Draft
Site Inspection
CC RVAAP-77 Building 1037 Laundry Waste Water Sump
Revision 0

Ravenna Army Ammunition Plant
Ravenna, Ohio

June 17, 2013

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

Prepared for:

U.S. Army Corps of Engineers, Louisville District
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CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

ECC has completed the Draft Site Inspection at the CC RVAAP-77 Building 1037 Laundry Waste Water Sump at the Ravenna Army Ammunition Plant, Ravenna, 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 principals and procedures, utilizing justified and valid assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing USACE policy.

Willard A. Murray

____________________________________ June 14, 2013

Willard Murray, Ph.D., P.E. Date

Senior Engineer

Debra MacDonald

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Debra MacDonald, P.E., PMP Date

Project Manager

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Ohio EPA – NEDO = Ohio Environmental Protection Agency Northeast District Office
ARNG = Army National Guard
OHARNG = Ohio Army National Guard
RVAAP = Ravenna Army Ammunition Plant
USACE = United States Army Corps of Engineers
REIMS = Ravenna Environmental Information Management System
ECC = Environmental Chemical Corporation

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ACRONYMS AND ABBREVIATIONS

amsl	Above Mean Sea Level
AOC	Area of Concern
APA	Abbreviated Preliminary Assessment
ARNG	Army National Guard
AST	Above Ground Storage Tank
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
CC	Army Environmental Database Compliance-Related Cleanup Program
CERCLA	Comprehensive Environmental Response, Compensation Liability Act
cm	Centimeter
COPC	Chemical of Potential Concern
CR	Compliance Restoration
CRJMTC	Camp Ravenna Joint Military Training Center
DDE	Dichlorodiphenyldichloroethylene
DFFO	Director’s Final Findings and Orders
DI	Deionized
DoD	Department of Defense
DO	Delivery Order
DOT	Department of Transportation
DSB	Deep Soil Boring
DU	Decision Unit
ECC	Environmental Chemical Corporation
^{o}F	Degrees Fahrenheit
ft	Feet
FWCUG	Facility-Wide Cleanup Goal
FWHHRAM	Facility-Wide Human Health Risk Assessor Manual
FWQAPP	Facility-Wide Quality Assurance Project Plan
FWSAP	Facility-Wide Sampling and Analysis Plan
gpm	Gallons Per Minute
HI	Hazardous Index
HQ	Hazard Quotient
HRR	Historical Records Review
HTRW	Hazardous, Toxic, or Radioactive Waste
IDW	Investigation-Derived Waste
IRP	Installation Restoration Program
ISM	Incremental Sampling Methodology
J	Estimated Value
kg	Kilogram

ACRONYMS AND ABBREVIATIONS (CONTINUED)

km	Kilometer
km^2	Square Kilometers
LOQ	Limit of Quantitation
m	Meter
mil	Millimeter
MEC	Munitions and Explosives of Concern
MDC	Maximum Detected Concentration
mg	Milligram
MgA	Mahoning Silt Loam, 0-2% Slopes
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAD	North American Datum
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NGT	National Guard Trainee
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
ODNR	Ohio Department of Natural Resources
PAH	Polynuclear Aromatic Hydrocarbon
PBA	Performance-Based Acquisition
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PPE	Personal Protective Equipment
PWS	Performance Work Statement
QA	Quality Assurance
QC	Quality Control
QSM	Quality Systems Manual
RCI	Reactivity, Corrosivity, and Ignitability
RDA/RDI	Recommended Daily Allowance/Recommended Daily Intake
RAF	Resident Farmer Adult
RAFLU	Reasonably Anticipated Future Land Use
RI	Remedial Investigation
RRSE	Relative Risk Site Evaluation
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SB	Soil Boring
SI	Site Inspection
SRC	Site-Related Chemical

ACRONYMS AND ABBREVIATIONS (CONTINUED)

SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TR	Target Risk
ug/kg	Microgram per Kilogram
USACE	United States Army Corps of Engineers
USATHMA	United States Army Toxic and Hazardous Materials Agency
USACHPPM	United States Army Center for Health Promotion & Preventive Medicine
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
VISTA	VISTA Sciences Corporation
VOC	Volatile Organic Compound
WOE	Weight-Of-Evidence

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EXECUTIVE SUMMARY

Environmental Chemical Corporation (ECC) was 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-77 Building 1037 Laundry Waste Water Sump at the Ravenna Army Ammunition Plant (RVAAP), in Ravenna, Ohio, under Contract Number W912QR-04-D-0039, Delivery Order (DO) Number 0004. The SI for CC RVAAP-77 was conducted in accordance with the United States Environmental Protection Agency's (USEPA) *Interim Final Guidance for Performing Site Inspections Under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* (USEPA 1992).

The SI was initiated as a result of the Historical Records Review (HRR) report conclusion that identified CC RVAAP-77 was a candidate for further investigation due to a waste water sump that received discharge water from the former laundry operation within Building 1037, which may have resulted in a release of contaminants to the Area of Concern (AOC) soils.

The HRR report for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern) (SAIC 2011b) identified historic uses and potential environmental concerns at this CR site with respect to possible Hazardous, Toxic, and Radioactive Waste (HTRW) and/or Munitions and Explosives of Concern (MEC) issues. The HRR report was utilized in this SI and will be referenced and summarized throughout this report. The SI also included an initial intrusive investigation at CC RVAAP-77, presented herein, to assess the potential presence of contamination. The environmental media included in this SI evaluation were surface and subsurface soils, sediment and surface water. However, since no sediment or perennial streams or surface water bodies were observed on site, only surface and subsurface soils were sampled as part of this SI at CC RVAAP-77. The data quality objectives of the intrusive investigation of CC RVAAP-77 were as follows:

- Conduct Incremental Sampling Methodology (ISM) sampling of surface soils that produce representative and repeatable data.

- Conduct ISM sampling of subsurface soils that produce representative and repeatable data.

- Provide sufficient Quality Assurance (QA)/Quality Control (QC) sampling to evaluate the overall quality of both the field and laboratory sampling procedures.

- Provide sufficient analytical data to compare sampling results with the sets of facility-wide cleanup goals (FWCUG) for the various Ravenna receptors and assess whether exposure pathways exist to determine if further investigation is warranted.

All data quality objectives were met. The Building 1037 Laundry Waste Water Sump was assigned one decision unit (DU), which was the sump and immediate drainage area surrounding it. The focus of the sampling was explosives and propellants in soil, as indicated by the HRR (SAIC 2011b).

The SI sample distribution is summarized as follows. One ISM surface soil sample (0 - 1 feet below ground surface [ft bgs]) was collected. Two horizontal ISM subsurface soil samples were collected (depths of 1 - 4 and 4 - 7 ft bgs). Five vertical ISM subsurface samples were collected (1 - 7 ft bgs). Finally, one deep composite subsurface soil sample was collected from 7 - 13 ft bgs for evaluation of residential (unrestricted) land use scenario as required by CERCLA. No sediment or surface water was sampled as part of the SI as they are not present on this AOC. Groundwater was not sampled because it is being investigated under RVAAP-66 Facility-Wide Groundwater.

A summary of the SI results for this AOC are as follows:

- No volatile organic compounds (VOC), polychlorinated biphenyls (PCB), explosives or their derivatives, or propellant compounds were detected above the respective FWCUGs in the ISM surface soil or subsurface soil samples collected. These chemicals were not identified as chemicals of potential concern (COPC) at this AOC.

- One polynuclear aromatic hydrocarbon (PAH) (semi-volatile compound), benzo(a)pyrene, was reported at a concentration above the FWCUG for the Resident Farmer Adult; however, PAHs are not associated with the past historical activities at CC RVAAP-77 and are not related to the activities at this AOC, but reflect the off-AOC activities and processes associated with overland drainage from nearby asphalt roadways and other sources adjacent to this AOC such as the former Power House No.6 and the coal storage area for the Power House. PAHs were not identified as COPCs at this AOC.

- Chromium, mercury, nickel and zinc exceeded their respective background values but were below their respective FWCUGs. No other metals exceeded the respective FWCUGs. Metals were not identified as COPCs at this AOC.

- There were no reported detections of explosives derivatives or propellants in the subsurface soil samples collected at CC RVAAP-77 during this SI. Therefore, these groups of chemicals were not identified as COPCs.

Based on the SI data evaluation in conjunction with the results of the HRR (SAIC 2011b), the conclusions are as follows:

- No COPCs were identified as a result of this SI performed at CC RVAAP-77 Building 1037 Laundry Waste Water Sump.

- No potential human or ecological exposure risks via air, soil, surface water, or groundwater pathways were identified during the SI. Further evaluation of potential receptor pathways for soil, sediment, surface water, air, and groundwater is not warranted.

- No Further Action (NFA) is warranted for soil, sediment, or surface water at CC RVAAP-77 Building 1037 Laundry Waste Water Sump. Groundwater is currently being addressed separately under RVAAP-66 Facility-Wide Groundwater.

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1.0 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 RVAAP-77 Building 1037 Laundry Waste Water Sump at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio, under Contract Number W912QR-04-D-0039.

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 (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to complete the SI for Area of Concern (AOC) CC RVAAP-77. The SI for CC RVAAP-77 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 at Compliance Restoration Sites (Revision 0), Ravenna Army Ammunition Plant, Ravenna, Ohio* (ECC 2012). This governing document is referred to as the "Final SI/RI (Remedial Investigation) Work Plan" in this SI Report.

The SI was initiated as a result of the HRR report conclusion that identified CC RVAAP-77 as a candidate for further investigation due to a waste water sump that received discharge water from the former laundry operation within Building 1037, which may have resulted in a release of contaminants to the AOC soils.

The 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
- Comparison of results with the most recent Facility-Wide Cleanup Goals (FWCUG)
- Exposure pathways evaluation 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 USACE Louisville District in accordance with the Performance Work Statement (PWS), Contract Number W912QR-04-D-0039, Delivery Order (DO) Number 0004 under a firm-fixed price Performance-Based Acquisition (PBA) to provide environmental investigation and remediation services at 14 Compliance Restoration sites at the RVAAP, Ravenna, Ohio (Figure 1-1 and 1-2). The DO was issued by the USACE Louisville District on August 15, 2011.

Environmental work at RVAAP under the Installation Restoration Program (IRP) began in 1989, with 32 environmental AOCs. The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) collected environmental samples at each AOC and performed a Relative Risk Site Evaluation (RRSE), 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. Again, relative risk rankings were performed to prioritize those additional environmental AOCs. Since 1998, new environmental AOCs have been added. This SI discusses one of these AOCs, CC RVAAP-77 Building 1037 Laundry Waste Water Sump.

Historical information for CC RVAAP-77 is presented in the *Final Historical Records Review Report for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern) at the Ravenna Army Ammunition Plant, Ravenna, Ohio,* dated December 22, 2011 (SAIC 2011b). The aforementioned document is referred to as the HRR in this SI Report. The HRR followed the guidance and requirements of a CERCLA Abbreviated Preliminary Assessment (APA); *USEPA Improving Site Assessment: Abbreviated Preliminary Assessments*, dated October 1999.

The HRR identified historic uses and potential environmental concerns at this site with respect to possible Hazardous, Toxic, and Radioactive Waste (HTRW) issues. A brief description and history of CC RVAAP-77 are provided in Section 2.0.

1.2 FACILITY DESCRIPTION

When the RVAAP IRP began in 1989, RVAAP was identified as a 21,419-acre facility. The property boundary was resurveyed by Ohio Army National Guard (OHARNG) over a 2-year period (2002 and 2003) and the total acreage of the property was found to be 21,683 acres. As of June 2010, administrative accountability for 20,423 acres of the former 21,683-acre RVAAP has been transferred to the Army National Guard (ARNG) and subsequently licensed to OHARNG for use as a military training site, Camp Ravenna Joint Military Training Center (Camp Ravenna).

The current RVAAP consists of 1,260 acres scattered throughout the OHARNG Camp Ravenna (Figure 1-2). Camp Ravenna is in northeastern Ohio within Portage and Trumbull counties, approximately 3 miles (4.8 km) east-northeast of the City of Ravenna and approximately 1 mile (1.6 km) northwest of the City of Newton Falls. The RVAAP portions of the property are solely located within Portage County. RVAAP and Camp Ravenna occupy a parcel of property approximately 11 miles (17.7 km) long and 3.5 miles (5.6 km) wide bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garrett, McCormick, and Berry roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east (Figures 1-1 and 1-2). Camp Ravenna is surrounded by several communities: Windham on the north; Garrettsville 6 miles (9.6 km) to the northwest; Newton Falls 1 mile (1.6 km) to the southeast; Charlestown to the southwest; and Wayland 3 miles (4.8 km) to the south.

When RVAAP was operational, Camp Ravenna did not exist and the entire 21,683-acre parcel was a government-owned, contractor-operated, industrial facility. The RVAAP Installation Restoration Program (IRP) encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP. References to RVAAP in this document indicate the historical extent of RVAAP, which is inclusive of the combined acreages of the current Camp Ravenna and RVAAP, unless otherwise specifically stated.

1.3 DEMOGRAPHY AND LAND USE

RVAAP consists of 21,683 acres in northeastern Ohio, approximately 23 miles (37 km) east–northeast of Akron and 30 miles (48.3 km) west–northwest of Youngstown. RVAAP 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 RVAAP are Ravenna, with a population of 11,724, and Newton Falls, with a population of 4,795.

The RVAAP facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55% of Portage County, in which the majority of RVAAP 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 RVAAP portion of the facility is operated by the Base Realignment and Closure (BRAC) Division, who manages the restoration activities in coordination with ARNG/OHARNG. ARNG is accountable for the remainder of the facility, Camp Ravenna (which comprises the remainder of the property), who licenses it 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 RAVENNA ENVIRONMENTAL SETTING

This section describes the physical features, topography, geology, hydrogeology, and environmental characteristics of RVAAP. The environmental setting specific to CC RVAAP-77 is included in Section 6.0.

1.4.1 Physiographic Setting

RVAAP is located within the Southern New York Section of the Appalachian Plateaus physiographic province (USGS 1968). This province is characterized by elevated uplands underlain primarily by Mississippian- and Pennsylvanian-age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography with incised streams having dendritic drainage patterns. The Southern New York Section has been modified by glaciation, which rounded ridges, filled major valleys, and blanketed many areas with glacially-derived unconsolidated 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 RVAAP is gently undulating with an overall decrease in ground surface elevation from a topographic high of approximately 1,220 ft above mean sea level (amsl) in the far western portion of the facility to low areas at approximately 930 ft amsl in the far eastern portion of the facility.

USACE mapped the facility topography in February 1998 using a 2-ft (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 the spring of 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 RVAAP consists of horizontal to gently dipping bedrock strata of Mississippian- and Pennsylvanian-age overlain by unconsolidated glacial deposits of varying thicknesses. The bedrock and unconsolidated surficial deposits are described in the following subsections.

1.4.3.2 Soil and Glacial Deposits

Bedrock at RVAAP 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 1-3). Unconsolidated glacial deposits vary considerably in thickness across RVAAP, 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 coverings of glacial material have been completely removed as a consequence of human activities at locations such as Ramsdell Quarry. Bedrock is present at or near the ground surface in locations such as Load Line 1 and the Erie Burning Grounds (USACE 2001).

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

Several soil types are present at RVAAP as shown in Figure 1-4 and Figure 1-5. The primary soil type present at CC RVAAP-77 is shown in Figure 1-6 and summarized in Table 1-1.

Table 1-1: Soil Types

Soil Series Classification	Parent Material	Geographic Setting	Slope %	Drainage	Surface Runoff	Permeability
Mahoning silt loams (MgA)	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 %	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 RVAAP (Figure 1-7). 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 Shale, Connoquenessing Sandstone (also known as the Massillon Sandstone), Mercer Shale, and uppermost Homewood Sandstone, have been observed (Figure 1-7). The regional dip of the Pottsville Formation measured in the west portion of RVAAP is between 1.5 and 3.5 m per 1.6 km (5 to 11.5 ft per mile) to the south.

The Sharon Shale is a gray to black, sandy to micaceous shale containing thin coal, underclay, and sandstone lenses. The Mercer Member of the Pottsville Formation consists of silty to carbonaceous shale with abundant thin, discontinuous sandstone lenses in the upper portion. Regionally, the Mercer Member also has been noted to contain interbeds of coal.

