 083SB-0004M-0001-SO.
ISM	4-10	SB03	083SB-0005M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil.
ISM	4-10	SB03	083SB-0006M-0001-SO	12-Aug-13	QC. FD sample of 083SB-0005M-0001-SO.
ISM	4-10	SB03	083SB-0007M-0001-SO	12-Aug-13	QA. Split sample of 083SB-0005M-0001-SO.
ISM	4-10	SB04	083SB-0008M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil.
ISM	4-10	SB05	083SB-0009M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil.
ISM	4-10	SB05	083SB-0010M-0001-SO	12-Aug-13	QA. Split sample of 083SB-0009M-0001-SO.
ISM	4-10	SB06	083SB-0011M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil.
ISM	4-10	SB07	083SB-0012M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil. Analyzed for Ravenna Army Ammunition Plant Full Suite analysis.
ISM	4-10	SB08	083SB-0013M-0001-SO	12-Aug-13	Determine the vertical presence or absence of potential contamination in subsurface soil.
Composite	7-13	SB05	083SB-0014-0001-SO	12-Aug-13	Determine presence or absence of potential contamination in soil to a depth of 13 ft bgs.
Grab	NA	Trip Blank	083SB-0016-0001-TB	12-Aug-13	QC. Trip Blank.
Grab	NA	Trip Blank	083SB-0017-0001-TB	12-Aug-13	QA. Trip Blank.
Grab	NA	Trip Blank	083SB-0004-0001-TB	15-Aug-13	QC. Trip Blank.
Grab	NA	Trip Blank	083SB-0020-0001-TB	14-Aug-13	QC. Trip Blank.
Grab	NA	Trip Blank	083SB-0018-0001-TB	12-Aug-13	QC. Trip Blank.

Notes:

bgs	=	Below ground surface.
DU	=	Decision Unit.
FD	=	Field duplicate.
ft	=	Feet.
ID	=	Identification.
ISM	=	Incremental sampling methodology.
MS	=	Matrix spike.
MSD	=	Matrix spike duplicate.
NA	=	Not applicable.
QA	=	Quality assurance.
QC	=	Quality control.
SB	=	Soil boring.

Table 4-3: Sample Preparation and Analytical Methods, August 2013, CC RVAAP-83

Parameter	Soil(1)		Aqueous	
	Preparation	Analysis	Preparation	Analysis
Propellants*	9056 Modified	Nitrocellulose 9056 Modified	SW8330	SW8330
	SW8330	Nitroguanidine SW8330B	E353.2	E353.2
	NA	NA	9056M	9056M(1)
TAL Metals	SW3015	Metals SW6010C	SW3050B	SW6020
	SW7471B	Mercury SW7471B	SW7470A	SW7470A
	NA	NA	SW3050B	SW6010C(1)
TPH GRO	NA	NA	SW5030B	SW8015V Modified
			SW5030B	SW8015C(1)
TPH DRO	NA	NA	SW3520C	SW8015D Modified
			SW3520C	SW8015C(1)
Pesticides	SW3546	SW8081B	SW3520C	SW8081
			SW3520C	SW8081B
Explosives	SW8330B	SW8330B	SW8330A	SW8330A
			SW8330B	SW8330B
PCB	SW3540C	SW8082A	SW3520C	SW8082
			SW3520C	SW8082A(1)
Herbicides	NA	NA	SW3510C	SW8151A
VOC**	SW5035	SW8260C	SW5030B	SW8260B
SVOC***	SW3550	SW8270D/SW8270D SIM	SW3510C	SW8270C
			SW3510C	SW8270D(1)
			SW3510C	SW8270D/SIM(1)

Notes:
All soil samples, except for VOCs, undergo incremental sample preparation by air drying, then passed through a rotary hammer mill, and sieved.

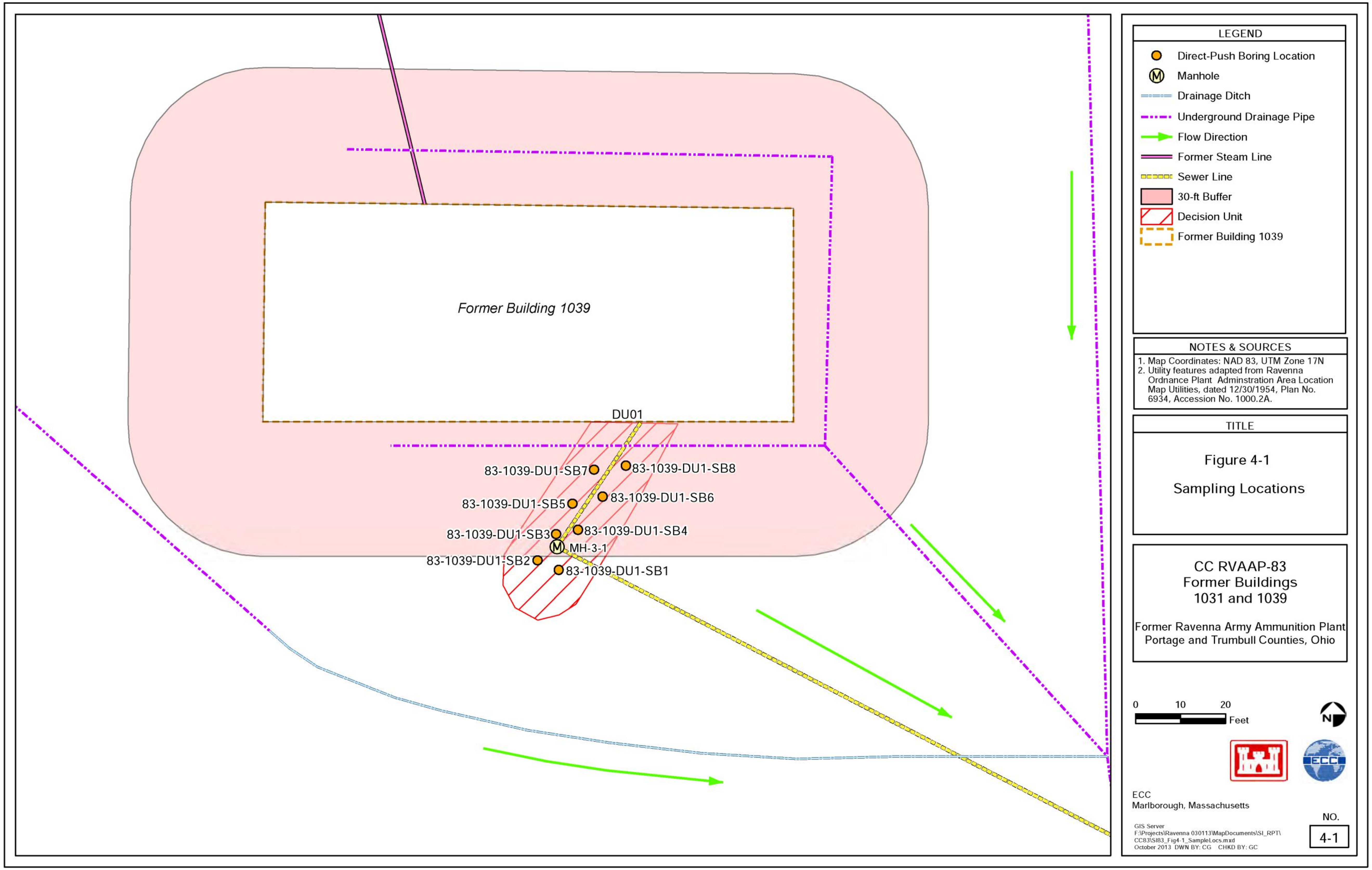
1. Analytical method performed by CT Laboratories, LLC other methods are for TestAmerica Laboratory analysis of equipment rinsate blanks.

* Propellant nitroglycerin reported by explosives method (SW8330B).

** Includes benzene, ethylbenzene, toluene, total xylenes, and methyl tert-butyl ether.

*** Includes polycyclic aromatic hydrocarbon using SIM mode.

DRO = Diesel range organic.
GRO = Gasoline range organic.
PCB = Polychlorinated biphenyl.
TAL = Target Analyte List.
TPH = Total petroleum hydrocarbon.
SIM = Selected ion monitoring.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.


Former Building 1039
DU01
83-1039-DU1-SB7
83-1039-DU1-SB8
83-1039-DU1-SB5
83-1039-DU1-SB6
83-1039-DU1-SB3
83-1039-DU1-SB4
MH-3-1
83-1039-DU1-SB2
83-1039-DU1-SB1
LEGEND
Direct-Push Boring Location
Manhole
Drainage Ditch
Underground Drainage Pipe
Flow Direction
Former Steam Line
Sewer Line
30-ft Buffer
Decision Unit
Former Building 1039
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N
2. Utility features adapted from Ravenna Ordnance Plant Adminstration Area Location Map Utilities, dated 12/30/1954, Plan No. 6934, Accession No. 1000.2A.
TITLE
Figure 4-1
Sampling Locations
CC RVAAP-83
Former Buildings
1031 and 1039
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0 10 20
Feet
N
ECC
Marlborough, Massachusetts
NO.
4-1
October 2013 DWN BY: CG CHKD BY: GC

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5. DATA EVALUATION AND SUMMARY OF ANALYTICAL RESULTS

This chapter summarizes the analytical sampling results for the Former Building 1039 at CC RVAAP-83. The laboratory analytical data for this SI are provided in Appendix E.

5.1 DATA EVALUATION

The data collected during this SI were verified and validated in accordance with the procedures outlined in the FWSAP (SAIC 2011b). The processes used to evaluate the analytical data are described in this section. The completed data verification report is included in Appendix D and the data validation report is included as Appendix F. Chemical data reported as non-detect were reported as not detected in the summary of analytical results tables included in Chapter 5 and at the Limit of Detection in Appendix D.

5.1.1 Soil Sampling Intervals

The soil sampling intervals defined for this SI are as follows:

- Subsurface Soil Horizontal Profile (1-4, 4-7, and 7-10 ft bgs)
- Subsurface Soil Boring Vertical Profile (4-10 ft bgs)
- DSB (7-13 ft bgs)

5.1.2 Data Verification, Validation, and Determination of Potential Contamination

5.1.2.1 Data Verification and Validation

Data verification was performed on the subsurface soil samples. The analytical results were reported by the laboratory in accordance with the FWSAP (SAIC 2010).

Data qualifiers were assigned to each result based on the laboratory (i.e., TestAmerica of North Canton, Ohio) QA review and verification criteria. The SI analytical results were qualified as follows:

- "U" is not detected.

- "UJ" is not detected and the reporting limit is an estimated value.

- "J" denotes that the analyte was positively identified, but the associated numerical value is an approximate concentration of the analyte in the sample.

- "R" indicates that the result is not usable.

In addition to assigning qualifiers, the verification process also selected 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 or not 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 that exceeded the calibration range of the undiluted sample. A complete discussion of verification process results is contained in the Data Verification Report (Appendix D).

A data validation report was completed for all six CR sites inclusive of Site CC RVAAP-83, where ECC conducted SIs. The *Final Data Validation Report for Compliance Restoration Sites: RVAAP-70 East Classification Yard, RVAAP-71 Barn No. 5 Petroleum Release, RVAAP-72 Facility-Wide Underground Storage Tanks, RVAAP-75 George Road Sewer Treatment Plant Mercury Spill, RVAAP-77 Building 1037 Laundry Waste Water Sump and RVAAP-83 Former Buildings 1031 and 1039* was issued by North Wind Services and MEC^{x} in August 2014. The report is provided in Appendix F. In general, the data validation performed for the CC RVAAP-83 SI indicates that no false negatives or false positives were identified, and the results are usable for their intended purposes.

5.1.2.2 Determination of Potential Contamination

This section provides an outline of the process used to determine if potential contamination is present at this AOC. Per the *Facility-Wide Human Health Risk Assessment Manual* (USACE 2005), a chemical detected at a concentration greater than the established background value, which is not an essential nutrient, or screened out through a frequency of detection evaluation is identified as an SRC. An SRC may, or may not, be related to the former operations at the site. The maximum detected concentration of each SRC is then compared to the most stringent FWCUG for the Resident Receptor between the adult and child using the Target Cancer Risk (TCR) level of 10^{-6} or the Target Hazard Quotient (THQ) of 0.1 for each SRC, as outlined in the *Final Facility-Wide Human Health Cleanup Goals for RVAAP* (SAIC 2010). Both risk levels (carcinogenic and non-carcinogenic) were assessed for the Resident Receptor (adult and child) to determine which one was the most stringent for comparison to each SRC. The specific criteria used to identify SRCs and potential contamination at the AOC are described below:

- ***Background Screening***—The maximum detected concentrations of inorganic chemicals were compared to the RVAAP background concentrations, where established. If exceedances of background concentrations occurred, the respective inorganic chemicals were identified as SRCs. Several inorganic chemicals were screened against a background concentration of 0 milligrams per kilogram (mg/kg) (e.g., cadmium, silver). A value of 0 mg/kg was assigned as background when the chemical was not detected in any of the samples collected during the background study.

- ***Screening of Essential Human Nutrients***—Chemicals that are essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are an integral part of the human food supply and often added to foods as supplements. The 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).

- ***Frequency of Detection/WOE***—A frequency of detection evaluation was not completed as part of the WOE since less than 20 soil samples were collected during this investigation. Therefore, frequency of detection was not used to further screen the identified SRCs as part of this SI. The SRCs that exceeded the most stringent Resident Receptor FWCUGs using the TCR level of 10^{-6} or THQ = 0.1 for non-carcinogenic risks were then evaluated using a WOE approach, to determine if the SRC is AOC-related. A WOE evaluation considers the SRCs that exceeded their FWCUGs, as described above, to determine if the chemical should be identified as potential contamination. If the results of the WOE evaluation indicated that potential contamination was present, then an additional investigation, such as an RI, is recommended. However, if no potential contamination was identified, then NFA is recommended.

If no FWCUG has been developed for the particular chemical, then the USEPA's Regional Screening Levels (RSLs) (USEPA 2014) for the Residential Receptor were used for comparison using the same TCR of 10^{-6} and THQ of 0.1. The National Guard Trainee FWCUGs and the USEPA Industrial RSLs (November 2014) are provided on the data summary tables in this section for comparison purposes only and were not used to determine whether or not chemicals were identified as potential contamination. If potential contamination is identified in this SI, it indicates that further investigation under CERCLA, in the form of an RI, is warranted at this AOC.

Tables 5-1 and 5-2 provide a summary of the SRCs identified in the subsurface soil at CC RVAAP-83. The complete laboratory analytical data packages, including laboratory analytical results tables with final qualifiers, are included in Appendix E.

5.2 SUMMARY OF HORIZONTAL SUBSURFACE SOIL ANALYTICAL RESULTS

CC RVAAP-83 subsurface soil sampling data were evaluated to identify the SRCs at the AOC. Three horizontal subsurface soil ISM samples were collected from one DU in order to determine the presence or absence of subsurface soil contamination. One ISM sample was collected from the 1- to 4-ft bgs interval, one ISM sample was collected from the 4- to 7-ft bgs interval, and one ISM was collected from the 7- to 10-ft bgs interval. A total of eight soil borings were advanced at DU01 to obtain the horizontal subsurface soil ISM samples. The ISM subsurface soil samples were analyzed for VOCs, SVOCs, TAL metals, explosives, and propellants.

Table 5-1 presents the determination of SRCs in the subsurface soil at Former Building 1039 CC RVAAP-83. The identified SRCs in subsurface soil are shown in Figures 5-1 and 5-2for organic chemicals and Figure 5-3 for inorganic chemicals.

The following organic and inorganic SRCs have been identified in the horizontal subsurface soil at CC RVAAP-83 Former Building 1039:

- Several SVOCs, primarily polycyclic aromatic hydrocarbon [PAH] compounds, have been identified as SRCs, as these chemicals were detected at low or estimated concentrations in all three horizontal subsurface soil ISM samples.

- Two metals (antimony and lead) were identified as SRCs as these chemicals were detected in the horizontal subsurface soil ISM samples at concentrations greater than the background criteria.
  - Antimony was detected in the 1- to 4-ft and 4- to 7-ft bgs interval samples, at concentrations greater than the background criteria.
  - Lead was only detected in the 1- to 4-ft bgs interval subsurface soil sample.
- No metals were detected at concentrations greater than the background criteria in the 7- to 10-ft bgs interval subsurface soil sample.

Tables 5-2 and 5-3 provide a summary of the analytical results for organic and inorganic chemicals detected in subsurface soil at CC RVAAP-83, respectively. The organic and inorganic chemicals detected in the subsurface soil samples are shown in Figures 5-1, 5-2, and Figure 5-3. Complete copies of all the laboratory data packages and laboratory analytical results summary tables are presented in Appendix E.

The analytical results from the horizontal subsurface soil samples are summarized in the following sections.

5.2.1 Volatile Organic Compounds

All three horizontal subsurface soil ISM samples from DU01 were analyzed for VOCs and MTBE. No VOCs (including MTBE compounds) were detected in any of the horizontal subsurface soil ISM samples. VOCs were not identified as potential contaminants at this AOC.

5.2.2 Semivolatile Organic Compounds

All three horizontal subsurface soil ISM samples from DU01 were analyzed for SVOCs. SVOCs were not detected at concentrations exceeding their respective Resident Receptor FWCUG or RSL in any of the horizontal subsurface soil ISM samples. Therefore, no SVOCs were identified as potential contaminants at this AOC.

5.2.3 Target Analyte List Metals

All three horizontal subsurface soil ISM samples from DU01 were analyzed for TAL metals analysis. TAL metals were not detected in the subsurface soil samples at concentrations exceeding their respective Resident Receptor FWCUGs or RSLs in any of the horizontal subsurface soil ISM samples. Therefore, metals were not identified as potential contaminants at this AOC.

5.2.4 Explosives and Propellants

All three horizontal subsurface soil ISM samples from DU01 were analyzed for explosives and propellants analysis. No explosive or propellant chemicals were detected in any of the horizontal subsurface soil ISM samples above the detection limits. Therefore, explosives and propellants were not identified as potential contaminants at this AOC.

5.3 SUMMARY OF VERTICAL SUBSURFACE SOIL ANALYTICAL RESULTS

Eight vertical subsurface soil ISM samples and one field duplicate sample (at soil boring SB03) were collected at DU01 as part of this SI. A total of eight soil borings ranging in depth from 4 to10 ft bgs were advanced at DU01 to obtain the vertical subsurface soil ISM samples. The samples were analyzed for VOCs, SVOCs, TAL metals, explosives, and propellants.

The following organic and inorganic SRCs have been identified in the vertical subsurface soil at CC RVAAP-83 Former Building 1039:

- Several SVOCs, primarily PAH compounds, were identified as SRCs as these chemicals were detected at low or estimated concentrations in the vertical subsurface soil samples. No background values have been established for these chemicals.

- Three metals (antimony, beryllium, and cadmium) were identified as SRCs as these chemicals were detected in the vertical subsurface soil samples above background criteria. No background value has been established for cadmium and a value of zero has been applied as the background for this chemical.

In addition to the primary subsurface soil samples collected for this SI, one vertical ISM sample was collected between 4 and 10 ft bgs at soil boring SB07 and analyzed for RVAAP Full-Suite analysis for QA/QC purposes. This analysis includes VOCs, SVOCs, TAL metals, PCBs, pesticides, explosives, and propellants. One SRC was identified in the vertical subsurface soil ISM sample collected for the RVAAP Full Suite analysis, as follows:

- One pesticide (delta-hexachlorocyclohexane [delta-BHC]) was identified as an SRC in the vertical subsurface soil ISM sample, as the pesticide was detected at a low estimated concentration of 1.1 J micrograms per kilogram (µg/kg). No background value has been established for this chemical.

The analytical results from the vertical subsurface soil samples are summarized in the following sections.

5.3.1 Volatile Organic Compounds

All vertical subsurface soil ISM samples from DU01 were analyzed for VOCs. No VOC chemicals were detected in any of the vertical subsurface soil ISM samples. Therefore, VOCs were not identified as potential contaminants at this AOC.

5.3.2 Semivolatile Organic Compounds

All vertical subsurface soil ISM samples from DU01 were analyzed for SVOCs. SVOCs were not detected in any of the vertical subsurface soil ISM samples at concentrations exceeding their respective Resident Receptor FWCUGs or RSLs. Therefore, SVOCs were not identified as potential contaminants at this AOC.

5.3.3 Target Analyte List Metals

All vertical subsurface soil ISM samples from DU01 were analyzed for TAL metals analysis. Analytical results were compared to established background values where applicable. TAL metals were not detected at concentrations exceeding their respective Resident Receptor FWCUGs or RSLs in any of the vertical subsurface soil ISM samples. Therefore, metals were not identified as potential contaminants at this AOC.

5.3.4 Explosives and Propellants

All vertical subsurface soil ISM samples from DU01 were analyzed for explosives and propellants analysis. No explosive or propellant chemicals were detected in any of the vertical subsurface soil ISM samples. Therefore, explosive and propellants were not identified as potential contaminants at this AOC.

5.3.5 Pesticides

One vertical subsurface soil ISM sample was collected from soil boring location SB07 at DU01 and was submitted for a RVAAP Full Suite analysis which includes VOCs, SVOCs, TAL metals, explosives, propellants, PCBs, and pesticides.

- One pesticide (delta-BHC) was detected at an estimated concentration of 1.1 J µg/kg. An FWCUG has not been established for delta-BHC and there are no USEPA Residential RSL (USEPA 2014) criteria established for this chemical. Pesticide compounds are not SRCs.

In summary, no VOCs, SVOCs, TAL metals, explosives, propellants, PCBs, and pesticides were detected at concentrations exceeding their respective FWCUGs or RSLs in the vertical subsurface soil samples. Therefore, no potential contaminants were identified in the vertical subsurface soil samples collected at this AOC.

5.4 SUMMARY OF DEEP SOIL BORING SAMPLE ANALYTICAL RESULTS

One composite subsurface soil sample was collected between 7 and 13 ft bgs at soil boring SB05 within DU01. This sample was analyzed for VOCs, SVOCs, TAL metals, explosives, and propellants.

SRCs were identified in the DSB sample as follows:

- Eleven PAH compounds, 2-methylnaphthalene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and pyrene, were identified as SRCs as these chemicals were detected in the DSB sample at low concentrations. No background criteria have been established for these chemicals in soils.

The analytical results from the subsurface soil sample collected between 7 and 13 ft bgs are summarized in the following sections.

5.4.1 Volatile Organic Compounds

The DSB sample from DU01 was analyzed for VOCs. No VOCs were detected in the DSB sample. Therefore, VOCs were not identified as potential contaminants at this AOC.

5.4.2 Semivolatile Organic Compounds

The DSB sample from DU01 was analyzed for SVOCs. The reported SVOCs values and estimated values were not detected at concentrations exceeding their respective Resident Receptor FWCUGs or RSLs in the DSB sample. Therefore, SVOCs were not identified as potential contaminants at this AOC.

5.4.3 Target Analyte List Metals

The DSB sample from DU01 was analyzed for TAL metals analysis. Analytical results were compared to established background values, where applicable. TAL metals were not detected at concentrations exceeding their respective background criteria in the DSB sample. Therefore, metals were not identified as potential contaminants at this AOC.

5.4.4 Explosives and Propellants

The DSB sample from DU01 was analyzed for explosives and propellants. No explosive or propellant chemicals were detected in the DSB sample. Therefore, explosive and propellants were not identified as potential contaminants at this AOC.

5.5 INVESTIGATION-DERIVED WASTE ANALYTICAL RESULTS

A description of the waste streams generated during this SI, along with the Toxicity Characteristic Leaching Procedure waste characterization analysis results and disposal recommendations, are provided in the IDW disposal letter report (Appendix G).