The Homewood Sandstone Member is the uppermost unit of the Pottsville Formation. It typically occurs as a caprock on bedrock highs in the subsurface, and ranges from well-sorted, coarse-grained, white quartzose sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. Thin shale layers are prevalent in the Homewood member as indicated by a darker gray shade of color.

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 Areas of Concern at the Ravenna Army Ammunition Plant, 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 RVAAP have not been delineated. The regional potentiometric surface at RVAAP for unconsolidated surficial deposits and bedrock are presented in Figure 1-8 and Figure 1-9, respectively.

The thickness of unconsolidated surficial deposits at RVAAP ranges from thin to absent in the eastern and northeastern portion of RVAAP to an estimated 150 ft (46 m) in the central portion of the facility. The water table (Figure 1-8) is encountered within the unconsolidated zone in many areas of the facility. Because of the heterogeneous nature of the unconsolidated glacial material, however, groundwater flow patterns are difficult to determine. Laterally, most groundwater flow in the surficial deposits likely follows topographic contours and stream drainage patterns (Figure 1-8), with preferential flow along pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities than surrounding clay or silt-rich material. Aquifer recharge from precipitation likely occurs via infiltration along root zones, desiccation cracks, and partings within the soil column.

Beneath RVAAP, the principal bedrock aquifer is the Sharon Conglomerate (Figure 1-10). Depending on overburden thickness, the Sharon Conglomerate bedrock aquifer ranges from an unconfined to a leaky artesian aquifer hydraulically. According to one source, yields from on-site supply wells completed in the Sharon Conglomerate range from 30 to 400 gallons per minute (gpm) (USATHMA 1978). Yields of 5 to 200 gpm have also been reported for on-site bedrock wells completed in the Sharon Conglomerate (Kammer 1982).

Other, less important, local bedrock aquifers include the Homewood Sandstone (Figure 1-9), which is generally thinner and only capable of well yields less than 10 gpm, and the Connoquenessing Sandstone. Wells completed in the Connoquenessing Sandstone in Portage County yield from 5 to 100 gpm, but are typically less productive than the Sharon Conglomerate due to lower permeabilities in the sandstone.

In general, the hydraulic gradient in the Sharon Conglomerate bedrock aquifer results in a regional eastward flow of groundwater (Figure 1-10) that appears to be more uniform than flow directions in unconsolidated deposits (Figure 1-8) because local surface topography influences the latter. Due to the lack of well data in the western portion of RVAAP, general flow patterns are difficult to discern. For much of the eastern half of RVAAP, 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

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

In addition, as of 2011, 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 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 RVAAP, 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 RVAAP is for domestic and livestock supply, with the Sharon Conglomerate acting as the major producing aquifer in the area. The Connoquenessing and Homewood sandstones also provide limited groundwater supplies, primarily to the western half of RVAAP. Unconsolidated deposits can also be an important source of groundwater. Many of the domestic wells and small public water supplies located near RVAAP 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 1-8). 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 RVAAP contains proportionately high levels of iron, manganese, and 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

RVAAP 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 RVAAP boundary before joining the Mahoning River east of RVAAP.

The western and northern portions of RVAAP 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 RVAAP are as follows (Figure 1-2):

- 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 km^2), flows generally in a northeast direction to its confluence with the south fork of Eagle Creek. In turn, the south fork of Eagle Creek continues in a northerly direction for 2.7 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 km^2), including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Route 88 and State Route 303 to the north of the facility. Hinkley Creek, with a drainage area of 11.0 square miles (28.5 km^2), flows in a southerly direction through the facility, and converges with the west branch of the Mahoning River south of the facility (USACE 2001).

Approximately one-third of RVAAP 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 RVAAP 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 RVAAP could support aquatic vegetation and biota. Storm water runoff is controlled primarily by natural drainage, except in former operations areas where an extensive storm sewer network helps to direct runoff to drainage ditches and settling ponds. 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 RVAAP area is continental and is characterized by moderately warm and humid summers, reasonably cold and cloudy winters, and wide variations in precipitation from year to year. Climate data for the RVAAP area presented below were obtained from available National Weather Service records for the 30-year period of record from 1971 to 2000 at the Youngstown Regional Airport, Ohio **(http://www.weather.gov/climate/xmacis.php?wfo=cle).** Wind speed data for Youngstown, Ohio, are from the National Climatic Data Center **(http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html)** for the available 53-year period of record from 1950 through 2002.

Average annual rainfall in the RVAAP area is 38.15 inches (96.9 cm), with the highest monthly average occurring in July (4.14 inches [10.5 cm]) and the lowest monthly average occurring in February (2.03 inches [5.15 cm]). Average annual snowfall totals approximately 52.8 inches (134.1 cm) with the highest monthly average occurring in January (13.8 inches [35.05 cm]). Due to the influence of lake-effect snowfall events associated with Lake Erie (located approximately 35 miles [56.3 km] northwest of RVAAP), snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the RVAAP area is 48.8ºF, with an average daily high temperature of 58.3ºF and an average daily low temperature of 39.3ºF. 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 RVAAP is from the southwest, with the highest average wind speed occurring in January (11.4 miles [18.3 km] per hour) and the lowest average wind speed occurring in August (7.4 miles [11.9 km] per hour). Thunderstorms occur on approximately 35 days per year and are most abundant from April through August. The RVAAP 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

The SI report is organized into the following nine 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 RVAAP.
- Chapter 2 (Site Description and Operational History) - Provides the site descriptions and land use history of the site. The physical property characteristics, chronological history, military operations, and summary of past investigations are included.

- Chapter 3 (Waste Characteristics and Management) - Summarizes the historical waste sources, types, known waste characteristics, and management practices at the site.
- Chapter 4 (Field Investigation) - Addresses the scope of activities performed under the 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 surface and subsurface soil 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 (Investigation Results) - Provides a summary of surface and subsurface soil ISM sampling results and compares analytical results to the human health FWCUGs for the facility. A discussion of the IDW characterization results is included.
- Chapter 6 (Exposure Pathways) - Summarizes physical conditions, 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 the nature and extent of contamination within the site based on SI sampling results and potential human health and ecological risks. The conclusions of the SI are provided.
- Chapter 8 (References) - Lists references used during report preparation.

Report appendices contain the summarized investigation data as follows:

- Appendix A – Historical Aerial Photographs
- Appendix B – Activity Field Logs
- 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

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Figure 1-1
Location Map
Ravenna Army Ammunition Plant
Ravenna, Ohio

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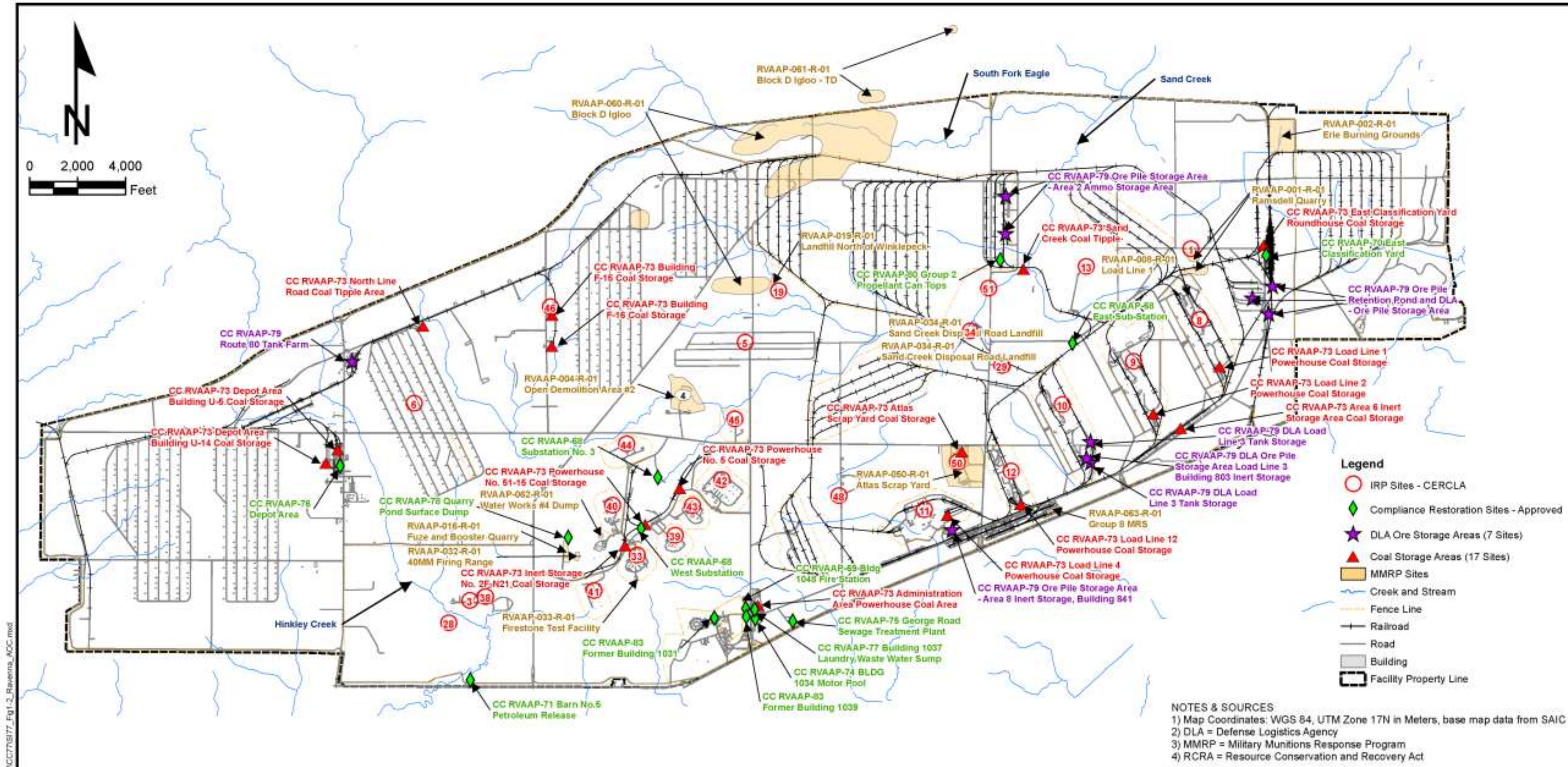

IRP SITES - CERCLA		
1	CC RVAAP-01	Ramsdell Quarry Landfill
3	CC RVAAP-03	Open Demolition Area #1
5	CC RVAAP-05	Winklepeck Burning Grounds
6	CC RVAAP-06	C Block Quarry
8	CC RVAAP-08	Load Line 1
9	CC RVAAP-09	Load Line 2
10	CC RVAAP-10	Load Line 3
11	CC RVAAP-11	Load Line 4
12	CC RVAAP-12	Load Line 12
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 (14 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 Propellant 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 1 MRS
RVAAP-016-R-01	Fuze and Booster Quarry MRS
RVAAP-019-R-01	Landfill North of Winklepeck MRS
RVAAP-032-R-01	40 mm Firing Range MRS
RVAAP-033-R-01	Firestone Test Facility MRS
RVAAP-034-R-01	Sand Creek Dump MRS
RVAAP-050-R-01	Atlas Scrap Yard MRS
RVAAP-060-R-01	Block D Igloo MRS
RVAAP-061-R-01	Block D Igloo - TD MRS
RVAAP-062-R-01	Water Works #4 Dump MRS
RVAAP-063-R-01	Group 8

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

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Figure 1-2
Location of Compliance Restoration Sites
RVAAP/CAMP RAVENNA
RAVENNA, OHIO

990

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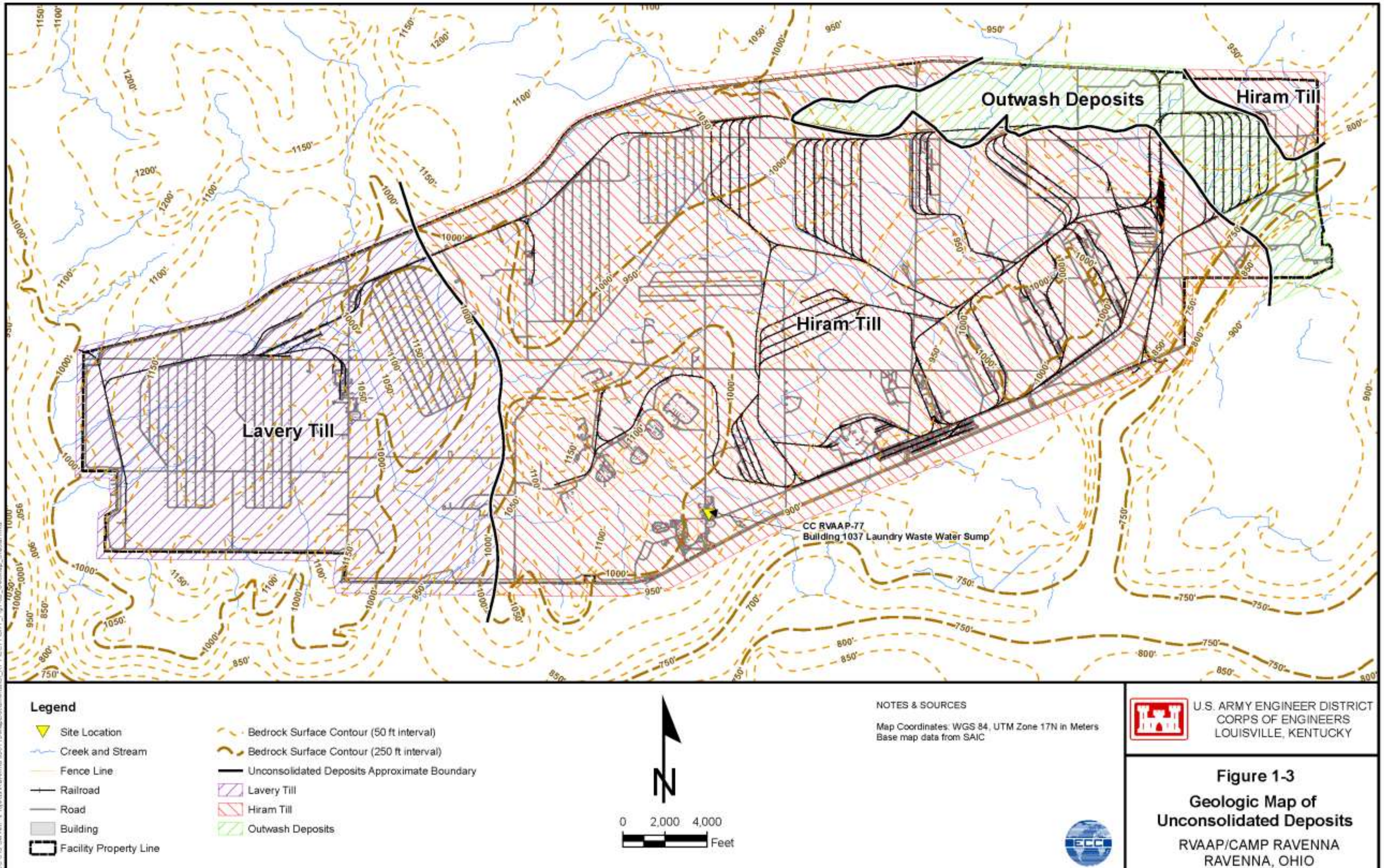

Figure 1-3
Geologic Map of Unconsolidated Deposits
RVAAP/CAMP RAVENNA
RAVENNA, OHIO