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Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013 at CC RVAAP-83

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[a]	SRC (Yes/No)	SRC Justification
1,1,1-Trichloroethane	71-55-6	0/13	None	None	None	No	Not Detected
1,1,2,2-Tetrachloroethane	79-34-5	0/13	None	None	None	No	Not Detected
1,1,2-Trichloroethane	79-00-5	0/13	None	None	None	No	Not Detected
1,1-Dichloroethane	75-34-3	0/13	None	None	None	No	Not Detected
1,1-Dichloroethene	75-35-4	0/13	None	None	None	No	Not Detected
1,2-Dibromoethane (EDB)	106-93-4	0/13	None	None	None	No	Not Detected
1,2-Dichloroethane	107-06-2	0/13	None	None	None	No	Not Detected
1,2-Dichloroethene	156-59-2	0/13	None	None	None	No	Not Detected
1,2-Dichloropropane	78-87-5	0/13	None	None	None	No	Not Detected
2-Butanone (MEK)	78-93-3	0/13	None	None	None	No	Not Detected
2-Hexanone	591-78-6	0/13	None	None	None	No	Not Detected
4-Methyl-2-pentanone (MIBK)	108-10-1	0/13	None	None	None	No	Not Detected
Acetone	67-64-1	0/13	None	None	None	No	Not Detected
Benzene	71-43-2	0/13	None	None	None	No	Not Detected
Bromochloromethane	74-97-5	0/13	None	None	None	No	Not Detected
Bromodichloromethane	75-27-4	0/13	None	None	None	No	Not Detected
Bromoform	75-25-2	0/13	None	None	None	No	Not Detected
Bromomethane	74-83-9	0/13	None	None	None	No	Not Detected
Carbon Disulfide	75-15-0	0/13	None	None	None	No	Not Detected
Carbon Tetrachloride	56-23-5	0/13	None	None	None	No	Not Detected
Chlorobenzene	108-90-7	0/13	None	None	None	No	Not Detected
Chloroethane	75-00-3	0/13	None	None	None	No	Not Detected
Chloroform	67-66-3	0/13	None	None	None	No	Not Detected
Chloromethane	74-87-3	0/13	None	None	None	No	Not Detected

Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013 at CC RVAAP-83 (continued)

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[a]	SRC (Yes/No)	SRC Justification	Analyte
Volatile Organic Compounds (µg/kg)								
cis-1,2-Dichloroethylene	156-59-2	0/13	None	None	None	None	No	Not Detected
cis-1,3-Dichloropropene	542-75-6	0/13	None	None	None	None	No	Not Detected
Dibromochloromethane	124-48-1	0/13	None	None	None	None	No	Not Detected
Ethylbenzene	100-41-4	0/13	None	None	None	None	No	Not Detected
m,p-Xylene	106-42-3	0/13	None	None	None	None	No	Not Detected
Methylene Chloride	75-09-2	0/13	None	None	None	None	No	Not Detected
o-Xylene	95-47-6	0/13	None	None	None	None	No	Not Detected
Styrene	100-42-5	0/13	None	None	None	None	No	Not Detected
Methyl Tert-Butyl Ether	1634-04-4	0/3	None	None	None	None	No	Not Detected
Tetrachloroethene	127-18-4	0/13	None	None	None	None	No	Not Detected
Toluene	108-88-3	0/13	None	None	None	None	No	Not Detected
trans-1,2-Dichloroethene	156-60-5	0/13	None	None	None	None	No	Not Detected
trans-1,3-Dichloropropene	10061-02-6	0/13	None	None	None	None	No	Not Detected
Trichloroethene	79-01-6	0/13	None	None	None	None	No	Not Detected
Vinyl Chloride	75-01-4	0/13	None	None	None	None	No	Not Detected
Xylenes, Total	1330-20-7	0/13	None	None	None	None	No	Not Detected
Semivolatile Organic Compounds (µg/kg)								
2-Methylnaphthalene	95-48-7	**13/13**	**1.2**	**3.7**	**2.50**	**None**	**Yes**	**Detected Organic**
Acenaphthene	83-32-9	**9/13**	**0.52**	**2**	**1.26**	**None**	**Yes**	**Detected Organic**
Acenaphthylene	208-96-8	**1/13**	**0.46**	**0.46**	**0.46**	**None**	**Yes**	**Detected Organic**
Anthracene	120-12-7	**6/13**	**1**	**7.5**	**4.25**	**None**	**Yes**	**Detected Organic**
Benzo(a)anthracene	56-55-3	**8/13**	**1.5**	**16**	**8.75**	**None**	**Yes**	**Detected Organic**
Benzo(a)pyrene	50-32-8	**12/13**	**0.45**	**6.8**	**3.62**	**None**	**Yes**	**Detected Organic**
Benzo(b)fluoranthene	205-99-2	**13/13**	**3.2**	**16**	**9.60**	**None**	**Yes**	**Detected Organic**
Benzo(g,h,i)perylene	191-24-2	**13/13**	**1.5**	**8.3**	**4.90**	**None**	**Yes**	**Detected Organic**

Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013, at CC RVAAP-83 (continued)

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[a]	SRC (Yes/No)	SRC Justification	Analyte
Semivolatile Organic Compounds (µg/kg)								
Benzo(k)fluoranthene	207-08-9	**8/13**	**0.57**	**3.1**	**1.83**	**None**	**Yes**	**Detected Organic**
Chrysene	218-01-9	**13/13**	**4.1**	**16**	**10.05**	**None**	**Yes**	**Detected Organic**
Dibenz(a,h)anthracene	53-70-3	**13/13**	**0.57**	**1.9**	**1.23**	**None**	**Yes**	**Detected Organic**
Fluoranthene	206-44-0	**13/13**	**1.1**	**24**	**12.55**	**None**	**Yes**	**Detected Organic**
Fluorene	86-73-7	**12/13**	**0.49**	**2.9**	**1.69**	**None**	**Yes**	**Detected Organic**
Indeno(1,2,3-c,d)Pyrene	193-39-5	**13/13**	**0.58**	**5.2**	**2.89**	**None**	**Yes**	**Detected Organic**
Naphthalene	91-20-3	**13/13**	**1.5**	**3.7**	**2.60**	**None**	**Yes**	**Detected Organic**
Phenanthrene	85-01-8	**13/13**	**3.9**	**23**	**13.45**	**None**	**Yes**	**Detected Organic**
Pyrene	129-00-0	**13/13**	**0.72**	**18**	**9.36**	**None**	**Yes**	**Detected Organic**
2,4-Dimethylphenol	105-67-9	0/13	None	None	None	None	No	Not Detected
2,4-Dichlorophenol	120-83-2	0/13	None	None	None	None	No	Not Detected
2,4,5-Trichlorophenol	95-95-4	0/13	None	None	None	None	No	Not Detected
2,4,6-Trichlorophenol	88-06-2	0/13	None	None	None	None	No	Not Detected
3,3'-Dichlorobenzidine	91-94-1	0/13	None	None	None	None	No	Not Detected
Phenol	108-95-2	0/13	None	None	None	None	No	Not Detected
1,4-Dichlorobenzene	106-46-7	0/13	None	None	None	None	No	Not Detected
1,3-Dichlorobenzene	541-73-1	0/13	None	None	None	None	No	Not Detected
1,2,4-Trichlorobenzene	120-82-1	0/13	None	None	None	None	No	Not Detected
3-Nitroaniline	99-09-2	0/13	None	None	None	None	No	Not Detected
2-Chloronaphthalene	91-58-7	0/13	None	None	None	None	No	Not Detected
Bis(2-chloroethoxy)methane	111-91-1	0/13	None	None	None	None	No	Not Detected
2-Nitroaniline	88-74-4	0/13	None	None	None	None	No	Not Detected
1,2-Dichlorobenzene	95-50-1	0/13	None	None	None	None	No	Not Detected
2,4-Dinitrotoluene	121-14-2	0/13	None	None	None	None	No	Not Detected

Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013, at CC RVAAP-83 (continued)

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[(a)]	SRC (Yes/No)	SRC Justification	Analyte
Semivolatile Organic Compounds (µg/kg)								
2,6-Dinitrotoluene	606-20-2	0/13	None	None	None	None	No	Not Detected
Dibenzofuran	132-64-9	0/13	None	None	None	None	No	Not Detected
Pentachlorophenol	87-86-5	0/13	None	None	None	None	No	Not Detected
4-Bromophenyl phenyl ether	101-55-3	0/13	None	None	None	None	No	Not Detected
Bis(2-chloroethyl) ether	111-44-4	0/13	None	None	None	None	No	Not Detected
4-Chlorophenyl phenyl ether	7005-72-3	0/13	None	None	None	None	No	Not Detected
2,4-Dinitrophenol	51-28-5	0/13	None	None	None	None	No	Not Detected
2-Methyl-4,6-dinitrophenol	534-52-1	0/13	None	None	None	None	No	Not Detected
Carbazole	86-74-8	0/13	None	None	None	None	No	Not Detected
Hexachlorobenzene	118-74-1	0/13	None	None	None	None	No	Not Detected
2-Nitrophenol	88-75-5	0/13	None	None	None	None	No	Not Detected
Benzoic acid	65-85-0	0/13	None	None	None	None	No	Not Detected
4-Nitroaniline	100-01-6	0/13	None	None	None	None	No	Not Detected
Bis(2-chloroisopropyl) ether	108-60-1	0/13	None	None	None	None	No	Not Detected
Hexachloroethane	67-72-1	0/13	None	None	None	None	No	Not Detected
2-Chlorophenol	95-57-8	0/13	None	None	None	None	No	Not Detected
4-Chloro-3-methylphenol	59-50-7	0/13	None	None	None	None	No	Not Detected
4-Chloroaniline	106-47-8	0/13	None	None	None	None	No	Not Detected
4-Nitrophenol	100-02-7	0/13	None	None	None	None	No	Not Detected
2-Methylphenol	95-48-7	0/13	None	None	None	None	No	Not Detected
N-Nitrosodiphenylamine	86-30-6/122-39-4	0/13	None	None	None	None	No	Not Detected
Isophorone	78-59-1	0/13	None	None	None	None	No	Not Detected
Hexachlorocyclopentadiene	77-47-4	0/13	None	None	None	None	No	Not Detected

Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013, at CC RVAAP-83 (continued)

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[a]	SRC (Yes/No)	SRC Justification	Analyte
Semivolatile Organic Compounds (µg/kg)								
Di-n-octyl phthalate	117-84-0	**1/13**	**91**	**91**	**91**	**None**	**Yes**	**Detected Organic**
Nitrobenzene	98-95-3	0/13	None	None	None	None	No	Not Detected
Hexachlorobutadiene	87-68-3	0/13	None	None	None	None	No	Not Detected
Dimethyl phthalate	131-11-3	0/13	None	None	None	None	No	Not Detected
Diethyl phthalate	84-66-2	0/13	None	None	None	None	No	Not Detected
4-Methylphenol	1319-77-3	0/13	None	None	None	None	No	Not Detected
N-Nitroso-di-n-propylamine	621-64-7	0/13	None	None	None	None	No	Not Detected
Butylbenzyl phthalate	85-68-7	0/13	None	None	None	None	No	Not Detected
Benzyl alcohol	100-51-6	0/13	None	None	None	None	No	Not Detected
Di-n-butyl phthalate	84-74-2	**2/13**	**90**	**140**	**115**	**None**	**Yes**	**Detected Organic**
Pesticides (µg/kg)								
Aldrin	309-00-2	0/1	None	None	None	None	No	Not Detected
alpha-BHC	319-84-6	0/1	None	None	None	None	No	Not Detected
alpha-Chlordane	5103-71-9	0/1	None	None	None	None	No	Not Detected
alpha-Endosulfan	959-98-8	0/1	None	None	None	None	No	Not Detected
beta-BHC	319-85-7	0/1	None	None	None	None	No	Not Detected
beta-Endosulfan	33213-65-9	0/1	None	None	None	None	No	Not Detected
delta-BHC	**75-99-0**	**1/1**	**1.1**	**1.1**	**1.10**	**None**	**Yes**	**Detected Organic**
Dieldrin	60-57-1	0/1	None	None	None	None	No	Not Detected
Endosulfan Sulfate	1031-07-8	0/1	None	None	None	None	No	Not Detected
Endrin	72-20-8	0/1	None	None	None	None	No	Not Detected
Endrin Aldehyde	7421-93-4	0/1	None	None	None	None	No	Not Detected
Endrin Ketone	53494-70-5	0/1	None	None	None	None	No	Not Detected
gamma-BHC (Lindane)	58-89-9	0/1	None	None	None	None	No	Not Detected
gamma-Chlordane	5566-34-7	0/1	None	None	None	None	No	Not Detected

Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013, at CC RVAAP-83 (continued)

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[a]	SRC (Yes/No)	SRC Justification	Analyte
Pesticides (µg/kg)								
Heptachlor	76-44-8	0/1	None	None	None	None	No	Not Detected
Heptachlor Epoxide	1024-57-3	0/1	None	None	None	None	No	Not Detected
Methoxychlor	72-43-5	0/1	None	None	None	None	No	Not Detected
p,p'-DDD	72-54-8	0/1	None	None	None	None	No	Not Detected
p,p'-DDE	72-55-9	0/1	None	None	None	None	No	Not Detected
p,p'-DDT	50-29-3	0/1	None	None	None	None	No	Not Detected
Toxaphene	8001-35-2	0/1	None	None	None	None	No	Not Detected
Polychlorinated Biphenyls (µg/kg)								
PCB-1016 (Arochlor 1016)	12674-11-2	0/1	None	None	None	None	No	Not Detected
PCB-1221 (Arochlor 1221)	11104-28-2	0/1	None	None	None	None	No	Not Detected
PCB-1232 (Arochlor 1232)	11141-16-5	0/1	None	None	None	None	No	Not Detected
PCB-1242 (Arochlor 1242)	53469-21-9	0/1	None	None	None	None	No	Not Detected
PCB-1248 (Arochlor 1248)	12672-29-6	0/1	None	None	None	None	No	Not Detected
PCB-1254 (Arochlor 1254)	11097-69-1	0/1	None	None	None	None	No	Not Detected
PCB-1260 (Arochlor 1260)	11096-82-5	0/1	None	None	None	None	No	Not Detected
PCB-1262 (Arochlor 1262)	37324-23-5	0/1	None	None	None	None	No	Not Detected
PCB-1268 (Arochlor 1268)	11100-14-4	0/1	None	None	None	None	No	Not Detected
Explosives (mg/kg)								
1,3,5-Trinitrobenzene	99-35-4	0/13	None	None	None	None	No	Not Detected
1,3-Dinitrobenzene	99-65-0	0/13	None	None	None	None	No	Not Detected
2,4,6-Trinitrotoluene	118-96-7	0/13	None	None	None	None	No	Not Detected
2,4-Dinitrotoluene	121-14-2	0/13	None	None	None	None	No	Not Detected
2,6-Dinitrotoluene	606-20-2	0/13	None	None	None	None	No	Not Detected
2-Amino-4,6-dinitrotoluene	35572-78-2	0/13	None	None	None	None	No	Not Detected
2-Nitrotoluene	99-08-1	0/13	None	None	None	None	No	Not Detected
3,5-Dinitroaniline	618-87-1	0/13	None	None	None	None	No	Not Detected

Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013, at CC RVAAP-83 (continued)

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[(a)]	SRC (Yes/No)	SRC Justification	Analyte
Explosives (mg/kg)								
3-Nitrotoluene	88-72-2	0/13	None	None	None	None	No	Not Detected
4-Amino-2,6-Dinitrotoluene	19406-51-0	0/13	None	None	None	None	No	Not Detected
4-Nitrotoluene	99-99-0	0/13	None	None	None	None	No	Not Detected
Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	121-82-4	0/13	None	None	None	None	No	Not Detected
Nitrobenzene	98-95-3	0/13	None	None	None	None	No	Not Detected
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	2691-41-0	0/13	None	None	None	None	No	Not Detected
Pentaerythritol Tetranitrate	78-11-5	0/13	None	None	None	None	No	Not Detected
Tetryl	479-45-8	0/13	None	None	None	None	No	Not Detected
Propellants (mg/kg)								
Nitroguanidine	556-88-7	0/13	None	None	None	None	No	Not Detected
Nitroglycerin	55-63-0	0/13	None	None	None	None	No	Not Detected
Nitrocellulose	9004-70-0	0/13	None	None	None	None	No	Not Detected
Metals (mg/kg)								
Aluminum	7429-90-5	13/13	2,020	17,900	9,960	19,500	No	Below Background
Antimony	7440-36-0	**13/13**	**0.84**	**1.3**	**1.07**	**0.96**	**Yes**	**Exceeds Background**
Arsenic	7440-38-2	13/13	1.9	18.2	10.05	19.8	No	Below Background
Barium	7440-39-3	13/13	11.7	110	60.85	124	No	Below Background
Beryllium	7440-41-7	**13/13**	**0.1**	**0.92**	**0.51**	**0.88**	**Yes**	**Exceeds Background**
Cadmium	7440-43-9	**1/13**	**0.046**	**0.046**	**0.05**	**0**	**Yes**	**Exceeds Background**
Calcium**	7440-70-2	13/13	6,030	46,700	26,365	35,500	No	Essential Nutrient
Chromium	7440-47-3	13/13	3.1	25.5	14.30	27.2	No	Below Background
Cobalt	7440-48-4	13/13	1.8	15.8	8.80	23.2	No	Below Background
Copper	7440-50-8	13/13	3.5	25.4	14.45	32.3	No	Below Background
Iron**	7439-89-6	13/13	4,310	39,100	21,705	35,200	No	Essential Nutrient
Lead	7439-92-1	**13/13**	**1.7**	**21**	**11.35**	**19.1**	**Yes**	**Exceeds Background**

Table 5-1: Site-Related Chemical Determination for Subsurface Soil Results, August 2013 (continued)

Analyte	CAS Number	Frequency of Detects	Minimum Detect	Maximum Detect	Background Criteria[a]	SRC (Yes/No)	SRC Justification
Magnesium**	7439-95-4	13/13	1,480	11,000	8,790	No	Essential Nutrient
Manganese	7439-96-5	13/13	65.2	594	3,030	No	Below Background
Mercury	7439-97-6	13/13	0.0063	0.034	0.044	No	Below Background
Nickel	7440-02-0	13/13	4.9	37.9	60.7	No	Below Background
Potassium**	7440-09-7	13/13	1,200	1,670	3,350	No	Essential Nutrient
Selenium	7782-49-2	0/13	None	None	None	No	Not Detected
Silver	7440-22-4	0/13	None	None	None	No	Not Detected
Thallium	7440-28-0	0/13	None	None	0.91	No	Not Detected
Sodium**	7440-23-5	13/13	49.2	96.4	145	No	Essential Nutrient
Vanadium	7440-62-2	12/13	14.7	25.6	37.6	No	Below Background
Zinc	7440-66-6	13/13	10	85	93.3	No	Below Background

Notes:

(a) The background concentrations for metals shown in this table were obtained from two sources: (1) The *Final Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant* (Science International Applications Corporation 2010), and (2) *Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (Science Applications International Corporation 2001).

Bold indicates analyte identified as an SRC.

Asterisk (**) denotes the chemical is an essential nutrient.

µg/kg = Microgram per kilogram.
BHC = Hexachlorocyclohexane.
CAS = Chemical abstract number.
DDD = p,p'-Dichlorodiphenyldichloroethane.
DDE = p,p'-Dichlorodiphenyldichloroethylene.
DDT = 1,1,1-trichloro-2,2-di(4-chlorophenyl)ethane.
mg/kg = Milligram per kilogram.
PCB = Polychlorinated biphenyl.
SRC = Site-related chemical.

Table 5-2: Summary of Analytical Results for Organic Chemicals Detected in Subsurface Soil Samples Collected August 2013 at CC RVAAP-83

						Sample Type:	Primary	Primary	Primary	Primary	Primary
						Location ID:	83-1039-DU1-SB	83-1039-DU1-SB	83-1039-DU1-SB	83-1039-DU1-SB1	83-1039-DU1-SB2
						Field Sample ID:	083SB-0001M-0001-SO	083SB-0002M-0001-SO	083SB-0015M-0001-SO	083SB-0003M-0001-SO	083SB-0004M-0001-SO
						Lab Sample ID:	337811	337812	337834	337813	337815
						Sample Date:	08/12/2013	08/12/2013	08/12/2013	08/12/2013	08/12/2013
						Location Type:	Horizontal ISM	Horizontal ISM	Horizontal ISM	Vertical ISM	Vertical ISM
						Sample Depth	1-4	4-7	7-10	4-10	4-10
		Facility-Wide Cleanup Goals			**USEPA RSL**						
			Resident Receptor								
Method/Chemical	**BKG**	**National Guard Trainee**	**Resident Child**	**Resident Adult**	**Industrial**	**Residential**					
Semivolatile Organic Compounds (µg/kg)											
2-Methylnaphthalene	None	2,384,000*	30,600*	238,000*			**3.1**	**1.5**	**2.9**	**1.2 J**	**1.6**
Acenaphthene	None	None	None	None	3,300,000	340,000	**1.3 J**	**1.2 J**	**0.52 J**	ND	**2.0**
Acenaphthylene	None	None	None	None	None	None	**0.46 J**	ND	ND	ND	ND
Anthracene	None	None	None	None	17,000,000	1,700,000	**1.1 J**	**2.4**	ND	**1.0 J**	**3.8**
Benzo(a)anthracene	None	4,770	650	221			**4.7**	**5.3**	ND	**1.5 J**	**16.0**
Benzo(a)pyrene	None	477	65	22			**2.6**	**2.1**	**0.59 J**	**0.78 J**	**6.8**
Benzo(b)fluoranthene	None	4,770	650	221			**6.7**	**6.0**	**4.7**	**4.5**	**16.0**
Benzo(g,h,i)perylene	None	None	None	None	None	None	**4.5**	**3.5**	**4.1**	**2.6**	**8.3**
Benzo(k)fluoranthene	None	47,700	6,500	2,210			**1.8**	**1.3 J**	ND	**0.70 J**	**3.1**
Chrysene	None	477,000	65,000	22,100			**4.1**	**5.6**	**12.0**	**7.6**	**14.0 J**
Dibenz(a,h)anthracene	None	477	65	22			**1.1 J**	**0.82 J**	**0.68 J**	**0.62 J**	**1.9**
Di-n-Butyl Phthalate	None	None	None	None	6,200,000	610,000	**140 J**	**90 J**	ND	ND	ND
Di-n-Octylphthalate	None	None	None	None	620,000	61,000	ND	**91 J**	ND	ND	ND
Fluoranthene	None	5,087,00*	163,000*	276,000*			**7.4**	**7.5**	**1.8**	**2.3**	**24.0 J**
Fluorene	None	11,458,000*	243,000*	737,000*			**2.9**	**1.2 J**	**0.67 J**	**0.56 J**	**1.3 J**
Indeno(1,2,3-c,d)pyrene	None	4,770	650	221			**3.2**	**2.2**	**1.1 J**	**1.3 J**	**5.2**
Naphthalene	None	1,541,000*	122,000*	368,000*			**2.6**	**1.9**	**2.6**	**1.5 J**	**1.8**
Phenanthrene	None	None	None	None	None	None	**9.2**	**7.3**	**9.1**	**4.6**	**16.0**
Pyrene	None	3,815,000*	122,000*	207,000*			**5.9**	**5.9**	**1.8**	**2.0**	**18.0**
Pesticides (µg/kg)											
delta-BHC (delta-Hexachlorocyclohexane)	None	None	None	None	None	None	NS	NS	NS	NS	NS

Table 5-2: Summary of Analytical Results for Organic Chemicals Detected in Subsurface Soil Samples Collected August 2013 at CC RVAAP-83 (continued)