1003

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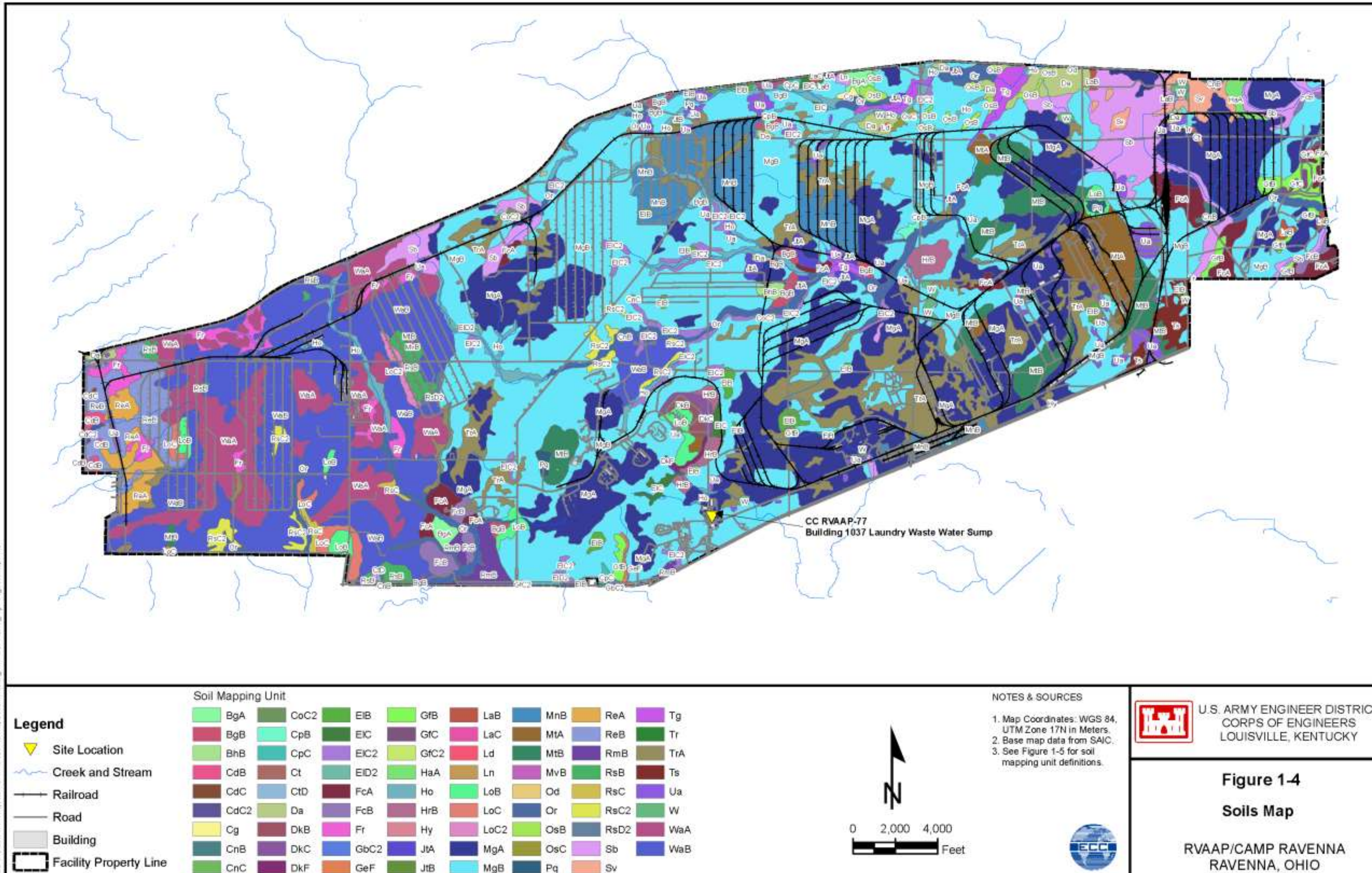
CC RVAAP-77
Building 1037 Laundry Waste Water Sump
Legend
Site Location
Creek and Stream
Railroad
Road
Building
Facility Property Line
Soil Mapping Unit
BgA BgB BhB CdB CdC CdC2 Cg CnB CnC
CoC2 CpB CpC Ct CtD Da DkB DkC DkF
EIB EIC EIC2 EID2 FcA FcB Fr GbC2 GeF
GfB GfC GfC2 HaA Ho HrB Hy JtA JtB
LaB LaC Ld Ln LoB LoC LoC2 MgA MgB
MnB MtA MtB MvB Od Or OsB OsC Pq
ReA ReB RmB RsB RsC RsC2 RsD2 Sb Sv
Tg Tr TrA Ts Ua W WaA WaB
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters.
2. Base map data from SAIC.
3. See Figure 1-5 for soil mapping unit definitions.
U.S. ARMY ENGINEER DISTRICT
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Figure 1-4
Soils Map
RVAAP/CAMP RAVENNA
RAVENNA, OHIO

1015

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Legend

Soil Mapping Unit

- BgA, Bogart silt loam, 0 to 2% slopes
- BgB, Bogart silt loam, 2 to 6% slopes
- BhB, Bogart-Haskins complex, 2 to 6% slopes
- CdB, Canfield silt loam, 2 to 6% slopes
- CdC, Canfield silt loam, 6 to 12% slopes
- CdC2, Canfield silt loam, 6 to 12% slopes, moderately eroded
- Cg, Carlisle muck
- CnB, Chili loam, 2 to 6% slopes
- CnC, Chili loam, 6 to 12% slopes
- CoC2, Chili gravelly loam, 6 to 12% slopes, moderately eroded
- CpB, Chili silt loam, 2 to 6% slopes
- CpC, Chili silt loam, 6 to 12% slopes
- Ct, Chili-Oshtemo complex
- CtD, Chili-Oshtemo complex, 12 to 18% slopes
- Da, Damascus loam
- DkB, Dekalb channery loam, 2 to 6% slopes
- DkC, Dekalb channery loam, 6 to 12% slopes
- DkF, Dekalb channery loam, 25 to 70% slopes
- EIB, Ellsworth silt loam, 2 to 6% slopes
- EIC, Ellsworth silt loam, 6 to 12% slopes
- EIC2, Ellsworth silt loam, 6 to 12% slopes, moderately eroded
- EID2, Ellsworth silt loam, 12 to 18% slopes, moderately eroded
- FcA, Fitchville silt loam, 0 to 2% slopes
- FcB, Fitchville silt loam, 2 to 6% slopes
- Fr, Frenchtown silt loam
- GbC2, Geeburg silt loam, 6 to 12% slopes, moderately eroded
- GeF, Geeburg and Glenford silt loams, steep
- GfB, Glenford silt loam, 2 to 6% slopes
- GfC, Glenford silt loam, 6 to 12% slopes
- GfC2, Glenford silt loam, 6 to 12% slopes, moderately eroded
- HaA, Haskins loam, 0 to 2% slopes
- Ho, Holly silt loam
- HrB, Hornell silt loam, 3 to 8% slopes
- Hy, Holly silt loam, frequently flooded
- JtA, Jimtown loam, 0 to 2% slopes
- JtB, Jimtown loam, 2 to 6% slopes
- LaB, Lakin loamy sand, 2 to 6% slopes
- LaC, Lakin loamy sand, 6 to 12% slopes
- Ld, Linwood muck
- Ln, Lorain silty clay loam
- LoB, Loudonville silt loam, 2 to 6% slopes
- LoC, Loudonville silt loam, 6 to 12% slopes
- LoC2, Loudonville silt loam, 6 to 12% slopes, moderately eroded
- MgA, Mahoning silt loam, 0 to 2% slopes
- MgB, Mahoning silt loam, 2 to 6% slopes
- MnB, Mahoning-Urban land complex, undulating
- MtA, Mitiwanga silt loam, 0 to 2% slopes
- MtB, Mitiwanga silt loam, 2 to 6% slopes
- MvB, Mitiwanga silt loam, 2 to 6% slopes, moderately weill drained variant
- Od, Olmsted loam
- Or, Orrville silt loam
- OsB, Oshtemo sandy loam, 2 to 6% slopes
- OsC, Oshtemo sandy loam, 6 to 12% slopes
- Pq, Pits, quarries
- ReA, Ravenna silt loam, 0 to 2% slopes
- ReB, Ravenna silt loam, 2 to 6% slopes
- RmB, Remsen silt loam, 2 to 6% slopes
- RsB, Rittman silt loam, 2 to 6% slopes
- RsC, Rittman silt loam, 6 to 12% slopes
- RsC2, Rittman silt loam, 6 to 12% slopes, moderately eroded
- RsD2, Rittman silt loam, 12 to 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 to 2% slopes
- Ts, Trumbull silty clay loam
- Ua, Udorthents
- W, Water
- WaA, Wadsworth silt loam, 0 to 2% slopes
- WaB, Wadsworth silt loam, 2 to 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 1-4 for soils map.

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Figure 1-5

Description of Soil Mapping Units

RVAAP/CAMP RAVENNA
RAVENNA, OHIO

ECC GIS Server F:\Projects\Ravenna 030113\MapDocuments\SI_RPT\CC77\SI77_Fig1-05_SoilsMap.mxd

1027

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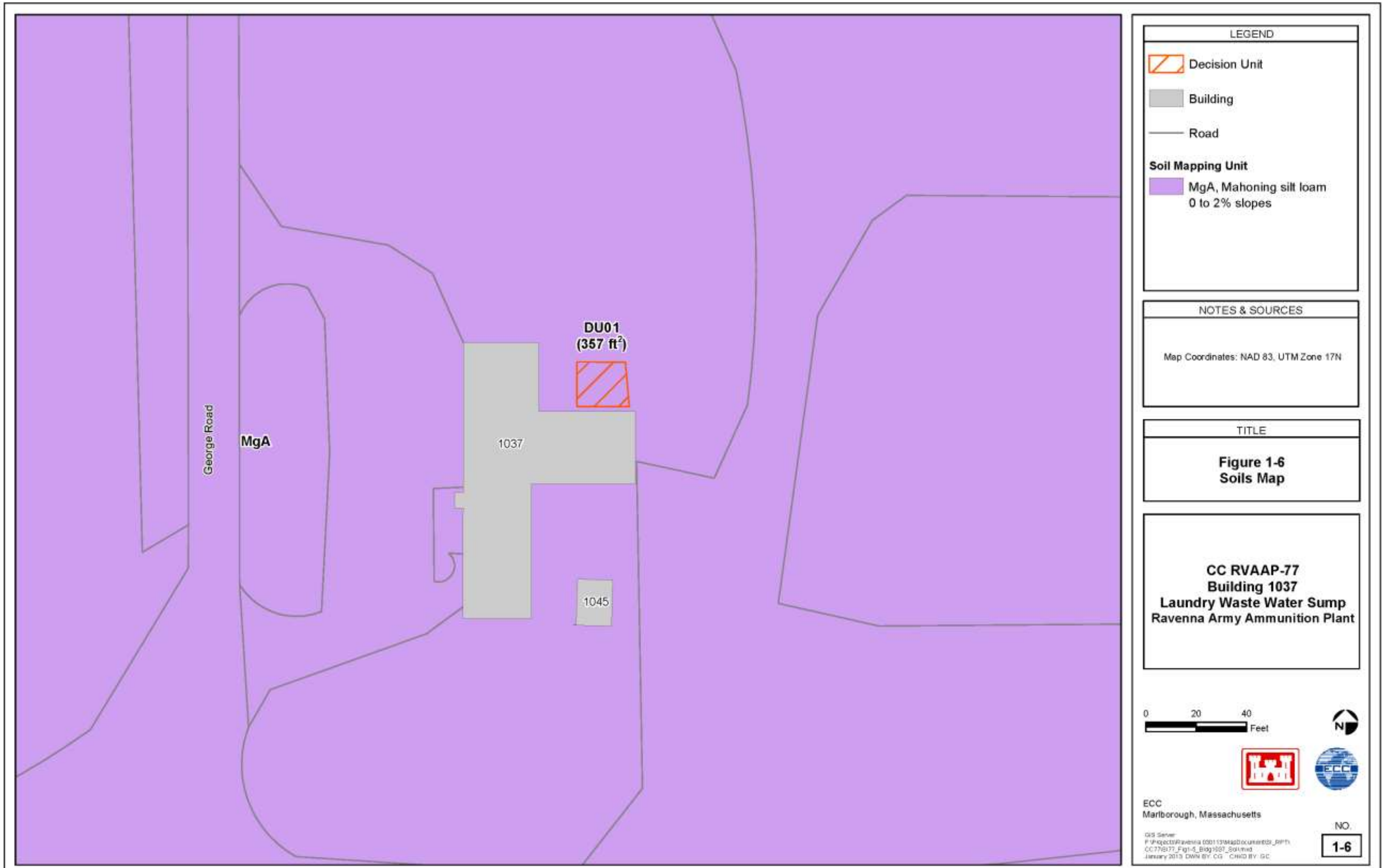
DU01
(357 ft²)
George Road
MgA
1037
1045
LEGEND
Decision Unit
Building
Road
Soil Mapping Unit
MgA, Mahoning silt loam
0 to 2% slopes
NOTES & SOURCES
Map Coordinates: NAD 83, UTM Zone 17N
TITLE
Figure 1-6
Soils Map
CC RVAAP-77
Building 1037
Laundry Waste Water Sump
Ravenna Army Ammunition Plant
0 20 40
Feet
N
ECC
Marlborough, Massachusetts
NO.
1-6

1039

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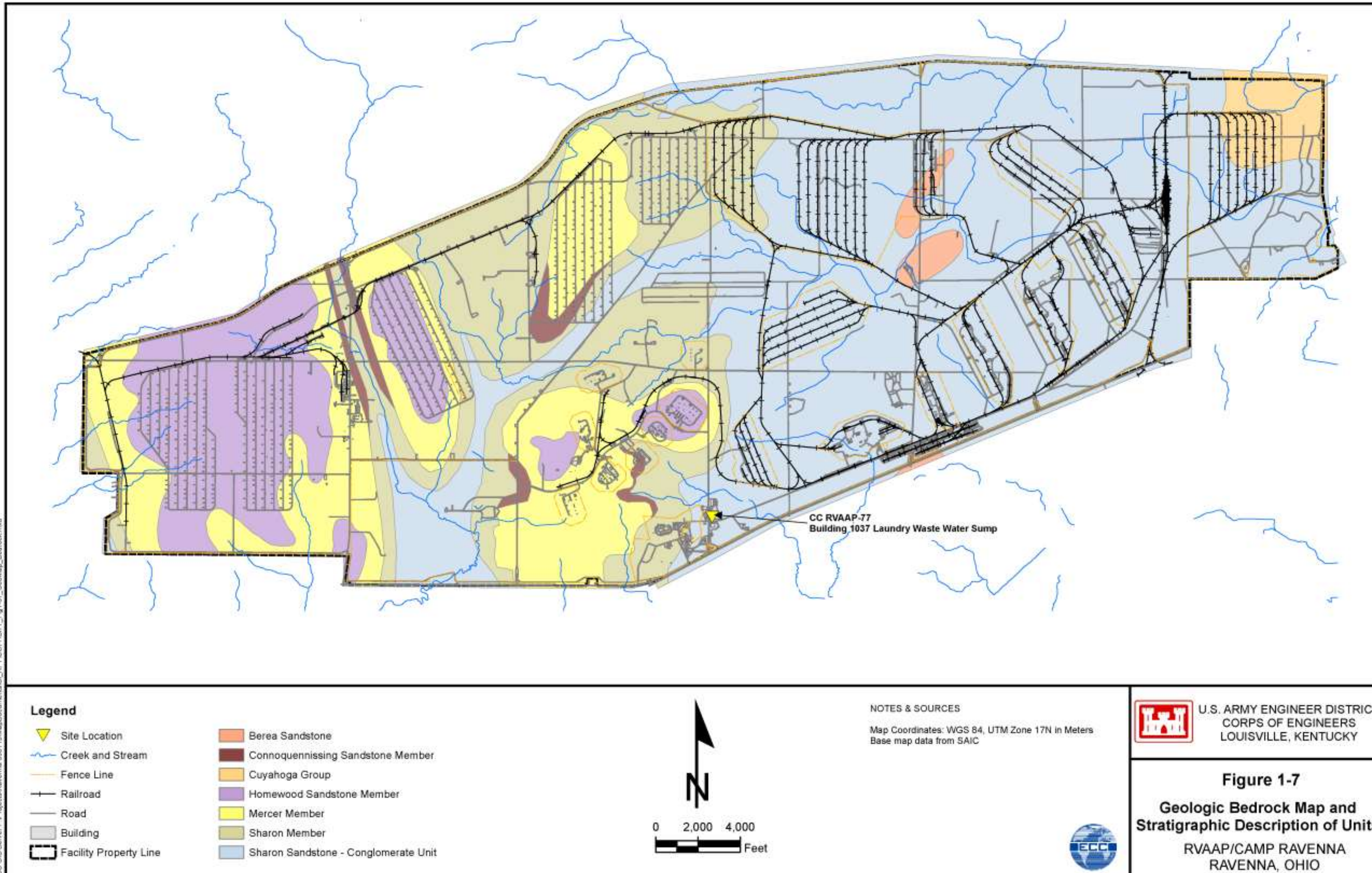
CC RVAAP-77
Building 1037 Laundry Waste Water Sump
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
Berea Sandstone
Connoquennissing Sandstone Member
Cuyahoga Group
Homewood Sandstone Member
Mercer Member
Sharon Member
Sharon Sandstone - Conglomerate Unit
N
0 2,000 4,000
Feet
NOTES & SOURCES
Map Coordinates: WGS 84, UTM Zone 17N in Meters
Base map data from SAIC
U.S. ARMY ENGINEER DISTRICT
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LOUISVILLE, KENTUCKY
Figure 1-7
Geologic Bedrock Map and
Stratigraphic Description of Units
RVAAP/CAMP RAVENNA
RAVENNA, OHIO