						Sample Type:	Primary	Duplicate	Primary	Primary
						Location ID:	83-1039-DU1-SB3	83-1039-DU1-SB3 (FD)	83-1039-DU1-SB4	83-1039-DU1-SB5
						Field Sample ID:	083SB-0005M-0001-SO	083SB-0006M-0001-SO	083SB-0008M-0001-SO	083SB-0009M-0001-SO
						Lab Sample ID:	337818	337820	337822	337824
						Sample Date:	08/12/2013	08/12/2013	08/12/2013	08/12/2013
						Location Type:	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM
						Sample Depth	4-10	4-10	4-10	4-10
		Facility-Wide Cleanup Goals			**USEPA RSL**					
			Resident Receptor							
Method/Chemical	**BKG**	**National Guard Trainee**	**Resident Child**	**Resident Adult**	**Industrial**	**Residential**				
Semivolatile Organic Compounds (µg/kg)										
2-Methylnaphthalene	None	2,384,000*	30,600*	238,000*			**1.9**	**2.0**	**1.7**	**2.8**
Acenaphthene	None	None	None	None	3,300,000	340,000	**0.78 J**	**0.71 J**	ND	**0.54 J**
Acenaphthylene	None	None	None	None	None	None	ND	ND	ND	ND
Anthracene	None	None	None	None	17,000,000	1,700,000	**2.1**	**7.5**	ND	ND
Benzo(a)anthracene	None	4,770	650	221			**7.3**	**11.0**	ND	**2.3**
Benzo(a)pyrene	None	477	65	22			**3.2**	**1.4 J**	**0.45 J**	**1.2 J**
Benzo(b)fluoranthene	None	4,770	650	221			**8.9**	**5.1**	**4.5**	**5.7**
Benzo(g,h,i)perylene	None	None	None	None	None	None	**6.0**	**3.8**	**3.0**	**5.4**
Benzo(k)fluoranthene	None	47,700	6,500	2,210			**1.9**	**0.98 J**	ND	**0.57 J**
Chrysene	None	477,000	65,000	22,100			**8.3**	**8.3**	**9.4**	**9.6**
Dibenz(a,h)anthracene	None	477	65	22			**1.2 J**	**0.75 J**	**0.57 J**	**0.91 J**
Di-n-Butyl Phthalate	None	None	None	None	6,200,000	610,000	ND	ND	ND	ND
Di-n-Octylphthalate	None	None	None	None	620,000	61,000	ND	ND	ND	ND
Fluoranthene	None	5,087,00*	163,000*	276,000*			**10.0**	**4.1**	**1.5 J**	**3.1**
Fluorene	None	11,458,000*	243,000*	737,000*			**0.93 J**	**0.74 J**	**0.62 J**	**0.54 J**
Indeno(1,2,3-c,d)pyrene	None	4,770	650	221			**3.6**	**1.8**	**1.1 J**	**1.9**
Naphthalene	None	1,541,000*	122,000*	368,000*			**2.0**	**2.6**	**1.7**	**2.9**
Phenanthrene	None	None	None	None	None	None	**11.0**	**7.7**	**4.7**	**7.4**
Pyrene	None	3,815,000*	122,000*	207,000*			**8.1**	**3.6**	**1.4 J**	**3.2**
Pesticides (µg/kg)										
delta-BHC (delta-Hexachlorocyclohexane)	None	None	None	None	None	None	NS	NS	NS	NS

Table 5-2: Summary of Analytical Results for Organic Chemicals Detected in Subsurface Soil Samples Collected August 2013 at CC RVAAP-83 (continued)

						Sample Type:	Primary	Primary	Primary	Primary
						Location ID:	83-1039-DU1-SB5	83-1039-DU1-SB6	83-1039-DU1-SB7	83-1039-DU1-SB8
						Field Sample ID:	083SB-0014-0001-SO	083SB-0011M-0001-SO	083SB-0012M-0001-SO	083SB-0013M-0001-SO
						Lab Sample ID:	337832	337826	337828	337830
						Sample Date:	08/12/2013	08/12/2013	08/12/2013	08/12/2013
						Location Type:	DSB Composite	Vertical ISM	Vertical ISM	Vertical ISM
						Sample Depth	7-13	4-10	4-10	4-10
		Facility-Wide Cleanup Goals			**USEPA RSL**					
			Resident Receptor							
Method/Chemical	**BKG**	**National Guard Trainee**	**Resident Child**	**Resident Adult**	**Industrial**	**Residential**				
Semivolatile Organic Compounds (µg/kg)										
2-Methylnaphthalene	None	2,384,000*	30,600*	238,000*			**3.7**	**2.2**	**2.1**	**1.8**
Acenaphthene	None	None	None	None	3,300,000	340,000	ND	**0.54 J**	**0.57 J**	ND
Acenaphthylene	None	None	None	None	None	None	ND	ND	ND	ND
Anthracene	None	None	None	None	17,000,000	1,700,000	ND	ND	ND	ND
Benzo(a)anthracene	None	4,770	650	221			ND	ND	**2.8**	ND
Benzo(a)pyrene	None	477	65	22			**0.68 J**	**0.75 J**	**1.4 J**	ND
Benzo(b)fluoranthene	None	4,770	650	221			**5.9**	**3.9**	**5.6**	**3.2**
Benzo(g,h,i)perylene	None	None	None	None	None	None	**6.5**	**4.3**	**3.6**	**1.5**
Benzo(k)fluoranthene	None	47,700	6,500	2,210			ND	ND	**0.95 J**	ND
Chrysene	None	477,000	65,000	22,100			**16.0**	**8.6**	**8.3**	**6.5**
Dibenz(a,h)anthracene	None	477	65	22			**0.89 J**	**0.60 J**	**0.66 J**	**0.65 J**
Di-n-Butyl Phthalate	None	None	None	None	6,200,000	610,000	ND	ND	ND	ND
Di-n-Octylphthalate	None	None	None	None	620,000	61,000	ND	ND	ND	ND
Fluoranthene	None	5,087,00*	163,000*	276,000*			**2.5**	**1.5 J**	**4.5**	**1.1 J**
Fluorene	None	11,458,000 *	243,000*	737,000*			ND	**0.49 J**	**0.66 J**	**0.50 J**
Indeno(1,2,3-c,d)pyrene	None	4,770	650	221			**1.4 J**	**1.3 J**	**1.7**	**0.58 J**
Naphthalene	None	1,541,000*	122,000*	368,000*			**3.7**	**2.2**	**2.4**	**2.8**
Phenanthrene	None	None	None	None	None	None	**23.0**	**6.4**	**9.1**	**3.9**
Pyrene	None	3,815,000*	122,000*	207,000*			**2.6**	**1.8**	**3.6**	**0.72 J**
Pesticides (µg/kg)										
delta-BHC (delta-Hexachlorocyclohexane)	None	None	None	None	None	None	NS	NS	**1.1 J**	NS

Notes:
Yellow shading of a result indicates concentration is greater than the FWCUG for the most stringent Resident Receptor.
The FWCUGs used for data comparison are the values for the most stringent Resident Receptor FWCUG between the adult and the child receptor using the Target Cancer Risk (TCR) level of 10^{-6}. The RSLs shown are also the values for the TCR 10^{-6}. Any exceptions are noted with an asterisk (*).
Asterisk (*) indicates non-carcinogenic FWCUGs and RSLs using the Target Hazard Quotient (THQ) = 0.1).
Bold indicates chemical detected.
µg/kg = Micrograms per kilogram.
BKG = Background.
DU = Decision Unit.
ft = Feet.
FWCUG = Facility-Wide Cleanup Goal (Science Applications International Corporation 2010).
ID = Identification.
ISM = Incremental sampling methodology.
J = Estimated value less than reporting limits.
mg/kg = Milligram per kilogram.
NA = Not applicable.
ND = Not detected at the Limit of Detection.
NS = Not sampled.
RSL = Regional Screening Level (USEPA 2014).
RSLs are presented only for chemicals without Resident Receptor FWCUGs.
USEPA = United States Environmental Protection Agency.
Note: The National Guard Trainee FWCUGs and the Industrial RSLs are shown on this table for comparison purposes only.

Table 5-3: Summary of Analytical Results for Inorganic Chemicals Detected in Subsurface Soil Samples Collected August 2013 at CC RVAAP-83

						Sample Type:	Primary	Primary	Primary	Primary	Primary	Primary
						Location ID:	83-1039-DU1-SB	83-1039-DU1-SB	83-1039-DU1-SB	83-1039-DU1-SB1	83-1039-DU1-SB2	83-1039-DU1-SB3
						Field Sample ID:	083SB-0001M-0001-SO	083SB-0002M-0001-SO	083SB-0015M-0001-SO	083SB-0003M-0001-SO	083SB-0004M-0001-SO	083SB-0005M-0001-SO
						Lab Sample ID:	337811	337812	337834	337813	337815	337818
						Sample Date:	08/12/2013	08/12/2013	08/12/2013	08/12/2013	08/12/2013	08/12/2013
						Location Type:	Horizontal ISM	Horizontal ISM	Horizontal ISM	Vertical ISM	Vertical ISM	Vertical ISM
						Sample Depth (ft)	1-4	4-7	7-10	4-10	4-10	4-10
		Facility-Wide Cleanup Goals			**USEPA RSL**							
			Resident Receptor									
Method/Chemical	**BKG**	**National Guard Trainee**	**Resident Child**	**Resident Adult**	**Industrial**	**Residential**						
Metals (mg/kg)												
Aluminum	19,500	3,496*	7,380*	52,923*			**11,300**	**12,300**	**2,020**	**17,900**	**10,900**	**12,500**
Antimony	0.96	175*	2.82*	13.6*			**1.0**	**1.1**	**0.86 J**	**0.96**	**1.0 J**	**1.2 J**
Arsenic	19.8	2.78	0.524	0.425			**13.9**	**16.6**	**1.9**	**18.2**	**13.3 J**	**13.9**
Barium	124	351*	1,413*	8,966*			**73.5 J**	**83.4 J**	**11.7 J**	**110 J**	**76.5 J**	**78.1 J**
Beryllium	0.88	None	None	None	200	16	**0.65**	**0.67**	**0.10**	**0.92**	**0.56 J**	**0.68 J**
Cadmium	0	10.9	6.41*	22.3*			ND	ND	ND	ND	ND	ND
Calcium**	35,500	None	None	None	None	None	**23,100**	**31,900**	**6,030**	**46,700**	**31,600**	**28,900 J**
Chromium	27.2	329,763*	8,174*	19,694*			**17.0**	**18.7**	**3.1**	**25.5**	**15.4 J**	**18.3 J**
Cobalt	23.2	7.03	131*	803			**11.9**	**13.7**	**1.8**	**15.8**	**11.1 J**	**11.8 J**
Copper	32.3	25,368*	311*	2,714*			**20.2**	**20.7**	**3.5**	**25.4**	**14.2 J**	**21.3 J**
Iron**	35,200	184,370*	2,313*	19,010*			**24,800**	**27,800**	**4,310**	**39,100**	**25,100**	**27,200**
Lead	19.1	None	None	None	800	400	**21.0**	**12.2**	**1.7**	**16.6**	**8.5 J**	**11.8 J**
Magnesium**	8,790	None	None	None	None	None	**6,070 J**	**8,100 J**	**1,480 J**	**11,000 J**	**6,720 J**	**7,530 J**
Manganese	3,030	35.1*	293*	1,482*			**432**	**515**	**65.2**	**594**	**481**	**428**
Mercury	0.044	172*	2.27*	16.5*			**0.034 J**	**0.010 J**	**0.0076 J**	**0.0090 J**	**0.0072 J**	**0.013 J**
Nickel	60.7	12,639*	155*	1,346*			**27.8**	**31.4**	**4.9**	**37.9**	**24.5 J**	**29.2 J**
Potassium**	3,350	None	None	None	None	None	**1,200**	**1,420**	**1,670**	**1,590**	**1,660**	**1,300**
Sodium **	145	None	None	None	None	None	**49.2**	**68.2**	**87.5**	**66.6**	**67.0**	**55.2**
Vanadium	37.6	2,304*	44.9*	156*			**18.3**	**18.5**	ND	**25.6**	**15.5 J**	**18.8 J**
Zinc	93.3	187,269*	2,321*	19,659*			**60.3**	**63.0**	**10.0**	**85.0**	**46.1 J**	**70.2 J**

Table 5-3: Summary of Analytical Results for Inorganic Chemicals Detected in Subsurface Soil Samples Collected August 2013 at CC RVAAP-83 (Continued)