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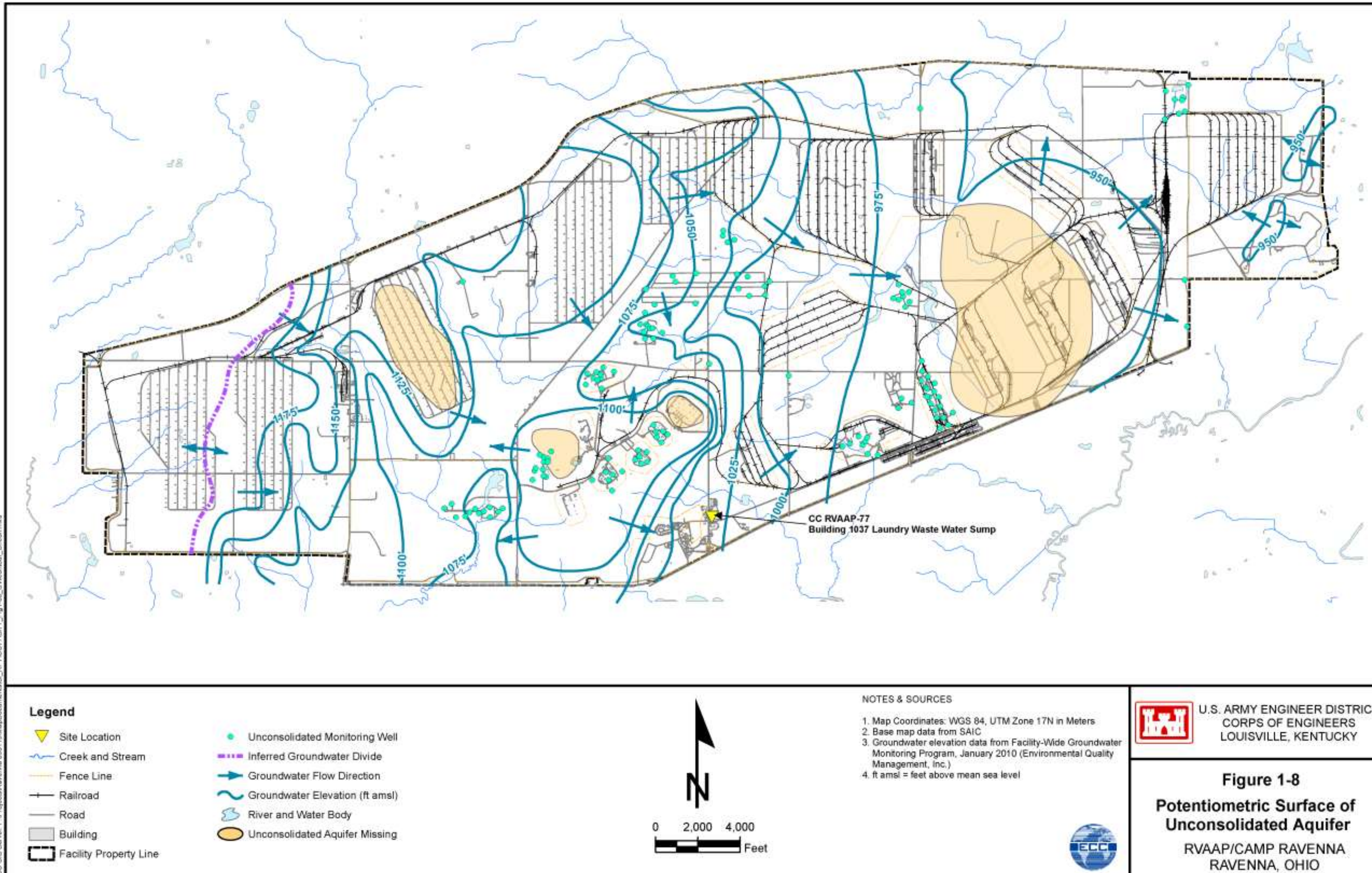
1175'
1150'
1125'
1100'
1075'
1050'
1025'
1000'
975'
950'
CC RVAAP-77
Building 1037 Laundry Waste Water Sump
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
Unconsolidated Monitoring Well
Inferred Groundwater Divide
Groundwater Flow Direction
Groundwater Elevation (ft amsl)
River and Water Body
Unconsolidated Aquifer Missing
N
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters
2. Base map data from SAIC
3. Groundwater elevation data from Facility-Wide Groundwater Monitoring Program, January 2010 (Environmental Quality Management, Inc.)
4. ft amsl = feet above mean sea level
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Figure 1-8
Potentiometric Surface of Unconsolidated Aquifer
RVAAP/CAMP RAVENNA
RAVENNA, OHIO

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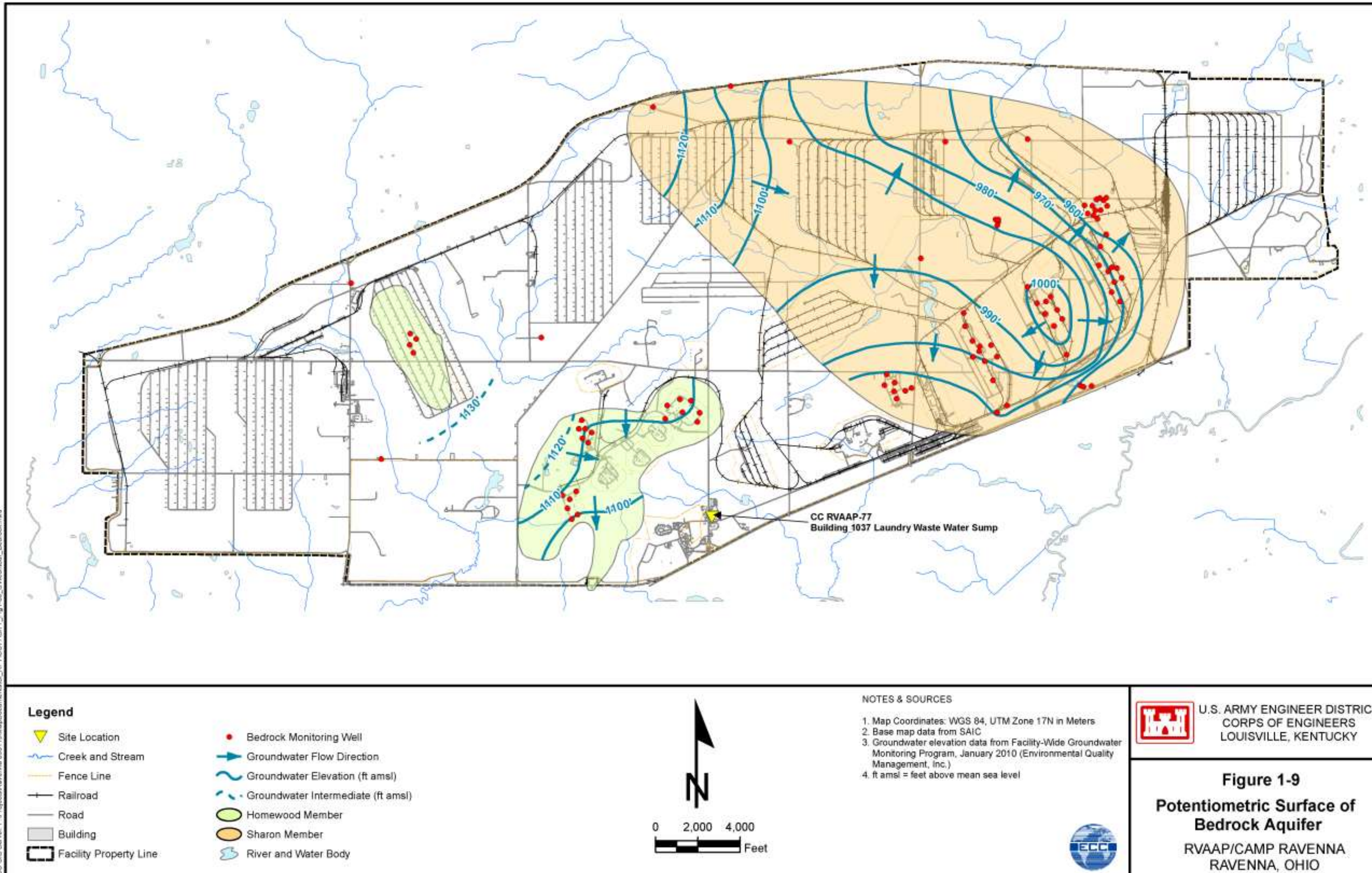
1120'
1110'
1100'
980'
970'
960'
1000'
990'
1130'
CC RVAAP-77
Building 1037 Laundry Waste Water Sump
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
Bedrock Monitoring Well
Groundwater Flow Direction
Groundwater Elevation (ft amsl)
Groundwater Intermediate (ft amsl)
Homewood Member
Sharon Member
River and Water Body
N
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters
2. Base map data from SAIC
3. Groundwater elevation data from Facility-Wide Groundwater Monitoring Program, January 2010 (Environmental Quality Management, Inc.)
4. ft amsl = feet above mean sea level
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ECC
Figure 1-9
Potentiometric Surface of Bedrock Aquifer
RVAAP/CAMP RAVENNA
RAVENNA, OHIO

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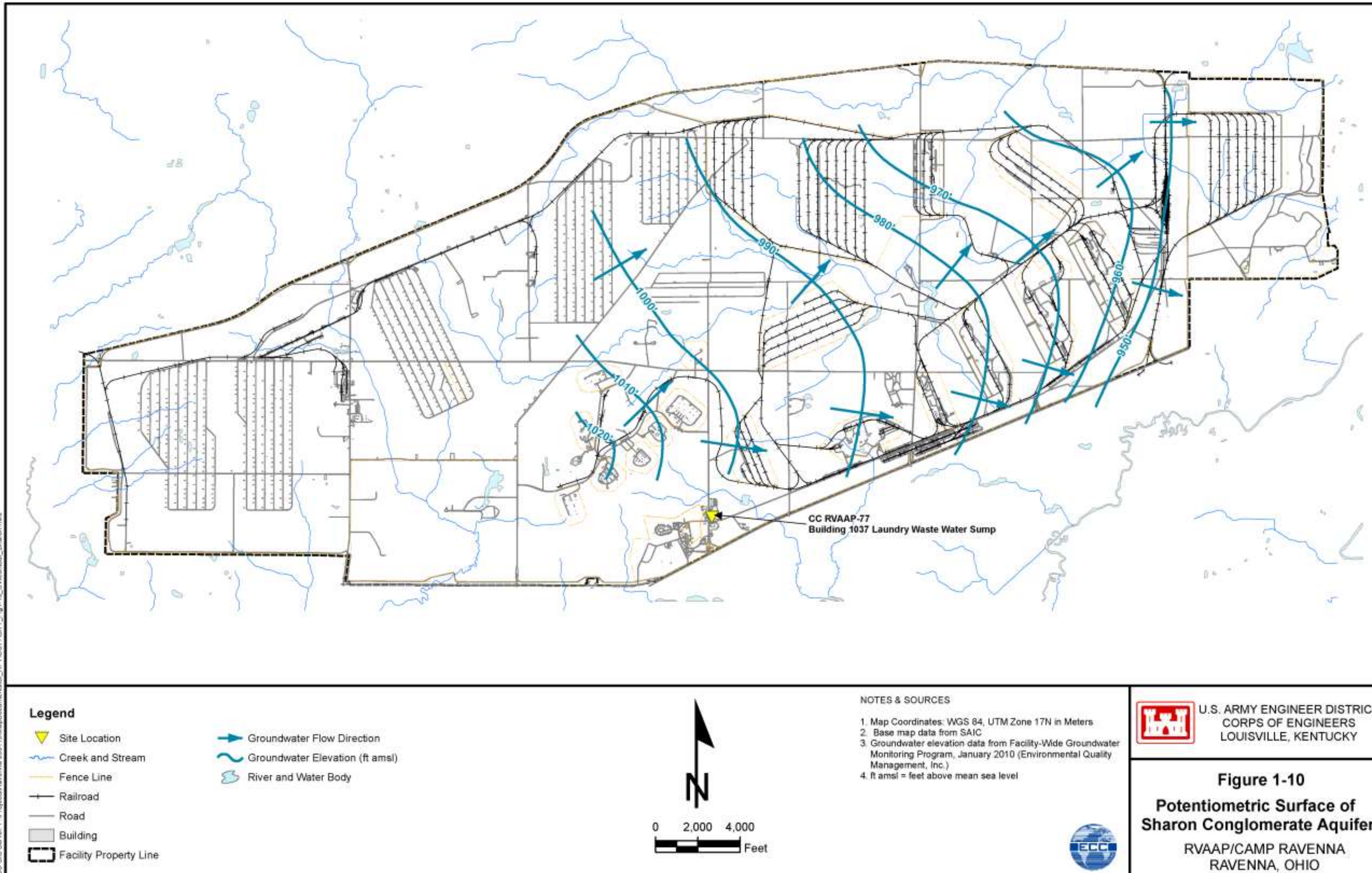

Figure 1-10
Potentiometric Surface of Sharon Conglomerate Aquifer

1087

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2.0 SITE DESCRIPTION & OPERATIONAL HISTORY

2.1 SITE DESCRIPTION

The CR site CC RVAAP-77 Building 1037 Laundry Waste Water Sump AOC (Figure 2-1) consists of the former concrete sump at Building 1037. The building was used from World War II until 1992 as the laundry for the facility. The former laundry was used to launder workers' coveralls, which were potentially contaminated with explosive and propellant compounds handled by workers during munitions production. The concrete sump was a 13 ft by 16 ft underground structure located adjacent to the building. It served as a settling tank for discharged laundry rinse water prior to entering the sanitary sewer. The sump was used to capture solids carried by the rinse water, including potentially explosive-contaminated residues, prior to the water being discharged to the sewer (USACE 2010).

The concrete sump was removed in 2009 as part of the *Disposal of Discarded Munitions Debris and Components, Demolition of the Laundry Flame Proofing Building and Evaluation and Recommendations for Closure of Clean-Hard Fill Sites at the RVAAP* (USACE 2010). Building 1037 has been used since 1992 by the BRAC Division as administrative offices.

Building 1037 is located east of George Road and north of South Service Road in the Administration Area (Figure 2-1). The acreage of the CR site has not been specifically calculated, but is less than one acre.

2.2 LAND USE AND OWNERSHIP HISTORY

CC RVAAP-77, Building 1037 Laundry Waste Water Sump is located within RVAAP which is a federally owned facility. The reasonably anticipated future land use (RAFLU) for this site is military training. Appendix A contains historical aerial photographs (1940 to 2009) of the CR site.

2.3 PHYSICAL PROPERTY CHARACTERISTICS

Site topography is generally flat (Figure 2-1). Surface water runoff drains to the storm sewer system within the Administration Area. The former concrete sump measured approximately 13 ft by 16 ft and was constructed and located approximately 11.5 ft bgs. The sump was located on the north side of Building 1037, the historic laundry building. Building 1037 is currently used for BRAC administrative offices.

2.4 CHRONOLOGICAL PROPERTY SUMMARY

Building 1037 was used from World War II until 1992 as the laundry building for the facility. The concrete sump was removed in 2009 (USACE 2010). The building is now used for administrative offices.

2.5 MILITARY OPERATIONS

The AOC is part of the former operations at RVAAP which is a federally owned facility. With the exception of the laundry support services performed as part of the former RVAAP operations, no other documented evidence of historical military operations being performed at Building 1037 has been reported.

2.6 PREVIOUS INVESTIGATIONS

As described above, demolition and removal of the concrete sump was performed in 2009. Samples of the resultant wood, concrete, and demolition debris were collected. The samples were tested to determine if debris could be classified as being decontaminated to Army level 5X, meaning that the debris is free of explosive residue. All 5X certification sampling results verified that no explosive hazards existed for any of the building debris material. Excavated soil, soil underlying the floor slab, footer, and basin, were visually inspected by an unexploded ordnance (UXO) technician for bulk explosives. No bulk explosives were identified. No samples of excavated soil or soil within excavations were collected for analysis. Following sump demolition and removal, excavated site soil was used as backfill to fill the excavation. In addition, 94.5 tons of additional backfill, approved for use by the Ohio EPA (USACE 2010), was imported to complete the work.

An HRR was conducted in 2010 (SAIC 2011b) for this CR site. The report made the following observations and conclusions:

- The concrete sump was used as a settling tank to remove solids from the laundry rinse water prior to entering the sanitary sewer. The concrete settling basin approximately 13 ft by 16 ft was demolished and removed from Building 1037 in 2009. Solids were periodically removed from the sump and burned to remove explosive residues, presumably at either Erie Burning Grounds or the Winklepeck Burning Grounds.

- Samples of the resultant wood, concrete, and soil from the piled debris were collected. All 5X certification sampling results verified no explosive hazards existed with any of the building material. Excavated soil, and soil underlying the floor slab, footer, and basin, was visually inspected by UXO technician for bulk explosives. No bulk explosives were identified.

- No samples of excavated soil or soil within the excavations were collected for analysis.

- Excavated site soil was used as backfill with about 94.5 tons of additional off-site backfill sampled and approved for use by the Ohio EPA.

- Interviewees during the HRR indicated the workers' coveralls were treated with flame retardant. Interviewees also indicated that dry cleaning operations were not conducted at the laundry facility; furthermore, no records of dry cleaning operations have been found.

- No documented evidence of a spill or release at the laundry building was found during the historical records review. No confirmation samples were collected from the excavation pit. No documentation regarding the presence of above ground storage tanks (AST) or underground storage tanks (UST) associated with Building 1037 Laundry Waste Water Sump AOC was discovered during the HRR.

- No visual evidence of impacts (e.g., stained soil, stressed vegetation) was observed during the property visit.

- The HRR recommended further investigation for subsurface soil around the former sump locations for target analytes to include explosives and propellants at CC RVAAP-77 (SAIC 2011b).

Based on information available and discovered during the HRR report (as listed above), the following area was identified as requiring additional investigation at the Building 1037 Laundry Waste Water Sump AOC and is the focus of this SI:

- Area of former sump and drainage area

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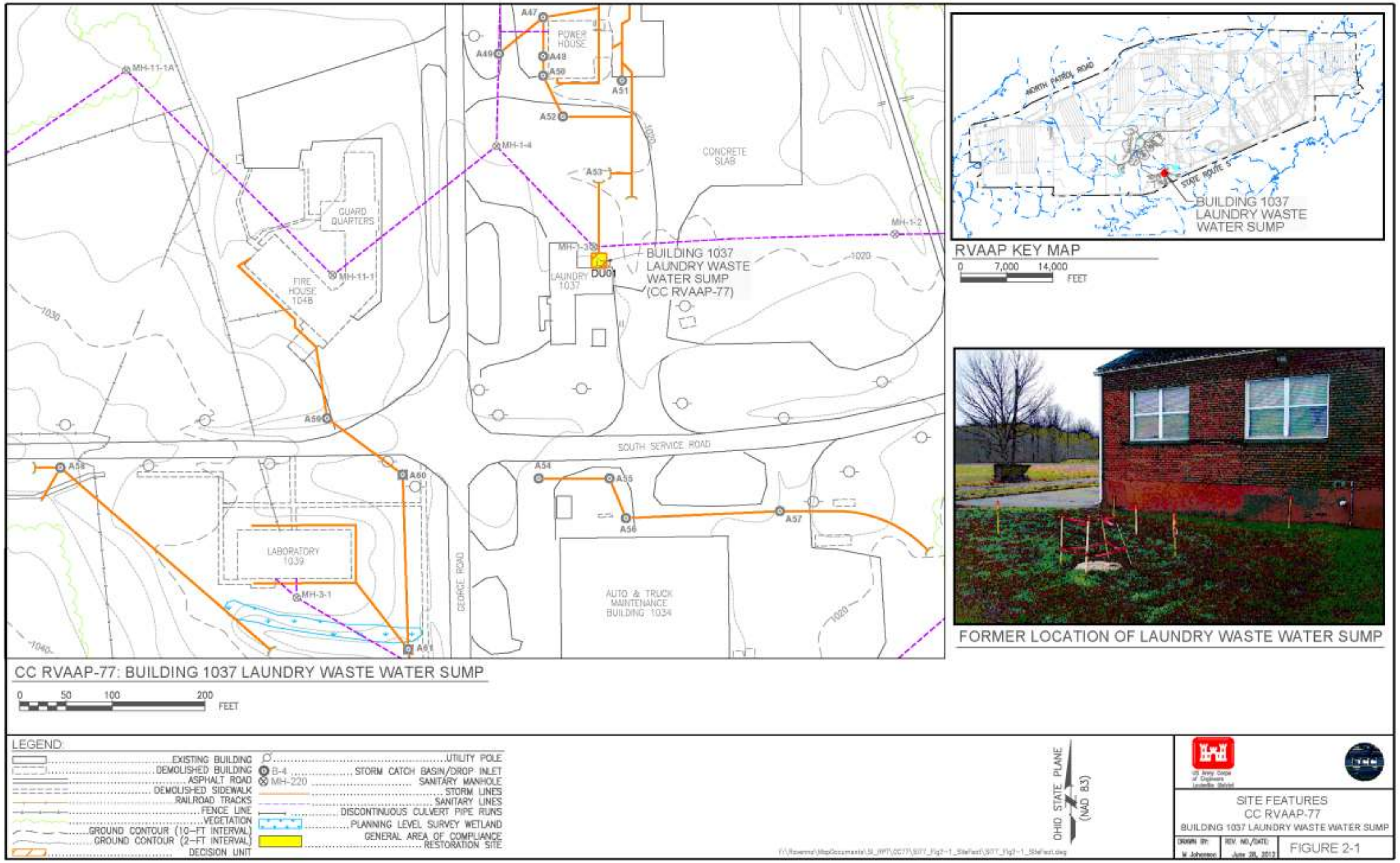
A47
POWER HOUSE
A49
A48
A50
A51
MH-11-1A
A52
MH-1-4
CONCRETE SLAB
A53
GUARD QUARTERS
MH-1-2
MH-1-3
BUILDING 1037
LAUNDRY WASTE
WATER SUMP
(CC RVAAP-77)
LAUNDRY 1037
DU01
FIRE HOUSE 1048
MH-11-1
1030
A59
SOUTH SERVICE ROAD
A58
A60
A54
A55
A56
A57
LABORATORY 1039
GEORGE ROAD
MH-3-1
AUTO & TRUCK MAINTENANCE BUILDING 1034
1020
1040
A61
NORTH PATROL ROAD
STATE ROUTE 5
BUILDING 1037
LAUNDRY WASTE
WATER SUMP
RVAAP KEY MAP
0 7,000 14,000
FEET
FORMER LOCATION OF LAUNDRY WASTE WATER SUMP
CC RVAAP-77: BUILDING 1037 LAUNDRY WASTE WATER SUMP
0 50 100 200
FEET
LEGEND:
EXISTING BUILDING
DEMOLISHED BUILDING
ASPHALT ROAD
DEMOLISHED SIDEWALK
RAILROAD TRACKS
FENCE LINE
VEGETATION
GROUND CONTOUR (10-FT INTERVAL)
GROUND CONTOUR (2-FT INTERVAL)
DECISION UNIT
UTILITY POLE
B-4 STORM CATCH BASIN/DROP INLET
MH-220 SANITARY MANHOLE
STORM LINES
SANITARY LINES
DISCONTINUOUS CULVERT PIPE RUNS
PLANNING LEVEL SURVEY WETLAND
GENERAL AREA OF COMPLIANCE RESTORATION SITE
OHIO STATE PLANE (NAD 83)
SITE FEATURES
CC RVAAP-77
BUILDING 1037 LAUNDRY WASTE WATER SUMP
FIGURE 2-1

1218

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3.0 HISTORICAL OR FORMER OPERATIONS

3.1 HISTORICAL OPERATIONS

According to the HRR report (SAIC 2011b), the laundry building was used to launder RVAAP production facility workers' coveralls that were potentially contaminated with explosive and propellant chemicals. Interviewees contacted as part of the HRR indicated the coveralls were treated with flame retardant. Interviewees also indicated that dry cleaning operations were not conducted at the laundry facility, and there are no records of dry cleaning operations associated with this CR site.

The concrete sump was used as a settling tank to remove the solids from laundry rinse water prior to entering the sanitary sewer. The system included the use of sawdust to trap explosives. Solids were periodically removed from the sump and burned to remove explosive residues, presumably at either Erie Burning Grounds or the Winklepeck Burning Grounds. The filtered water was discharged to the sanitary sewer for treatment at the George Road Sewage Treatment Plant (CC RVAAP-75). No other information related to historical operations, spills, or releases of contaminants were reported or discovered during the HRR.

3.2 POTENTIAL CONTAMINANTS OF CONCERN

Former operations at CC RVAAP-77 discovered during the HRR (SAIC 2011b) are summarized in Table 3-1.

Table 3-1: Summary of Historical or Former Operations

Past Operations - Building 1037 Laundry Waste Water Sump – CC RVAAP-77		
Operations	**Reported Documentation**	**Evidence/Description/Potential Contaminants**
Military Operations	None	None
Operations Involving HTRW	Yes	- Laundry support service provided for workers' coveralls potentially contaminated with explosive and propellant chemicals. - Flame retardants – Used as protective coating on coveralls, which were laundered at the CR site.

Historical Aerial Photographic Review - Building 1037 Laundry Waste Water Sump – CC RVAAP-77		
Years of Photo	**Notable Findings**	**Description**
1940 - 2009	None	Not Applicable

Table 3-1: Summary of Historical or Former Operations (Continued)

Previous Investigations/Removal Actions- Building 1037 Laundry Waste Water Sump – CC RVAAP-77		
Year	**Type Investigation/Action**	**Findings**
2009	Removal of concrete sump	– 5X certification sampling indicated no explosive hazards existed in building material. – Visual inspection of excavated soils showed no evidence of bulk explosives.
2011	Historical Records Review	Facility was used to launder coveralls potentially contaminated with explosives and propellants. Interviewees indicated that the coveralls were also treated with flame retardants. The laundry sump was recommended for further investigation.

4.0 FIELD INVESTIGATION

Work conducted for this SI was conducted in accordance with the Final SI/RI Work Plan (ECC 2012) and the *Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC 2011a) dated February 24, 2011, unless specifically noted otherwise (Section 4.4).

4.1 SAMPLING RATIONALE

This SI addresses surface soil, subsurface soil and sediment at CC RVAAP-77. Surface water is not present at the AOC. Sampling was conducted at CC RVAAP-77 to ascertain whether contamination is present in the subsurface soil or in sediment (if found within the manhole which the former sump discharged to).

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 any necessary notifications to the RVAAP Facility Manager, Ohio EPA, the operating contractor, and other stakeholders.

4.2.1 Site Walk, Locate Decision Units and Direct-Push Boring Locations

ECC personnel mobilized to RVAAP on October 22, 2012 to conduct a site walk and pre-mark Decision Units (DU) and direct-push boring locations at CC RVAAP-77. One decision unit, DU01, was designated for this CR site.

4.2.1.1 Site Walk

ECC conducted a site walk at CC RVAAP-77 to assess current site conditions and to note any potential health and safety hazards that could affect field work.

4.2.1.2 Decision Units and Direct-Push Boring Locations

CC RVAAP-77 contains one DU (DU01) sampling area as shown on Figure 4-1. Surface soil ISM (0 - 1 ft bgs), and two horizontal subsurface soil ISM samples were collected at intervals 1 - 4 ft bgs and 4 - 7 ft bgs. Five vertical subsurface soil ISM samples were collected at the interval of 1 - 7 ft bgs. In addition, one boring (deep soil boring [DSB]) was advanced to the 7 - 13 ft bgs to collect a composite subsurface soil sample to complete an evaluation of the unrestricted/residential land use scenario as outlined in the *Facility-Wide Human Health Risk Assessor Manual* (FWHHRAM) (USACE 2005).

After the DU was located and marked, direct-push soil boring locations were then marked with wooden stakes with high visibility paint and flagging prior to beginning the field activities.

4.2.1.3 MEC and Utility Clearance Surveys

Based on HRR findings (SAIC 2011b) and findings from the sump removal project, MEC clearance was not required or conducted at the Building 1037 Laundry Waste Water Sump. No documentation of military munitions being historically located or stored on-site was discovered.

ECC met with VISTA Sciences Corporation (VISTA) representatives on October 23, 2012 at Building 1037. During this meeting ECC inquired of Mr. James D. McGee, VISTA Project Manager for RVAAP, about utility clearance protocols at RVAAP. Mr. McGee said that ECC should contact the OHARNG regarding utility clearance. After his review of the sites, Mr. McGee reported that any utility within these areas would either have been previously removed or, if still in place, inactive and not energized. No live/active utilities were encountered during any of the drilling activities conducted at CC RVAAP-77.

4.2.1.4 Site Clearing Activities

As the area around Building 1037 is mowed grass, no site clearing activities were necessary.

4.2.1.6 Site Security

No specific site security was needed at CC RVAAP-77.

4.2.1.7 Equipment Decontamination

Prior to beginning surface soil sampling, all sampling equipment was decontaminated at a pre-designated area within Building 1036. For this purpose, a piece of plastic sheeting 5 feet square 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 consisting of pesticide grade isopropyl alcohol, a 10% 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% 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 the Building 1037 Laundry Waste Water Sump, 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% nitric acid solution, and laboratory supplied DI water contained in spray bottles. The decontamination area was set up on plastic sheeting off the eastern side of Building 1037.

All decontamination fluids were containerized in a Department of Transportation (DOT) 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 Facility-Wide Sampling and Analysis Plan (FWSAP) (SAIC 2011a).

4.3 FIELD SAMPLING

At CC RVAAP-77 Former Laundry Waste Water Sump, ISM soil samples were collected to ascertain whether contamination is present within the AOC. DU01 was designated within the site as shown in Figure 4-1. Between November 11 and December 3, 2012, both surface ISM (0 - 1 ft bgs) and subsurface ISM (1 - 4 ft, 4 - 7 ft, and 1 - 7 ft bgs) samples were collected within DU01.

Surface and subsurface soils collected at CC RVAAP-77 were sampled for one or more of the following analytes, which includes one RVAAP Full Suite sample analysis:

- Volatile organic compounds (VOC) using EPA Method SW-846, 8260B/5035 (only collected as a discrete sample)
- Semi-volatile organic compounds (SVOC) using EPA Method SW-846, 8270C/3540C
- Polychlorinated biphenyls (PCB) using EPA Method SW-846, 8082/3540C
- Explosive derivatives using EPA Method SW-846, 8330B
- Propellants using EPA Methods Nitrocellulose E353.2 and Nitroguanidine 8330

- Pesticides using EPA Method 8081/3540C
- Target Analyte List (TAL) Metals using EPA Method SW-846, 6010B/6020/7471A, including total chromium analysis

Table 4-1 summarizes the SI samples and sample rationale specific to DU01.