						Sample Type:	Duplicate	Primary	Primary	Primary	Primary	Primary	Primary
						Location ID:	83-1039-DU1-SB3 (FD)	83-1039-DU1-SB4	83-1039-DU1-SB5	83-1039-DU1-SB5	83-1039-DU1-SB6	83-1039-DU1-SB7	83-1039-DU1-SB8
						Field Sample ID:	083SB-0006M-0001-SO	083SB-0008M-0001-SO	083SB-0009M-0001-SO	083SB-0014-0001-SO	083SB-0011M-0001-SO	083SB-0012M-0001-SO	083SB-0013M-0001-SO
						Lab Sample ID:	337820	337822	337824	337832	337826	337828	337830
						Sample Date:	08/12/2013	08/12/2013	08/12/2013	08/12/2013	08/12/2013	08/12/2013	08/12/2013
						Location Type:	Vertical ISM	Vertical ISM	Vertical ISM	DSB Composite	Vertical ISM	Vertical ISM	Vertical ISM
						Sample Depth (ft)	4-10	4-10	4-10	7-13	4-10	4-10	4-10
		Facility-Wide Cleanup Goals			**USEPA RSL**								
		National Guard Trainee	**Resident Receptor**										
Method/Chemical	**BKG**		**Resident Child**	**Resident Adult**	**Industrial**	**Residential**							
Metals (mg/kg)													
Aluminum	19,500	3,496*	7,380*	52,923*			**10,800**	**12,500**	**11,600**	**8,880**	**11,200**	**11,300**	**10,100**
Antimony	0.96	175*	2.82*	13.6*			**1.0 J**	**0.92 J**	**0.92 J**	**0.84 J**	**1.0 J**	**1.1 J**	**1.3 J**
Arsenic	19.8	2.78	0.524	0.425			**12.6**	**11.7**	**11.6**	**7.0**	**12.6**	**11.1**	**11.0**
Barium	124	351*	1,413*	8,966*			**70.2 J**	**80.4 J**	**76.2 J**	**56.3 J**	**79.8 J**	**76.6 J**	**58.6 J**
Beryllium	0.88	None	None	None	200	16	**0.61**	**0.64**	**0.59**	**0.47**	**0.58**	**0.57**	**0.53**
Cadmium	0	10.9	6.41*	22.3*			**0.046 J**	ND	ND	ND	ND	ND	ND
Calcium**	35,500	None	None	None	None	None	**24,400**	**36,200**	**30,500**	**25,200**	**33,900**	**32,200**	**27,400**
Chromium	27.2	329,763*	8,174*	19,694*			**16.2**	**18.5**	**17.6**	**14.8**	**16.6**	**16.2**	**15.1**
Cobalt	23.2	7.03	131*	803			**11.0**	**12.5**	**11.6**	**6.5**	**12.9**	**8.8**	**9.1**
Copper	32.3	25,368*	311*	2,714*			**19.9**	**20.7**	**19.3**	**11.1**	**18.5**	**16.7**	**16.9**
Iron**	35,200	184,370*	2,313*	19,010*			**23,800**	**26,000**	**25,000**	**19,200**	**24,600**	**24,200**	**22,300**
Lead	19.1	None	None	None	800	400	**10.8**	**11.5**	**10.7**	**6.4**	**9.1**	**9.2**	**8.6**
Magnesium**	8,790	None	None	None	None	None	**6,660 J**	**8,800 J**	**8,030 J**	**4,750 J**	**7,730 J**	**6,980 J**	**6,890 J**
Manganese	3,030	35.1*	293*	1,482*			**380**	**441**	**387**	**275**	**482**	**307**	**314**
Mercury	0.044	172*	2.27*	16.5*			**0.012 J**	**0.0097 J**	**0.0097 J**	**0.0075 J**	**0.0073 J**	**0.0065 J**	**0.0063 J**
Nickel	60.7	12,639*	155*	1,346*			**27.0**	**29.9**	**27.9**	**16.5**	**28.9**	**22.7**	**23.0**
Potassium**	3,350	None	None	None	None	None	**1,250**	**1,610**	**1,570**	**1,630**	**1,580**	**1,480**	**1,480**
Sodium **	145	None	None	None	None	None	**53.7**	**72.6**	**76.1**	**81.6**	**91.1**	**85.3**	**96.4**
Vanadium	37.6	2,304*	44.9*	156*			**16.7**	**18.8**	**17.8**	**14.7**	**16.6**	**16.5**	**15.5**
Zinc	93.3	187,269*	2,321*	19,659*			**64.1**	**62.2**	**58.9**	**33.6**	**54.7**	**51.3**	**48.7**

Notes:
Yellow shading of a result indicates concentration is greater than the FWCUG for the most stringent Resident Receptor.
The FWCUGs used for data comparison are the values for the most stringent Resident Receptor FWCUG between the adult and the child receptor using the Target Cancer Risk (TCR) level of 10^{-6}. The RSLs shown are also the values for the TCR 10^{-6}. Any exceptions are noted with an asterisk (*).
Asterisk (*) indicates non-carcinogenic FWCUGs and RSLs using the Target Hazard Quotient (THQ) = 0.1).
Asterisk (**) denotes the chemical is an essential nutrient.
Bold indicates chemical detected.
BKG = Background.
DU = Decision Unit.
ft = Feet.
FWCUG = Facility-Wide Cleanup Goal (Science Applications International Corporation 2010).
ID = Identification.
ISM = Incremental sampling methodology.
J = Estimated value less than reporting limits.
mg/kg = Milligram per kilogram.
ND = Not detected at the Limit of Detection.
RSL = Regional Screening Level (USEPA 2014).
RSLs are presented only for chemicals without Resident Receptor FWCUGs.
USEPA = United States Environmental Protection Agency.
The National Guard Trainee FWCUGs and the Industrial RSLs are shown on this table for comparison purposes only.

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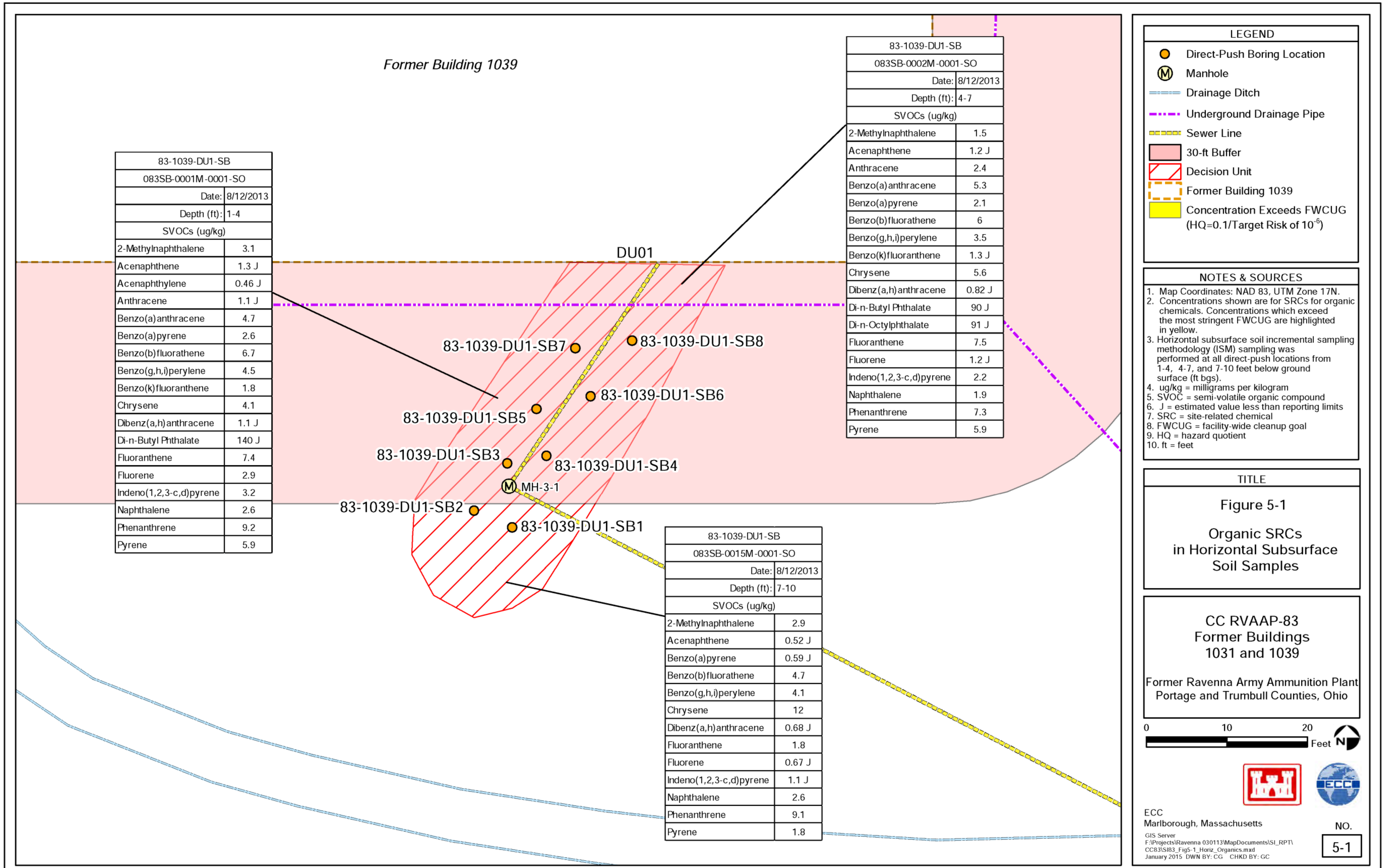

83-1039-DU1-SB	
083SB-0001M-0001-SO	
Date:	8/12/2013
Depth (ft):	1-4
SVOCs (ug/kg)	
2-Methylnaphthalene	3.1
Acenaphthene	1.3 J
Acenaphthylene	0.46 J
Anthracene	1.1 J
Benzo(a)anthracene	4.7
Benzo(a)pyrene	2.6
Benzo(b)fluorathene	6.7
Benzo(g,h,i)perylene	4.5
Benzo(k)fluoranthene	1.8
Chrysene	4.1
Dibenz(a,h)anthracene	1.1 J
Di-n-Butyl Phthalate	140 J
Fluoranthene	7.4
Fluorene	2.9
Indeno(1,2,3-c,d)pyrene	3.2
Naphthalene	2.6
Phenanthrene	9.2
Pyrene	5.9

83-1039-DU1-SB	
083SB-0002M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-7
SVOCs (ug/kg)	
2-Methylnaphthalene	1.5
Acenaphthene	1.2 J
Anthracene	2.4
Benzo(a)anthracene	5.3
Benzo(a)pyrene	2.1
Benzo(b)fluorathene	6
Benzo(g,h,i)perylene	3.5
Benzo(k)fluoranthene	1.3 J
Chrysene	5.6
Dibenz(a,h)anthracene	0.82 J
Di-n-Butyl Phthalate	90 J
Di-n-Octylphthalate	91 J
Fluoranthene	7.5
Fluorene	1.2 J
Indeno(1,2,3-c,d)pyrene	2.2
Naphthalene	1.9
Phenanthrene	7.3
Pyrene	5.9

83-1039-DU1-SB	
083SB-0015M-0001-SO	
Date:	8/12/2013
Depth (ft):	7-10
SVOCs (ug/kg)	
2-Methylnaphthalene	2.9
Acenaphthene	0.52 J
Benzo(a)pyrene	0.59 J
Benzo(b)fluorathene	4.7
Benzo(g,h,i)perylene	4.1
Chrysene	12
Dibenz(a,h)anthracene	0.68 J
Fluoranthene	1.8
Fluorene	0.67 J
Indeno(1,2,3-c,d)pyrene	1.1 J
Naphthalene	2.6
Phenanthrene	9.1
Pyrene	1.8