Table 4-1: SI Samples and Rationales

Sample Type	Depth (ft bgs)	Location	Sample ID	Date Sampled	Comments/Rationale
ISM	0-1	DU01	077SS-0001M-0001-SO	11/11/2012	Characterize an area not previously sampled. Analyzed for RVAAP full-suite analytes.
ISM	0-1	DU01	077SS-0002M-0001-SO	11/11/2012	QA/QC, duplicate sample of 077SS-0002M-0001-SO
ISM	0-1	DU01	077SS-0001M-0002-SO	11/11/2012	MS/MSD of 077SS-0001M-0001-SO
ISM	0-1	DU01	077SS-0003M-0001-TB	11/11/2012	QA/QC, Trip blank
ISM	1-4	DU01/SB1 – SB5	077SS-0004M-0001-SO	12/3/2012	Characterize horizontal area not previously sampled.
ISM	4-7	DU01/SB1 – SB5	077SS-0005M-0001-SO	12/3/2012	Characterize horizontal area not previously sampled.
ISM	1-7	DU01/SB1	077SS-0006M-0001-SO	12/3/2012	Characterize vertical extent not previously sampled.
ISM	1-7	DU01/SB2	077SS-0007M-0001-SO	12/3/2012	Characterize vertical extent not previously sampled.
ISM	1-7	DU01/SB3	077SS-0008M-0001-SO	12/3/2012	Characterize vertical extent not previously sampled.
ISM	1-7	DU01/SB4	077SS-0009M-0001-SO	12/3/2012	Characterize vertical extent not previously sampled.
ISM	1-7	DU01/SB5	077SS-0010M-0001-SO	12/3/2012	Characterize vertical extent not previously sampled.
Composite	7-13	DU01/SB2	077SS-0011M-0001-SO	12/3/2012	Deep soil boring. Characterize deep interval not previously sampled.

Notes:
DU = Decision Unit
ft bgs = feet below ground surface
ID = Identification
ISM = Incremental Sampling Methodology
QA/QC = Quality Assurance/Quality Control
RVAAP = Ravenna Army Ammunition Plant
SB = Soil Boring
SI = Site Inspection

Samples collected during the SI at CC RVAAP-77 were analyzed at TestAmerica Laboratories, Inc. (herein referred to as TestAmerica) of North Canton, Ohio and West Sacramento, California. Quality control split samples were not collected during this SI at CC RVAAP-77.

All analytical procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, Department of Defense (DoD) Quality Systems Manual (QSM) Version 3, USACE Louisville District analytical Quality

Assurance (QA) standards, and specific project goals and requirements. Preparation and analyses for chemical parameters were performed according to the methods listed in Table 4-2.

Table 4-2: Summary of SI Sample Preparation and Analytical Procedures

Parameter	Soil		Aqueous	
	Preparation	Analysis	Preparation	Analysis
Inorganic chemicals	SW-846 3050B	SW-846 6020	NA	NA
Mercury	--	SW-846 7471A	NA	NA
Propellants: - Nitrocellulose - Nitroguanidine	SW-846 3550A	E353.2 Modified SW-846 8330 Modified	NA	NA
SVOCs and PAHs	SW-846 3540C	SW-846 8270C	NA	NA
Explosives	SW-846 3550A	SW-846 8330B	NA	NA
VOCs	SW-846 5035	SW-846 8260B	SW-846 5030B	SW-846 8260B
Pesticides	SW-846 3540C	SW-846 8081A	NA	NA
PCBs	SW-846 3540C	SW-846 8082	NA	NA

Notes:
NA = Not Applicable
PAH = Polynuclear Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyl
SI = Site Inspection
SVOC = Semi-Volatile Organic Compound
VOC = Volatile Organic Compound

4.3.1 Surface Soil ISM Sampling

One surface soil ISM sample was collected at CC RVAAP-77. The surface soil sample aliquots were collected from 0 - 1 ft bgs using ISM methods as detailed in the Final SI/RI Work Plan (ECC 2012) in order to define the lateral extent of contamination in surface soil. Thirty individual soil samples (aliquots) were collected to comprise the ISM sample. The surface soil ISM samples were collected using the hand auger and trowel/spoon method as described in Sections 5.6.2.1.1 and 5.6.2.1.2, respectively, of the FWSAP (SAIC 2011a).

The hand auger consisted of a hollow stainless steel rod approximately ¾-inch in diameter and 4 ft in length with a "T" handle attached to the top. A 12-inch section at the tip of the sampler was cut away to facilitate collecting the sample. The sampler had a foot peg attached 12-inches from the bottom tip that was used to advance the sampler to 1 ft bgs. The sampler was advanced to 1 ft bgs, then withdrawn, and the soil sample was then collected from within the cut-away section using stainless steel scoopulas.

Surface soil samples were collected from 0 - 1 ft bgs. However, if rock or gravel was encountered at depths less than 1 foot, samples were collected from the accessible portion of the 0 - 1 ft interval. Samples were collected to assess contaminant occurrence and distribution in surface soils.

Table 4-1 presents a summary of the medium sampled, sample collection methods, number of samples collected, and rationale for sampling activities conducted at CC RVAAP-77. Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples were collected at a frequency of 5%. Field duplicate samples were collected at a frequency of 10%.

4.3.2 Subsurface Soil ISM Sampling

4.3.2.1 Horizontal ISM Soil Sampling

Two horizontal subsurface soil samples were collected. The first ISM subsurface horizontal soil sample was collected from 1 - 4 ft bgs, and the second from 4 - 7 ft bgs.

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 5.5.2.1.3 of the FWSAP (SAIC 2011a). Samples were collected using 5-ft long stainless steel sampling rods lined with acetate Microcore® samplers. Each sample was collected using a dedicated liner specific for that interval. The sampler was advanced to the desired depth. The sampler was then retrieved from the desired depth and the liner removed. The liner was then cut open length-wise and field screened with a photoionization detector (PID). Where applicable, the VOC sample was collected using a disposable Terracore® sampler. Soil characteristics for each interval were logged on a soil boring log. Based on required analysis, additional soil samples were collected from the respective interval and placed in appropriate container(s). All sample containers were labeled and placed in a cooler with ice following collection.

4.3.2.2 Vertical ISM Soil Sampling

Five vertical ISM samples were collected from five borings (SB1 – SB5) at the CC RVAAP-77. Vertical ISM samples were collected from 1 - 7 ft bgs. The 5-ft stainless steel sampler was advanced twice at each boring location to reach the final depth of 7 ft. A sample was collected by cutting open the acetate liner length-wise and running a stainless steel scoopula along the length of the sample from 1 - 5 ft and from 5 - 7 ft to collect a representative ISM vertical sample from that boring. Where applicable, VOC samples were collected immediately after the liner was opened and screened with the PID. Based on required analysis, additional soil samples were collected and placed in the appropriate container(s). All samples were labeled and placed in a cooler with ice following collection.

4.3.3 Deep Subsurface Soil Boring Sampling

One DSB was advanced at CC RVAAP-77 to evaluate the residential (unrestricted) scenario as required under CERCLA. The boring was advanced to a depth of 13 ft bgs, and a composite sample was collected from the 7 - 13 ft bgs interval. The sample was collected in accordance with composite sampling procedures as described in Section 5.5.2.5.1 in the FWSAP (SAIC 2011a). At CC RVAAP-77, the DSB sample was collected at decision unit DU01 at soil boring SB2.

4.3.4 Sediment Sampling

No sediment was observed at the bottom of the manhole and therefore, no sediment sample was collected at CC RVAAP-77 since no sediment was present when the manhole cover was removed on November 11, 2012. In accordance with the Final SI/RI Work Plan, a discrete sediment sample was proposed from the bottom of the manhole adjacent to DU01 only in the event that sediment was found in the manhole (ECC 2012). The drainage pipe from the former laundry sump to the manhole has been sealed with concrete. Flowing water approximately 1-inch deep was observed in the manhole flowing eastward toward the George Road Sewage Treatment Plant.

Table 4-3 summarizes the sampling by medium (surface soil, subsurface soil, vertical profile, and deep soil boring).

Table 4-3: Summary of Sampling by Medium

Medium	Sample Interval (ft bgs)	Sample Type		Laboratory Analysis[1]	
		ISM	C	Explosives	Propellants
Surface Soil	0 - 1	X		1[2]	1[2]
Subsurface Soil	1 - 4 and 4 - 7	X		2[2]	2[2]
Soil Boring Vertical Profile	1 - 7	X		5[2]	5[2]
Deep Soil Boring	7 - 13		X	1[2]	1[2]

1. In addition, RVAAP Full Suite (as defined in Facility-Wide Quality Assurance Project Plan [FWQAPP] Section 5.4.5) samples were collected at a frequency of 10%. One sample underwent full suite analysis.
2. Number represents number of samples collected.

C = Composite
ft bgs = feet below ground surface
ISM = Incremental Sampling Methodology

4.4 DEVIATIONS FROM WORK PLAN

The following deviation from the Final SI/RI Work Plan (ECC 2012) for fieldwork conducted at CC RVAAP-77 is listed below:

- No sediment soil samples were collected at CC RVAAP-77. A discrete sediment sample was originally proposed for collection from the bottom of the manhole adjacent to decision unit DU01. However, when the manhole cover was removed to facilitate sediment sampling, no sediment was observed at the bottom of the manhole. It was also noted during this inspection that the drainage pipe from the former laundry sump to the manhole is sealed with concrete. See Appendix H for photographs of the interior of this manhole.

4.5 SURVEYING

ECC subcontracted the surveying of the soil boring locations within CC RVAAP-77 to Campbell and Associates, Inc., Cuyahoga Falls, Ohio, a licensed surveyor in the State of Ohio. All survey data was reported in North American Datum (NAD) 1983 Universal Transverse Mercator (UTM) Zone 17 North in meters.

4.6 INVESTIGATION-DERIVED WASTE

Investigation-Derived Waste (IDW) consisted of soil cuttings from subsurface soil sampling, personal protective equipment (PPE), used, empty acetate liners, used TerraCore® samplers, and general non-environmental trash. The soil cuttings were primarily collected in plastic garbage liners placed inside 5-gallon buckets.

Additional soil materials were collected on the clear six millimeter (6-mil) thick plastic sheeting placed on the ground at the end of the cutting table and below the two five-gallon buckets used for collecting soil cuttings. A large garbage bag was used to contain used nitrile gloves, the used TerraCore® samplers, and cut-up pieces of acetate liners. A long-handled steel lopper was used to cut the acetate liners into 12 to 18-inch long pieces for ease of disposal. Finally, a large garbage bag was used to collect general non-environmental waste. The buckets for soil cuttings were brought to Building 1036 and placed in appropriately labeled 55-gallon open-headed drums.

4.6.1 Collection and Containerization

All IDW, including soil cuttings, PPE, disposable sampling equipment, and decontamination fluids, 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 RVAAP's Installation Hazardous Waste Management Plan (BRACO 2009).

4.6.2 Characterization for Disposal

IDW disposal characterization samples were collected by ECC personnel on December 12, 2012. Samples were comprised of liquid IDW consisting of decontamination fluids, and solid IDW consisting of drill cuttings. IDW analysis included both liquid and solid full Toxicity Characteristic Leaching Procedure (TCLP), and Reactivity, Corrosivity, and Ignitability (RCI) analysis.

4.6.3 Transportation and Disposal

On March 15, 2013, Ohio EPA approved the IDW letter report for the transport and disposal of the accumulated IDW as a result of executed SI tasks. The Ohio EPA approval letter for the IDW is provided in Appendix G. On April 5, 2013, the drummed IDW was transported under a non-hazardous waste manifest by Emerald Environmental Services, Inc. for disposal at Vexor Technology in Medina, Ohio. The manifest is provided in Appendix G.

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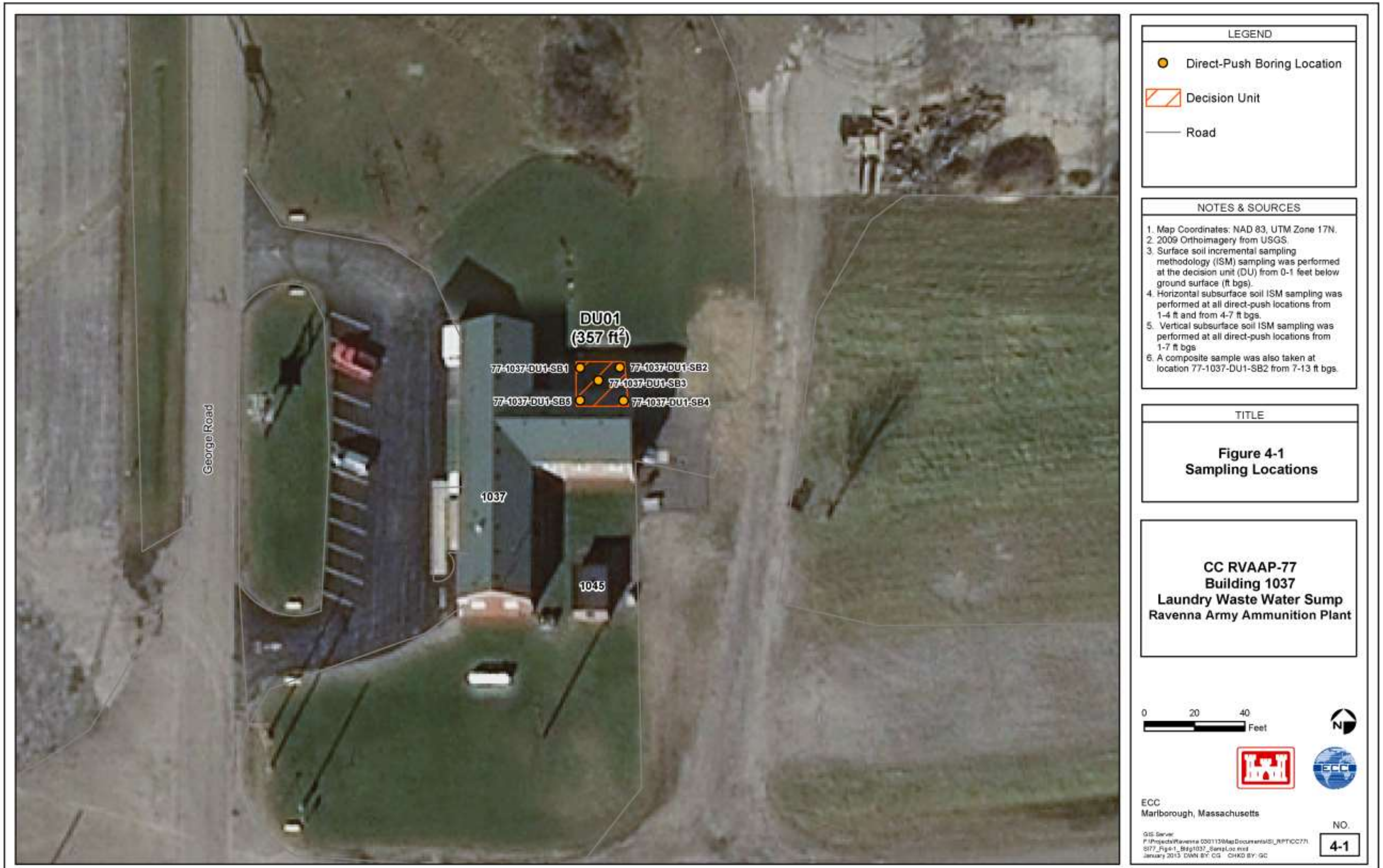
LEGEND
Direct-Push Boring Location
Decision Unit
Road
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N.
2. 2009 Orthoimagery from USGS.
3. Surface soil incremental sampling methodology (ISM) sampling was performed at the decision unit (DU) from 0-1 feet below ground surface (ft bgs).
4. Horizontal subsurface soil ISM sampling was performed at all direct-push locations from 1-4 ft and from 4-7 ft bgs.
5. Vertical subsurface soil ISM sampling was performed at all direct-push locations from 1-7 ft bgs
6. A composite sample was also taken at location 77-1037-DU1-SB2 from 7-13 ft bgs.
TITLE
Figure 4-1
Sampling Locations
CC RVAAP-77
Building 1037
Laundry Waste Water Sump
Ravenna Army Ammunition Plant
0
20
40
Feet
N
ECC
Marlborough, Massachusetts
NO.
4-1
DU01
(357 ft²)
77-1037-DU1-SB1
77-1037-DU1-SB2
77-1037-DU1-SB3
77-1037-DU1-SB5
77-1037-DU1-SB4
George Road
1037
1045

1586

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5.0 DATA EVALUATION AND INVESTIGATION RESULTS

This section summarizes the analytical sampling results for CC RVAAP-77 Building 1037 Laundry Waste Water Sump. Laboratory analytical data for the SI are provided in Appendix E.