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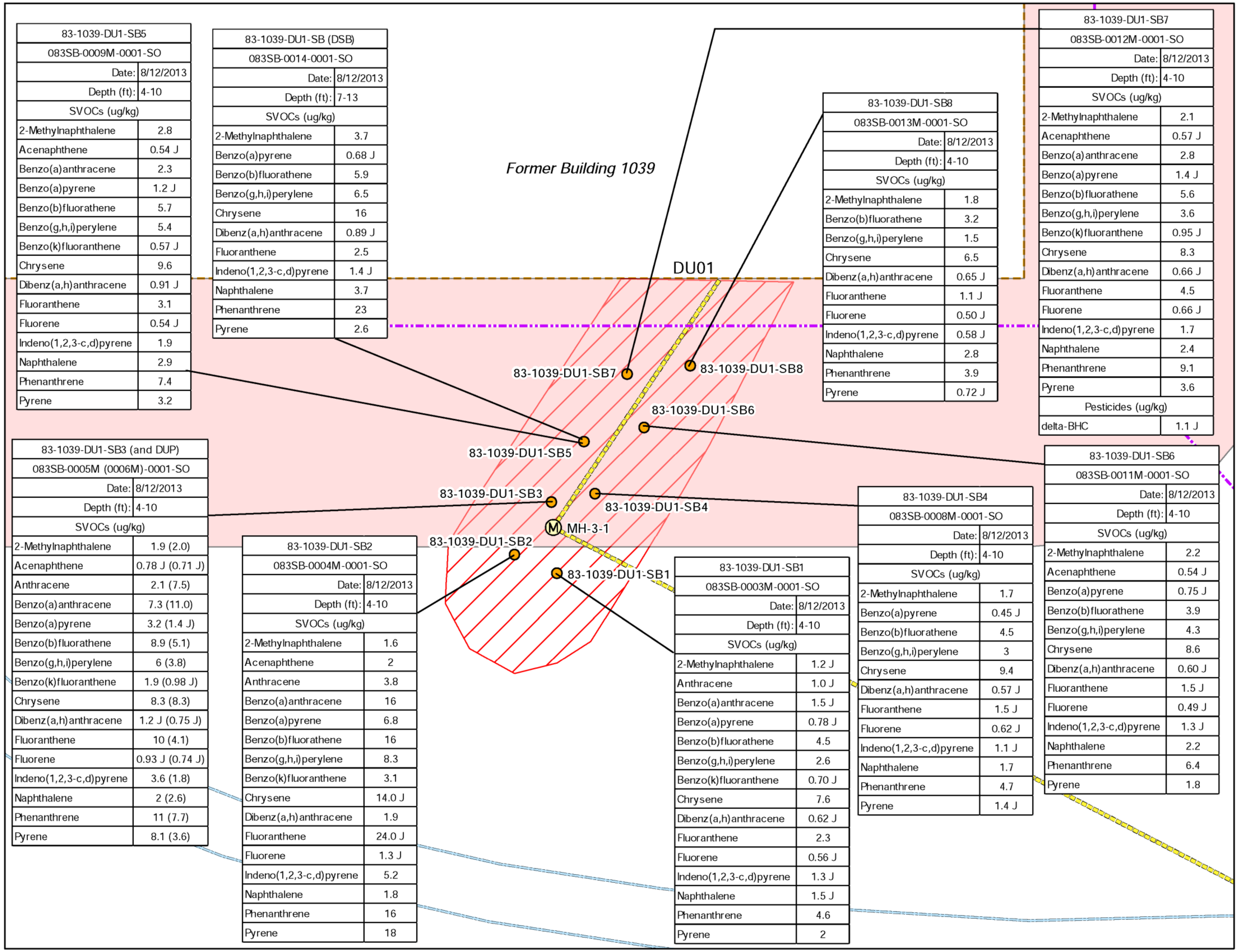

83-1039-DU1-SB5	
083SB-0009M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	2.8
Acenaphthene	0.54 J
Benzo(a)anthracene	2.3
Benzo(a)pyrene	1.2 J
Benzo(b)fluorathene	5.7
Benzo(g,h,i)perylene	5.4
Benzo(k)fluoranthene	0.57 J
Chrysene	9.6
Dibenz(a,h)anthracene	0.91 J
Fluoranthene	3.1
Fluorene	0.54 J
Indeno(1,2,3-c,d)pyrene	1.9
Naphthalene	2.9
Phenanthrene	7.4
Pyrene	3.2

83-1039-DU1-SB (DSB)	
083SB-0014-0001-SO	
Date:	8/12/2013
Depth (ft):	7-13
SVOCs (ug/kg)	
2-Methylnaphthalene	3.7
Benzo(a)pyrene	0.68 J
Benzo(b)fluorathene	5.9
Benzo(g,h,i)perylene	6.5
Chrysene	16
Dibenz(a,h)anthracene	0.89 J
Fluoranthene	2.5
Indeno(1,2,3-c,d)pyrene	1.4 J
Naphthalene	3.7
Phenanthrene	23
Pyrene	2.6

83-1039-DU1-SB8	
083SB-0013M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	1.8
Benzo(b)fluorathene	3.2
Benzo(g,h,i)perylene	1.5
Chrysene	6.5
Dibenz(a,h)anthracene	0.65 J
Fluoranthene	1.1 J
Fluorene	0.50 J
Indeno(1,2,3-c,d)pyrene	0.58 J
Naphthalene	2.8
Phenanthrene	3.9
Pyrene	0.72 J

83-1039-DU1-SB7	
083SB-0012M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	2.1
Acenaphthene	0.57 J
Benzo(a)anthracene	2.8
Benzo(a)pyrene	1.4 J
Benzo(b)fluorathene	5.6
Benzo(g,h,i)perylene	3.6
Benzo(k)fluoranthene	0.95 J
Chrysene	8.3
Dibenz(a,h)anthracene	0.66 J
Fluoranthene	4.5
Fluorene	0.66 J
Indeno(1,2,3-c,d)pyrene	1.7
Naphthalene	2.4
Phenanthrene	9.1
Pyrene	3.6
Pesticides (ug/kg)	
delta-BHC	1.1 J

83-1039-DU1-SB3 (and DUP)	
083SB-0005M (0006M)-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	1.9 (2.0)
Acenaphthene	0.78 J (0.71 J)
Anthracene	2.1 (7.5)
Benzo(a)anthracene	7.3 (11.0)
Benzo(a)pyrene	3.2 (1.4 J)
Benzo(b)fluorathene	8.9 (5.1)
Benzo(g,h,i)perylene	6 (3.8)
Benzo(k)fluoranthene	1.9 (0.98 J)
Chrysene	8.3 (8.3)
Dibenz(a,h)anthracene	1.2 J (0.75 J)
Fluoranthene	10 (4.1)
Fluorene	0.93 J (0.74 J)
Indeno(1,2,3-c,d)pyrene	3.6 (1.8)
Naphthalene	2 (2.6)
Phenanthrene	11 (7.7)
Pyrene	8.1 (3.6)

83-1039-DU1-SB2	
083SB-0004M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	1.6
Acenaphthene	2
Anthracene	3.8
Benzo(a)anthracene	16
Benzo(a)pyrene	6.8
Benzo(b)fluorathene	16
Benzo(g,h,i)perylene	8.3
Benzo(k)fluoranthene	3.1
Chrysene	14.0 J
Dibenz(a,h)anthracene	1.9
Fluoranthene	24.0 J
Fluorene	1.3 J
Indeno(1,2,3-c,d)pyrene	5.2
Naphthalene	1.8
Phenanthrene	16
Pyrene	18

83-1039-DU1-SB1	
083SB-0003M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	1.2 J
Anthracene	1.0 J
Benzo(a)anthracene	1.5 J
Benzo(a)pyrene	0.78 J
Benzo(b)fluorathene	4.5
Benzo(g,h,i)perylene	2.6
Benzo(k)fluoranthene	0.70 J
Chrysene	7.6
Dibenz(a,h)anthracene	0.62 J
Fluoranthene	2.3
Fluorene	0.56 J
Indeno(1,2,3-c,d)pyrene	1.3 J
Naphthalene	1.5 J
Phenanthrene	4.6
Pyrene	2

83-1039-DU1-SB4	
083SB-0008M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	1.7
Benzo(a)pyrene	0.45 J
Benzo(b)fluorathene	4.5
Benzo(g,h,i)perylene	3
Chrysene	9.4
Dibenz(a,h)anthracene	0.57 J
Fluoranthene	1.5 J
Fluorene	0.62 J
Indeno(1,2,3-c,d)pyrene	1.1 J
Naphthalene	1.7
Phenanthrene	4.7
Pyrene	1.4 J

83-1039-DU1-SB6	
083SB-0011M-0001-SO	
Date:	8/12/2013
Depth (ft):	4-10
SVOCs (ug/kg)	
2-Methylnaphthalene	2.2
Acenaphthene	0.54 J
Benzo(a)pyrene	0.75 J
Benzo(b)fluorathene	3.9
Benzo(g,h,i)perylene	4.3
Chrysene	8.6
Dibenz(a,h)anthracene	0.60 J
Fluoranthene	1.5 J
Fluorene	0.49 J
Indeno(1,2,3-c,d)pyrene	1.3 J
Naphthalene	2.2
Phenanthrene	6.4
Pyrene	1.8

LEGEND

- Direct-Push Boring Location
- Manhole
- Drainage Ditch
- Underground Drainage Pipe
- Sewer Line
- 30-ft Buffer
- Decision Unit
- Former Building 1039
- Concentration Exceeds FWCUG (HQ=0.1/Target Risk of 10^{-6})

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N.
2. Concentrations shown are for SRCs for organic chemicals. Concentrations which exceed the most stringent FWCUG are highlighted in yellow.
3. Vertical subsurface soil incremental sampling methodology (ISM) sampling was performed at all direct-push locations from 4-10 feet below ground surface (ft bgs).
4. A sample was also taken at location 83-1039-DU1-SB5 from 7-13 ft bgs.
5. ug/kg = micrograms per kilogram
6. delta-BHC = delta-hexachlorocyclohexane
7. SVOC = semi-volatile organic compound
8. J = estimated value less than reporting limits
9. DUP = duplicate sample (duplicate data in "( )")
10. DSB = deep soil boring
11. SRC = site-related chemical
12. FWCUG = facility-wide cleanup goal
13. HQ = hazard quoteint
14. ft = feet

TITLE

Figure 5-2

Organic SRCs
in Vertical Subsurface
Soil Samples

CC RVAAP-83
Former Buildings
1031 and 1039

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

0 10 20 Feet

N

ECC
Marlborough, Massachusetts

GIS Server
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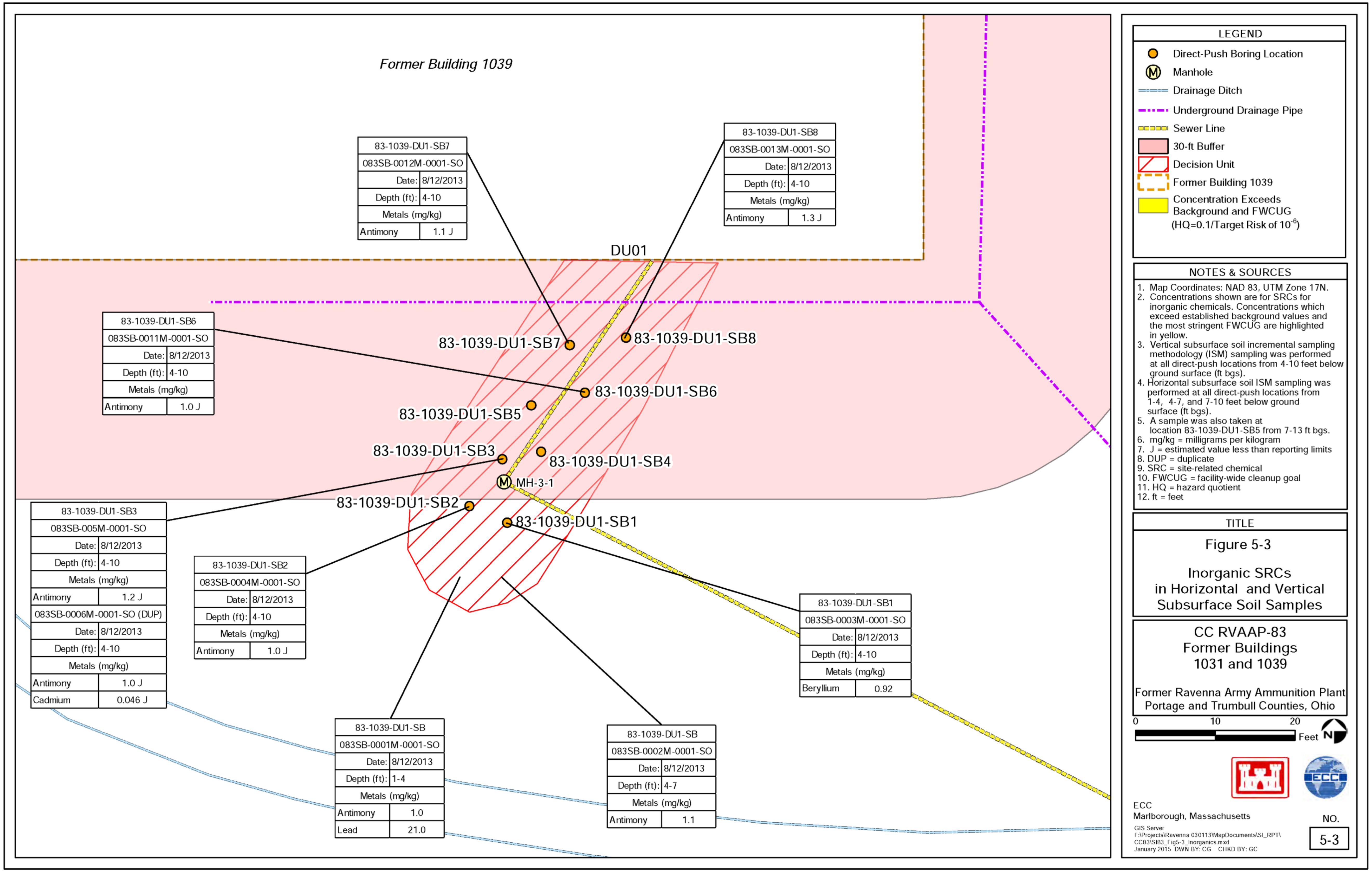
Former Building 1039
DU01
83-1039-DU1-SB7
083SB-0012M-0001-SO
Date: 8/12/2013
Depth (ft): 4-10
Metals (mg/kg)
Antimony 1.1 J
83-1039-DU1-SB8
083SB-0013M-0001-SO
Date: 8/12/2013
Depth (ft): 4-10
Metals (mg/kg)
Antimony 1.3 J
83-1039-DU1-SB6
083SB-0011M-0001-SO
Date: 8/12/2013
Depth (ft): 4-10
Metals (mg/kg)
Antimony 1.0 J
83-1039-DU1-SB5
83-1039-DU1-SB4
83-1039-DU1-SB3
083SB-005M-0001-SO
Date: 8/12/2013
Depth (ft): 4-10
Metals (mg/kg)
Antimony 1.2 J
083SB-0006M-0001-SO (DUP)
Date: 8/12/2013
Depth (ft): 4-10
Metals (mg/kg)
Antimony 1.0 J
Cadmium 0.046 J
83-1039-DU1-SB2
083SB-0004M-0001-SO
Date: 8/12/2013
Depth (ft): 4-10
Metals (mg/kg)
Antimony 1.0 J
MH-3-1
83-1039-DU1-SB1
083SB-0003M-0001-SO
Date: 8/12/2013
Depth (ft): 4-10
Metals (mg/kg)
Beryllium 0.92
83-1039-DU1-SB
083SB-0001M-0001-SO
Date: 8/12/2013
Depth (ft): 1-4
Metals (mg/kg)
Antimony 1.0
Lead 21.0
83-1039-DU1-SB
083SB-0002M-0001-SO
Date: 8/12/2013
Depth (ft): 4-7
Metals (mg/kg)
Antimony 1.1
LEGEND
Direct-Push Boring Location
Manhole
Drainage Ditch
Underground Drainage Pipe
Sewer Line
30-ft Buffer
Decision Unit
Former Building 1039
Concentration Exceeds Background and FWCUG (HQ=0.1/Target Risk of 10-5)
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N.
2. Concentrations shown are for SRCs for inorganic chemicals. Concentrations which exceed established background values and the most stringent FWCUG are highlighted in yellow.
3. Vertical subsurface soil incremental sampling methodology (ISM) sampling was performed at all direct-push locations from 4-10 feet below ground surface (ft bgs).
4. Horizontal subsurface soil ISM sampling was performed at all direct-push locations from 1-4, 4-7, and 7-10 feet below ground surface (ft bgs).
5. A sample was also taken at location 83-1039-DU1-SB5 from 7-13 ft bgs.
6. mg/kg = milligrams per kilogram
7. J = estimated value less than reporting limits
8. DUP = duplicate
9. SRC = site-related chemical
10. FWCUG = facility-wide cleanup goal
11. HQ = hazard quotient
12. ft = feet
TITLE
Figure 5-3
Inorganic SRCs in Horizontal and Vertical Subsurface Soil Samples
CC RVAAP-83 Former Buildings 1031 and 1039
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0 10 20 Feet
N
ECC
Marlborough, Massachusetts
NO.
5-3

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6. EXPOSURE PATHWAYS

6.1 SOIL EXPOSURE AND AIR PATHWAYS

6.1.1 Physical Conditions

The site is located within Hiram Till glacial deposits in an area referred to as the Administration Area. There is predominantly one type of silty loam soil beneath the Former Building 1039 AOC; Mahoning silt loams (0-2 and 2-6 percent slopes). The Mahoning silt loam, 0-2 percent slopes, is present in the northeast portion of the AOC, while the Mahoning silt loam, 2-6 percent slopes, occurs over 90 percent of the AOC (Figure 1-7). The inferred bedrock formation at Former Building 1039 is the Pennsylvanian-age Pottsville Formation, Sharon Sandstone Member, informally referred to as the Sharon Conglomerate Unit (Winslow and White 1966). The Sharon Conglomerate Unit bedrock interface at Former Building 1039 is estimated to be 950-1,000 ft amsl, based on Ohio Department of Natural Resources bedrock topography contours (Figure 1-3).

6.1.2 Soil and Air Targets

Current and future human and ecological (animal and plant) receptors may come into contact with subsurface soil if contaminants are present within the DU at this AOC. The former subsurface sump within Building 1039 had an outlet and associated piping below ground surface. Therefore, any release or leakage from the former sump would potentially occur below ground surface and impact the subsurface soil.

Airborne contamination (e.g., windblown dust) and soil gas vapors are not considered a viable migration or exposure pathway at the AOC. Potential releases of contaminants at Former Building 1039 would likely have been to subsurface soil adjacent to the sump. The operational areas are paved, gravel covered, or currently well vegetated. The facility is located in a humid climate, and soil moisture content is typically high, which reduces the potential for dust generation. No reported organic chemicals were detected in the samples that would pose a risk to soil gas vapors.

6.1.3 Soil and Air Pathway Conclusions

The SI analytical results indicate that no potential contaminants were identified in the subsurface soil collected between 1 and 7 ft bgs or in the deeper 7- to 13-ft bgs sampling intervals. Therefore, the exposure pathways for soil and air are incomplete.

6.2 SURFACE WATER PATHWAY

6.2.1 Hydrological Setting

No surface water or sediment samples were collected as part of this SI as surface water and sediment are not present at the AOC. The closest perennial feature to receive drainage from the former Administration Area is a tributary to the west branch of the Mahoning River located southeast of the site (Figure 1-3).

6.2.2 Surface Water Targets

Surface water targets include human receptors that use surface water for potable water supply or recreation, as well as environmental (e.g., streams, wetlands, sensitive aquatic environments) and physical targets (e.g., public or private water distribution system intakes) that may be affected by potential groundwater contamination on or adjacent to the site. No perennial streams are located at the AOC. There are no observed springs or groundwater discharge points to a surface water body in the vicinity of the site. Therefore, there is no direct exposure pathway for human receptors or ecological targets to surface water at the AOC.

6.2.3 Surface Water Pathway Conclusions

There are no perennial surface water streams or wetlands in the immediate vicinity of the AOC. Surface water flow and sediment transport are not migration pathways for potential contamination related to the Former Building 1039 as these media are not present at the AOC.

6.3 GROUNDWATER PATHWAY

6.3.1 Hydrogeological Setting

Section 1.4.4 presents the general hydrogeological setting for the facility. In April 2011, OHARNG installed two bedrock aquifer wells at the facility within the Sharon Conglomerate for use as an institutional groundwater supply. These potable wells are located near Buildings 1067 (north of the site) and 1068 (southwest of the site) within the former Administration Area. The OHARNG well near Building 1067 is on the west side of George Road, north of Building 1067 and a nearby creek. The second OHARNG well is southeast of Building 1068. There is one inactive non-potable groundwater supply well just south of Winklepeck Burning Grounds along the east side of George Road, which was formerly used to supply water for environmental restoration activities. There are also three monitoring wells located in the vicinity of the AOC, south of the site and within the former Administration Area (referenced as monitoring wells FWGmw-004, FWGmw-015, and FWGmw-016). Monitoring wells FWGmw-004 and FWGmw-015 are screened within the unconsolidated material at 19.5 and 23.5 ft bgs and are located 2,500 ft southwest and 1,500 ft south of Former Building 1039, respectively. Monitoring well FWGmw-016 is screened within the Sharon Conglomerate at a depth of 64.5 ft bgs and is approximately 1,500 ft south of Former Building 1039 (EQM 2014). Based on a review of the soil borings completed for this SI, the depth to water at the AOC is deeper than 13 ft bgs as no groundwater was encountered during the installation of the eight soil borings at CC RVAAP-83.

Based on review of the gauging data from the Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Annual Report for 2013 (EQM 2014), the potentiometric surface in the unconsolidated aquifer is approximately 1,025 ft amsl (Figure 1-9). The generalized potentiometric surface elevation of the Sharon Member bedrock aquifer in the site area is inferred to be approximately 1,020 ft amsl (Figure 1-10), based on facility-wide groundwater monitoring well data from 2013. Top of bedrock is estimated to lie at 980 ft amsl (Figure 1-4). The regional groundwater flow direction in both aquifers beneath the AOC is generally to the southeast toward a tributary of the west branch of the Mahoning River located southeast of the CR site.

6.3.2 Groundwater Targets

Groundwater receptors include human receptors that use groundwater for potable water supply, as well as environmental receptors (e.g., livestock, fish farms) and environmental receptors (e.g., springs) that may be affected by potential groundwater contamination on or adjacent to the AOC. There are no public, livestock, or commercial groundwater supply wells within the facility. Groundwater in the vicinity of the Former Building 1039 is used solely for onsite activities by OHARNG. It is likely that groundwater may be used in the future, although it has not been specifically designated; therefore, future human receptors may be potentially exposed to groundwater.

6.3.3 Groundwater Pathway Conclusion

The results of this SI indicate that the subsurface soil is not contaminated; therefore, soil is not a potential source of groundwater contamination at this AOC. The groundwater associated with CC RVAAP-83 is being evaluated under the RVAAP-66 Facility-Wide Groundwater.

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7. SUMMARY AND CONCLUSIONS

This chapter provides a summary of the findings and conclusions of this SI conducted by ECC at the Former Building 1039 at CC RVAAP-83. Only subsurface soils were sampled as part of this SI, since any releases from the former sump area would have been to subsurface soils. There are no surface water bodies, wetlands, streams, or sediment onsite, and the groundwater associated with CC RVAAP-83 is currently being addressed separately under RVAAP-66 Facility-Wide Groundwater.

7.1 SUMMARY OF RESULTS

The SI results of the subsurface soil sampling conducted at Former Building 1039 at CC RVAAP-83 are summarized as follows:

- A total of 19 SVOCs including PAH compounds; 1 pesticide (delta-BHC); and 4 metals (antimony, beryllium, cadmium, and lead) were identified as SRCs in the subsurface soil.

- No VOCs, SVOCs, metals, explosives, propellants, PCBs, or pesticides were detected at concentrations exceeding their respective Resident Receptor FWCUGs in the ISM subsurface soil samples collected.

- Therefore, no potential contaminants were identified in the subsurface soil collected at the Former Building 1039 at CC RVAAP-83.

7.2 CONCLUSIONS

The conclusions of this SI conducted at the Former Building 1039 at CC RVAAP-83 are as follows:

- No potential contaminants were identified in subsurface soil sampled at this AOC.

- The results of this SI indicate that the subsurface soil is not contaminated; therefore, soil is not a source of groundwater contamination at this AOC.

The results of this SI indicate that No Further Action (NFA) is warranted for soil at the Former Building 1039 at CC RVAAP-83. Since no additional investigation was previously granted at the Former Building 1031 hospital building, the entire AOC, consisting of both former buildings sites, at CC RVAAP-83 is recommended for NFA.

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