5.1 DATA EVALUATION METHOD

The SI data collected were verified and validated in accordance with the procedures outlined in the FWSAP (SAIC 2011a). The processes used to evaluate the analytical data involved three general steps: (1) defining data aggregates; (2) data verification, reduction, and screening; and (3) data presentation. The completed data verification report is included in Appendix D and the data validation report (to be provided by USACE, Louisville District) is included as Appendix F of this SI report. The data reporting convention used will be consistent with past data reporting practices to ensure comparability. Non-detect data will be reported at Limit of Quantitation (LOQ).

5.1.1 DEFINITION OF AGGREGATES

The basic aggregation of data for this SI was medium-specific as detailed in Section 4.0 and included the following:

- Surface Soils (0 to 1 ft bgs)
- Subsurface Soils Horizontal Profile (1 to 4 and 4 to 7 ft bgs)
- Soil Boring Vertical Profile (1 to 7 ft bgs)
- Deep Soil Boring (7 to13 ft bgs)

5.1.2 DATA VERIFICATION, REDUCTION, AND SCREENING

5.1.2.1 Data Verification

Data verification was performed on the surface and 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. Results were qualified as follows:

- “U” not detected
- “UJ” not detected, reporting limit estimated
- “J” indicates the analyte was positively identified, but the associated numerical value is an approximate concentration of the analyte in the sample
- “R” result 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 Quality Control (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).

Independent, third-party validation of 10% of the SI data and 100% of the USACE QA laboratory data will be performed by a USACE, Louisville District subcontractor and is provided as Appendix F – Data Validation Report.

5.1.2.2 Data Reduction

Data reduction was not completed for this SI. Due to the limited number of samples collected for the SI, statistical analysis of the data collected at the AOC was not necessary in the data evaluation process.

5.1.2.3 Data Screening

The data were screened to identify Site-Related Chemicals (SRC) using the processes outlined below. Figure 5-1 illustrates the screening process to identify SRCs and COPCs in accordance with the Final Facility-Wide Human Health Cleanup Goals (SAIC 2010). All chemicals not eliminated during the screening steps were retained as SRCs. The steps involved in the SRC screening are summarized below:

- **Data quality assessment**: Data were produced, reviewed, and reported by the laboratory in accordance with specifications in the FWSAP (SAIC 2011).

- **Background screening**: The maximum detected concentrations (MDC) of inorganic chemicals were compared to the RVAAP background concentrations, where established. If exceedances above background concentrations occurred, the respective inorganic chemicals were retained as SRCs. Several inorganic chemicals are screened against a background concentration of 0 mg/kg (e.g., cadmium, silver), as they were not detected in the samples collected during the background study. Therefore, any detection of these inorganic chemicals, regardless of magnitude, results in their identification as SRCs.

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

USEPA recommends these chemicals not be evaluated unless they are grossly elevated relative to background concentrations or would exhibit toxicity at the observed concentrations (USEPA 1989, USACE 2009).

For informational purposes only, the recommended daily allowance (RDA) and recommended daily intake (RDI) values are available for all of these nutrients. Screening values for receptors ingesting 100 milligrams (mg) of soil per day or 1 liter of groundwater per day to meet their RDA/RDI are listed in Table 5-1. In the case of calcium, magnesium, phosphorous, potassium, and sodium, a receptor ingesting 100 mg of soil per day would receive less than the RDA/RDI value even if the soil consisted of the pure mineral (i.e., soil concentrations at 1,000,000 mg/kg). Essential nutrients detected at or below their RDA/RDI-based screening levels were eliminated as COPCs. These inorganics were included in the analysis, but exceedances are not discussed in the text.

Table 5-1: Recommended Daily Allowance/Recommended Daily Intake Values

Essential Human Nutrient	USDA RDA/RDI[a] Value
Calcium	1,000 mg/d
Chloride[b]	3,400 mg/d
Iodine	150 ug/d
Iron	8 mg/d
Magnesium	400 mg/d
Potassium[b]	4,700 mg/d
Phosphorous	700 mg/d
Sodium[b]	2,300 mg/d

Notes:
Values were obtained from http://fnic.nal.usda.gov charts
[a] Dietary Reference intakes vary by gender and age, values present are for life stage group: Males 19-30 years.
[b] Adequate Intake Value
RDA/RDI = Recommended Daily Allowance/Recommended Daily Intake
mg/d = milligrams per day
ug/d= micrograms per day
USDA = United States Department of Agriculture

- **Frequency of detection/weight-of-evidence (WOE) screening**: Chemicals that were never detected in a given medium were eliminated as SRC. For chemicals detected in at least 20 samples and a frequency of detection of less than 5%, a WOE approach was used to determine if the chemical is AOC-related. The WOE approach evaluated magnitude and location (clustering) of detected results and if the distribution of detected results indicated a potential source of the chemical. If the detected results for a chemical showed: (1) no clustering; (2) concentrations were not substantially elevated relative to the detection limit; and (3) the chemical did not have an evident source, the results were considered spurious and the chemical was eliminated from further consideration. Frequency-of-detection/WOE screening was applied to the CC RVAAP-77 data set by matrix, surface soil and subsurface soil, frequency of detection in relation to the source, and concentrations of the chemical. This screening was applied to all organic and inorganic chemicals, with the exception of explosives and propellants. All detected explosives and propellants were considered as SRCs regardless of frequency of detection.

5.1.3 Data Presentation

Data screening results for SRCs identified at CC RVAAP-77 are presented for soils at the AOC (Figure 5-2 and Figure 5-3). Analytical results for SRCs are presented by sample location in Section 5.2. To provide an indication of the presence of contamination, concentrations of SRCs that exceed the lowest FWCUG [target risk (TR) = 10^{-6} and/or hazard index (HI) = 0.1], based on the National Guard Trainee or Resident Farmer Adult are highlighted in these figures. These SRCs were further evaluated in the screening process. The analytical results for SRCs are also presented in data summary tables (Table 5-4 and Table 5-5) for CC RVAPP-77. The complete laboratory analytical data packages are included in Appendix E as well as laboratory analytical result tables with final qualifiers.

5.1.4 Data Use Evaluation

The subsurface and surface soil sample data were evaluated as part of this SI and used to perform the AOC-specific screens and data evaluations. No previous data were used in the evaluation process. Groundwater is currently being investigated under a separate facility-wide program and was not sampled during this SI. Sediment and surface water are not present at this AOC.

Analytical results of the soil sampling conducted as part of this SI were initially used to determine whether the chemical was a SRC and was evaluated performing the AOC-specific screen. The reported results were used to (1) compare the reported concentrations to the background level (where established), (2) determine the frequency of detection, and (3) determine whether the chemical was an essential nutrient for each media (i.e., surface and subsurface soil). Table 5-2 and Table 5-3 present the SRC screening summary tables for surface soil and subsurface soil, respectively. All of the analytical data collected during this SI were also compared to the media-specific and depth interval-specific (surface [0 - 1 ft bgs] or subsurface [greater than 1 ft bgs]) FWCUGs as well as to background levels, if established, for both surface and subsurface soils as shown in Tables 5-4 and 5-5. The FWCUGs used were at the 10^{-6} cancer risk level and non-carcinogenic risk Hazard Quotient (HQ) using the 0.1 risk as values as specified in the FWSAP (SAIC 2011a). The cancer risk level is the excess risk of cancer from exposure to a chemical. The defined FWCUGs can be found in the Final Facility-Wide Human Health Cleanup Goals for the RVAAP (SAIC 2010). FWCUGs used for data comparison were the Resident Farmer Adult (RAF) values and the National Guard Trainee (NGT) values.

Table 5-2: SRC Screening Summary Surface Soil

Analytes	CAS Number	Freq Of Detect	Min Detect	Max Detect	Avg Result	BKG Criteria[(a)]	SRC (yes/no)	SRC Justification
VOCs (ug/kg)								
Methyl Isobutyl Ketone	108-10-1	1/2	0.09	0.09	.09	None	Yes	Detected Organic
SVOCs (ug/kg)								
2-Methylnaphthalene	95-48-7	2/2	54	60	57	None	Yes	Detected Organic
Anthracene	120-12-7	1/2	11	11	11	None	Yes	Detected Organic
Benzo(a)anthracene	56-55-3	2/2	48	57	52.5	None	Yes	Detected Organic
Benzo(a)pyrene	50-32-8	2/2	65	88	76.5	None	Yes	Detected Organic
Benzo(b)fluoranthene	205-99-2	2/2	81	91	86	None	Yes	Detected Organic
Benzo(g,h,i)perylene	191-24-2	2/2	37	47	42	None	Yes	Detected Organic
Benzo(k)fluoranthene	207-08-9	2/2	17	18	17.5	None	Yes	Detected Organic
Chrysene	218-01-9	2/2	57	66	61.5	None	Yes	Detected Organic
Dibenzofuran	132-64-9	2/2	14	14	14	None	Yes	Detected Organic
Fluoranthene	206-44-0	2/2	99	120	109.5	None	Yes	Detected Organic
Fluorene	86-73-7	1/2	9.6	9.6	9.6	None	Yes	Detected Organic
Indeno(1,2,3-c,d)Pyrene	193-39-5	2/2	44	55	49.5	None	Yes	Detected Organic
Naphthalene	91-20-3	2/2	44	54	49	None	Yes	Detected Organic
Phenanthrene	85-01-8	2/2	64	77	70.5	None	Yes	Detected Organic
Pesticides and PCBs (ug/kg)								
beta Endosulfan	33213-65-9	0/2	0	0	0	None	No	Not Detected
Heptachlor Epoxide	1021-57-3	0/2	0	0	0	None	No	Not Detected
p,p'-DDD	72-54-8	0/2	0	0	0	None	No	Not Detected
p,p'-DDE	72-55-9	2/2	5.2	8.6	6.9	None	Yes	Detected Organic
Metals (mg/kg)								
Aluminum	7429-90-5	2/2	7,700	8,200	7,950	17,700	No	Below Background
Antimony	7440-36-0	2/2	0.17	0.2	0.185	0.96	No	Below Background
Arsenic	7440-38-2	2/2	12	14	13	15.4	No	Below Background
Barium	7440-39-3	2/2	48	49	48.5	88.4	No	Below Background
Beryllium	7440-41-7	2/2	0.42	0.46	0.44	0.88	No	Below Background
Cadmium	7440-43-9	2/2	0.19	0.2	0.195	0	Yes	Exceeds Background
Calcium **	7440-70-2	2/2	4,500	5,200	4,850	15,800	No	Essential Nutrient
Chromium	7440-47-3	2/2	15	18	16.5	17.4	Yes	Exceeds Background
Cobalt	7440-48-4	2/2	7.4	7.7	7.55	10.4	No	Below Background
Copper	7440-50-8	2/2	16	17	16.5	17.7	No	Below Background
Iron	7439-89-6	2/2	20,000	22,000	21,000	23,100	No	Below Background
Lead	7439-92-1	2/2	21	22	21.5	26.1	No	Below Background
Magnesium **	7439-95-4	2/2	2,700	2,800	2,750	3,030	No	Essential Nutrient
Manganese	7439-96-5	2/2	520	540	530	1,450	No	Below Background
Mercury	7439-97-6	2/2	0.041	0.045	0.043	0.036	Yes	Exceeds Background
Nickel	7440-02-0	2/2	24	28	26	21.1	Yes	Exceeds Background
Potassium **	7440-09-7	2/2	740	830	785	927	No	Essential Nutrient
Selenium	7782-49-2	2/2	0.53	0.56	0.545	1.4	No	Below Background
Silver	7440-22-4	2/2	0.027	0.03	0.0285	0	Yes	Exceeds Background
Sodium **	7440-23-5	2/2	29	32	30.5	123	No	Essential Nutrient
Thallium	7440-28-0	2/2	0.13	0.14	0.135	0	Yes	Exceeds Background
Vanadium	7440-62-2	2/2	15	16	15.5	31.1	No	Below Background
Zinc	7440-66-6	2/2	62	63	62.5	61.8	Yes	Exceeds Background

Table 5-2: SRC Screening Summary Surface Soil (Continued)

Analytes	CAS	Freq	Min	Max	Avg	BKG	SRC	SRC Justification

	Number	Of Detect	Detect	Detect	Result	Criteria[(a)]	(yes/no)	
Explosives (mg/kg)								
Tetryl	**55-63-0**	**1/2**	**0.083**	**0.083**	**0.083**	**None**	**Yes**	**Detected Organic**
Propellants	**556-88-7**	**1/2**	**0.055**	**0.055**	**0.055**	**None**	**Yes**	**Detected Organic**
Nitroglycerin	**479-45-8**	**1/2**	**0.028**	**0.028**	**0.028**	**None**	**Yes**	**Detected Organic**
Nitroguanidine	**55-63-0**	**1/2**	**0.083**	**0.083**	**0.083**	**None**	**Yes**	**Detected Organic**

Notes:
(a) Background concentrations for wet sediment from final facility-wide background concentrations for RVAAP, published in the 2001 Phase II Remedial Investigation Report for Winklepeck Burning Grounds.
Bold indicates analyte identified as an SRC
CAS = Chemical abstract number
SRC = Site-related chemical
mg/kg = Milligrams per kilogram
ug/kg = Micrograms per kilogram
SVOC = Semi-volatile organic compound
VOC = Volatile organic compound
PCB = Polychlorinated biphenyl
DDD = Dichlorodiphenyldichloroethane
DDE = Dichlorodiphenyldichloroethylene

Table 5-3: SRC Screening Summary Subsurface Soil

Analytes	CAS Number	Freq Of Detect	Min Detect	Max Detect	Avg Result	BKG Criteria[(a)]	SRC (yes/no)	SRC Justification
Explosives (mg/kg)								
Tetryl	479-45-8	0/8	0	0	0	None	No	Not Detected
Propellants (mg/kg)								
Nitroglycerin	55-63-0	0/8	0	0	0	None	No	Not Detected
Nitroguanidine	556-88-7	0/8	0	0	0	None	No	Not Detected

Notes:
(a) Background concentrations for wet sediment from final facility-wide background concentrations for RVAAP, published in the 2001 Phase II Remedial Investigation Report for Winklepeck Burning Grounds.
Bold indicates analyte identified as an SRC
CAS = Chemical abstract number
SRC = Site-related chemical
mg/kg = Milligrams per kilogram
Freq = Frequency

Table 5-4: Organic Analytes Detected in Surface Soil Samples

				Sample Location:	Surface Sample DU-01	Field Dup of 0001M-0001
				Location ID:	77-1037-DU1-SS	77-1037-DU1-SS
				Field Sample ID:	077SS-0001M-0001-SO	077SS-0002M-0001-SO
				Lab Sample ID:	240-17525-5	240-17525-6
				Sample Date:	11/11/2012	11/11/2012
				Depth (ft):	0-1	0-1
Method/Chemicals	**BKG**	**NGT FWCUG**	**RAF FWCUG**	**RSL**		
Volatile Organic Compounds (ug/kg)						
Methyl Isobutyl Ketone	None	None	238,000	530,000	21 U	**0.90 J**
Semi-Volatile Organic Compounds (ug/kg)						
2-Methylnaphthalene	None	None	None	23,000	**54**	**60**
Anthracene	None	None	None	1,700,000	27 U	**11 J**
Benzo(a)anthracene	None	4,770	221	---	**57**	**48**
Benzo(a)pyrene	None	470	22	---	**88**	**65**
Benzo(b)fluoranthene	None	4770	221	---	**91**	**81**
Benzo(g,h,i)perylene	None	None	None	None	**47**	**37**
Benzo(k)fluoranthene	None	47,700	2,210	---	**18 J**	**17**
Chrysene	None	477,000	22,100	---	**66**	**57**
Dibenzofuran	None	1,192,000	119,000	---	**14 J**	**14 J**
Fluoranthene	None	5,087,000	276,000	---	**120**	**99**
Fluorene	None	11,458,000	30,000	---	27 U	**9.6 J**
Indeno(1,2,3-c,d)Pyrene	None	4,770	221	---	**55**	**44**
Naphthalene	None	1,541,000	360,000	---	**44**	**54**
Phenanthrene	None	None	None	None	**77**	**64**
Pyrene	None	3,815,000	207,000	---	**95**	**74**
Pesticides and PCBs (ug/kg)						
beta Endosulfan	None	None	None	None	25 UJ	25 UJ
Heptachlor Epoxide	None	1,480	152	---	25 UJ	25 UJ
p,p'-DDD	None	None	None	2,000	20 UJ	20 UJ
p,p'-DDE	None	49,100	4,080	---	**5.2 J**	**8.6 J**
Propellants (mg/kg)						
Nitroglycerin	None	982	81.6	---	0.50 U	**0.083 J**
Nitroguanidine	None	None	None	610	0.25 U	**0.055 J**
Explosives (mg/kg)						
Tetryl	None	None	None	24	0.25 U	**0.028 J**

Notes:
Exceeds one or more FWCUG, cell shaded yellow
NR = Not reported/not analyzed
J = estimated value less than reporting limits
UJ = not detected and reporting limit is estimated
U = non-detected concentration, below detection limit
mg/kg = milligrams per kilogram
ug/kg = micrograms per kilogram
--- Not applicable
FWCUG = Facility-Wide Clean Up Goal
RSL = Regional Screening Level (USEPA 2012)
RAF = Resident Farmer Adult
NGT = National Guard Trainee
BKG = Background
DU = Decision Unit
ft = feet
Bold indicates chemical detected

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Table 5-5: Inorganic Analytes Detected in Surface Soil Samples

				Sample Location:	Surface Sample DU-01	Field Dup of 0001M-0001
				Location ID:	77-1037-DU1-SS	77-1037-DU1-SS
				Field Sample ID:	077SS-0001M-0001-SO	077SS-0002M-0001-SO
				Lab Sample ID:	240-17525-5	240-17525-6
				Sample Date:	11/11/2012	11/11/2012
				Depth (ft):	0-1	0-1
Method/ Chemical	**BKG**	**NGT FWCUG**	**RAF FWCUG**	**RSL**		
Metals (mg/kg)						
Aluminum	17,700	3,496	52,923	---	**8,200**	**7,700**
Antimony	0.96	175	13.6	---	**0.20 J**	**0.17 J**
Arsenic	15.4	2.78	0.425	---	**12**	**14**
Barium	88.4	351	8,966	---	**49**	**48**
Beryllium	0.88	None	None	16.0	**0.46**	**0.42**
Cadmium	0	10.9	22.3	---	**0.19**	**0.20**
Calcium **	15,800	None	None	None	**4,500 J**	**5,200 J**
Chromium	17.4	329,763	19,694	---	**18**	**15**
Cobalt	10.4	7.03	803	---	**7.4**	**7.7**
Copper	17.7	25,368	2,714	---	**16 J**	**17 J**
Iron	23,100	184,370	19,010	---	**22,000**	**20,000**
Lead	26.1	None	None	40.0	**22**	**21**
Magnesium **	3,030	None	None	None	**2,800 J**	**2,700 J**
Manganese	1,450	35.1	1,482	---	**540**	**520**
Mercury	0.036	172	16.5	---	**0.045 J**	**0.041 J**
Nickel	21.1	12,639	1,346	---	**24**	**28**
Potassium **	927	None	None	None	**830**	**740**
Selenium	1.4	None	None	39.0	**0.56**	**0.53**
Silver	0	3,105	324	---	**0.027 J**	**0.030 J**
Sodium **	123	None	None	None	**29 J**	**32 J**
Thallium	0	47.7	4.76	---	**0.13**	**0.14**
Vanadium	31.1	2,304	156	---	**16**	**15**
Zinc	61.8	187,269	19,659	---	**63**	**62**

Notes:
Exceeds Background and one or more FWCUG, cell shaded yellow
J = Estimated value
mg/kg = Milligrams per kilogram
FWCUG = Facility-Wide Cleanup Goal
Bold indicates chemical detected
--- Not applicable
** = Essential nutrient
RSL = Regional Screening Level (USEPA 2012)
RAF = Resident Farmer Adult
NGT = National Guard Trainee
BKG = Background
DU = Decision Unit
ft = feet

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For metals, observed concentrations were compared to both to background values and to the FWCUGs. Metals whose concentrations exceeded background values are displayed on Figure 5-3. If the concentration also exceeded the FWCUG (or the FWCUG was equivalent to the background value), the value on the figure is highlighted. If a FWCUG has not been established, the concentration was compared to USEPA Regional Screening Levels (RSL) which is also provided in the summary tables (Tables 5-4 and 5-5).

For organic compounds, observed concentrations were compared to the FWCUGs. Concentrations of organic compounds are posted on Figure 5-2. If the concentration exceeded the FWCUG, the value on the figure is highlighted. If no FWCUG value has been established, detected concentrations were compared to USEPA RSLs.

Once the analytical results were compared to the FWCUGs, the chemicals were considered for further screening as COPCs in the subject medium when the following apply:

- The chemical is site-related
- The chemical was assigned a FWCUG
- The concentration of the chemical exceeds the Resident Farmer Adult FWCUG (equal to 10^{-6} and HI = 0.1)

While metals are also reported herein if detected concentrations exceeded published background values, then those metals were no considered to be SRCs.

5.2 SURFACE SOIL ISM ANALYTICAL RESULTS

Data from the CC RVAAP-77 surface soil samples were screened to identify SRCs representing current conditions at the AOC. The SRC screening process used the two surface soil ISM samples collected during the SI activities at DU01. These samples were analyzed for explosives, propellants and metals. In addition, they were analyzed for the RVAAP full-suite analytes (SVOCs, VOCs, PCBs, and pesticides). Table 5-2 presents the results of the SRC screening for surface soil samples for CC RVAAP-77.

As shown in Table 5-2, one VOC (methyl isobutyl ketone) was detected and identified as a SRC which is likely a laboratory contaminant. Several (14) SVOCs were identified as SRCs in surface soil as they were detected and no background values have been established for these chemicals. No pesticides or PCBs were identified as SRCs and seven metals (cadmium, chromium, mercury, nickel, thallium and zinc) were identified as SRCs as the reported concentrations were above background. Four explosive compounds were also identified as SRCs as they were detected as present; however, no background values have been established for these chemicals in surface soils. Of the SRC chemicals identified, only one of these chemicals (benzo(a)pyrene was reported in the surface soil collected from DU01 at a concentration above the FWCUG RAF.

As shown in Table 4-1, two ISM surface soil samples were collected at decision unit DU01. Constituents whose concentrations exceeded cleanup criteria (FWCUGs or background, as applicable) are shown in Figures 5-2 and 5-3. Figures 5-2 and 5-3 spatial present the distribution and concentrations of inorganic and organic SRCs that occur in the surface soil at CC RVAAP-77. To illustrate the extent and magnitude of contaminants on Figures 5-2 and 5-3, those SRCs that exceeded the most stringent FWCUGs are highlighted.

Tables 5-4 and 5-5 present the results for the detected analytes in the surface soil ISM samples. The results for the surface soil samples are presented in Appendix E along with complete copies of all laboratory analytical data packages.

For COPCs detected at concentrations exceeding FWCUGs (or background values in the case of metals), compound names are summarized by chemical suite in the following sections. While other constituents may also have been detected in a given sample, only compounds whose concentrations exceeded the FWCUGs, background values, or RSLs are identified by name in the following discussion.

Results for explosive derivatives and propellant compounds are discussed first because those contaminants were the focus of the investigation based on the HRR report (SAIC 2011b). Discussion of secondary constituents follows, where applicable. These secondary constituents were detected in samples collected as part of the sampling QA/QC protocol (i.e., in the RVAAP full analyte suite surface soil sample), and are not suspected to be site-related chemicals.

5.2.1 Explosives/Explosive Derivatives

At decision unit DU01, no explosives or their derivatives were detected in the ISM surface soil sample collected. Estimated concentrations, ranging from 0.028 J (estimated value) mg/kg to 0.083 J mg/kg, were reported in the duplicate sample collected. Therefore, explosive derivatives have not been identified as COPCs in surface soils at this AOC.

5.2.2 Propellant Compounds

At decision unit DU01, no propellants were detected in the ISM surface soil sample collected. Therefore, propellant compounds have not been identified as COPCs in surface soils at this AOC.

5.2.3 Semi-Volatile Organic Compounds

At decision unit DU01, one polynuclear aromatic hydrocarbon (PAH) benzo(a)pyrene was reported at a concentration of 88 micrograms per kilograms (ug/kg), which exceeds the RAF FWCUG of 22 ug/kg, but does not exceed the NGT FWCUG of 470 ug/kg (Figure 5-2). However, this PAH compound is not considered a COPC as it is not a site-related chemical at CC RVAAP-77 as it is not associated with past historical activities at this AOC.

Benzo(a)pyrene is a byproduct of incomplete combustion or burning of organic material, such as wood, gasoline, and coal (USEPA 2007). Benzo(a)pyrene is also used in asphalt material and materials used in railroad ties and is released to the environment by several mechanisms and through various pathways such as motor vehicle exhaust, emissions from coal, oil and wood burning furnaces, incinerators, and general soot and smoke from industrial sources through the air pathway. Further, surface water runoff and discharges from roadways and railroad ties is another source of PAHs in surface soils (also refer to Kohler, et.al, 2000 and USEPA 2013 for additional information).

However, there are several potential contributing sources for benzo(a)pyrene in surface soil located within 150 to 200 ft of this AOC. A former coal storage area was located to the northeast and Power House No. 6 was located north, approximately 200 ft, of this AOC. The former Power House burned coal to generate power for the facility. In addition to the Power House and coal storage pile, there is an asphalt paved parking area at the rear of Building 1037 that is located 30 feet southeast of DU01. The presence of PAHs detected within the surface soils is considered to be associated with both airborne discharges from the nearby former Power House No. 6 and from roadway surface runoff onto the property from off-AOC activities. The presence of PAHs is not uncommon in an industrialized setting and is considered to be attributable from off-AOC activities such as drainage and runoff of nearby asphalt roadways and deposition of airborne particulates (USEPA 2013). Benzo(a)pyrene is not considered to be a COPC at this AOC.

5.2.4 Volatile Organic Compounds

At decision unit DU01, no VOCs were reported in the primary ISM surface soil sample collected. VOCs are not considered to be a COPC at this AOC.

5.2.5 Polychlorinated Biphenyls

At decision unit DU01, no PCBs were reported above the FWCUGs. One PCB, p,p,-dichlorodiphenyldichloroethylene (DDE), was reported at an estimated concentration (5.2 J ug/kg) in the primary sample which, is less than the FWCUGs. PCBs are not considered to be a COPC at this AOC.

5.2.5 Target Analyte List Metals

At decision unit DU01, metals (chromium, mercury, nickel, and zinc) were reported in ISM surface soil sample at concentrations that exceed their respective background values (as shown in Figure 5-3). However, none of these reported metal concentrations exceeded the respective FWCUGs.

Several other metals (i.e., thallium, silver, and cadmium), for which no background values have been established, were detected at trace level concentrations (Table 5-5) but were below FWCUGs. The metals where background values have not been established are shown on the summary table with a value of zero. None of the detected metals are considered to be a COPC at this AOC.

5.3 HORIZONTAL SUBSURFACE SOIL ISM ANALYTICAL RESULTS

Data from the CC RVAAP-77 subsurface soil samples were screened per spatial aggregate to identify SRCs representing current conditions at the AOC. The SRC screening process for the subsurface soil was comprised of two horizontal ISM subsurface soil samples collected during the SI activities at DU01. These samples were analyzed for explosives and propellants. Table 5-3 presents the results of the SRC screening for all subsurface soil samples collected at CC RVAAP-77. There were no SRCs identified in the subsurface soils at this AOC.

As shown in Table 4-1, two horizontal ISM subsurface soil samples (1 to 4 and 4 to 7 ft bgs) were collected at decision unit DU01. Table 5-6 provides a summary of analytical results from horizontal ISM subsurface soil samples collected from this AOC. Laboratory results from horizontal subsurface soil samples indicated no detectable concentrations of explosive derivatives or propellant compounds. No COPCs have been identified in the subsurface soils sampled at this AOC.

5.4 VERTICAL SUBSURFACE SOIL ISM ANALYTICAL RESULTS

Data from the CC RVAAP-77 subsurface soil samples were screened per spatial aggregate to identify SRCs representing current conditions at the AOC. The SRC screening process for the subsurface soil was comprised of five ISM subsurface soil samples collected during the SI activities at DU01. These samples were analyzed for explosives and propellants. Table 5-3 presents the results of the SRC screening for all subsurface soil samples collected at CC RVAAP-77. There were no SRCs identified in the subsurface soils at this AOC.

As shown in Table 4-1, five vertical ISM subsurface soil samples were collected at decision unit DU01. Table 5-6 provides a summary of analytical results from vertical subsurface soil samples collected from this site. Laboratory results from vertical subsurface soil samples indicated no detectable concentrations of explosive derivatives or propellant compounds. No COPCs have been identified in the subsurface soils sampled at this AOC.

5.5 DEEP SUBSURFACE SOIL DISCRETE SAMPLE ANALYTICAL RESULTS

Data from the CC RVAAP-77 subsurface soil samples were screened per spatial aggregate to identify SRCs representing current conditions at the AOC. The SRC screening process for the subsurface soil was comprised of one deep subsurface soil sample collected from 7 to 13 ft bgs during the SI activities at DU01. This sample was analyzed for explosives and propellants. Table 5-3 presents the results of the SRC screening for all subsurface soil samples collected at CC RVAAP-77. There were no SRCs identified in the subsurface soils at this AOC.

As shown in Table 4-1, one deep subsurface soil sample was collected at DU01. Table 5-6 provides a summary of analytical results from the DSB (7 to 13 ft bgs) sample collected from this site. Laboratory results from the composite DSB sample indicated no detectable concentrations of explosive derivatives or propellant compounds. The analytical data results from DSB subsurface soil samples indicate that no COPCs have been identified at this AOC.

5.6 INVESTIGATION-DERIVED WASTE ANALYTICAL RESULTS

The characterized IDW streams generated during the SI, results of laboratory analyses, IDW classifications, and recommendation for disposal are summarized in a letter report included in Appendix G.

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Table 5-6: Organic Analytes Detected in Subsurface Soil Samples

				Sample Location:	Laundry Sump DU01	Laundry Sump DU01	Laundry Sump DU01	Laundry Sump DU01	Laundry Sump DU01	Laundry Sump DU01	Laundry Sump DU01	Laundry Sump DU01
				Location ID:	77-1037-DU1-SB1-5	77-1037-DU1-SB1-5	77-1037-DU1-SB1	77-1037-DU1-SB2	77-1037-DU1-SB3	77-1037-DU1-SB4	77-1037-DU1-SB5	77-1037-DU1-SB2
				Field Sample ID:	077SB-0004M-0001-SO	077SB-0005M-0001-SO	077SB-0006M-0001-SO	077SB-0007M-0001-SO	077SB-0008M-0001-SO	077SB-0009M-0001-SO	077SB-0010M-0001-SO	077SB-0011M-0001-SO
				Lab Sample ID:	240-18297-1	240-18297-2	240-18297-3	240-18297-4	240-18297-1	240-18297-2	240-18297-3	240-18297-4
				Sample Date:	12/3/2012	12/3/2012	12/3/2012	12/3/2012	12/3/2012	12/3/2012	12/3/2012	12/3/2012
				Depth:	Horizontal ISM, 1-4 ft	Horizontal ISM, 4-7 ft	Vertical ISM, 1-7 ft	Vertical ISM, 1-7 ft	Vertical ISM, 1-7 ft	Vertical ISM, 1-7 ft	Vertical ISM, 1-7 ft	Vertical (DSB), 7-13 ft
Method/ Chemical	**BKG**	**NGT FWCUG**	**RAF FWCUG**	**RSL**								
Explosives (mg/kg)												
Tetryl	None	None	None	24	0.50 U	0.49 U	0.50 U	0.50 U	0.50 U	0.49 U	0.50 U	0.50 U
Propellants (mg/kg)												
Nitrocellulose	None	None	None	8,000,000	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Nitroglycerin	None	982	81.6	---	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Nitroguanidine	None	None	None	610	50 U	48 U	50 U	49 U	48 U	43 U	50 U	53 U

Notes:
Exceeds one or more FWCUG, cell shaded yellow
U = Non-detected concentration
mg/kg = Milligrams per kilogram
FWCUG = Facility-Wide Cleanup Goal
RSL = Regional Screening Level (USEPA 2012)
RAF = Resident Farmer Adult
NGT = National Guard Trainee
BKG = Background
ISM = Incremental Sampling Methodology
DSB = Deep Soil Boring
DU = Decision Unit
ft = feet
--- Not Applicable

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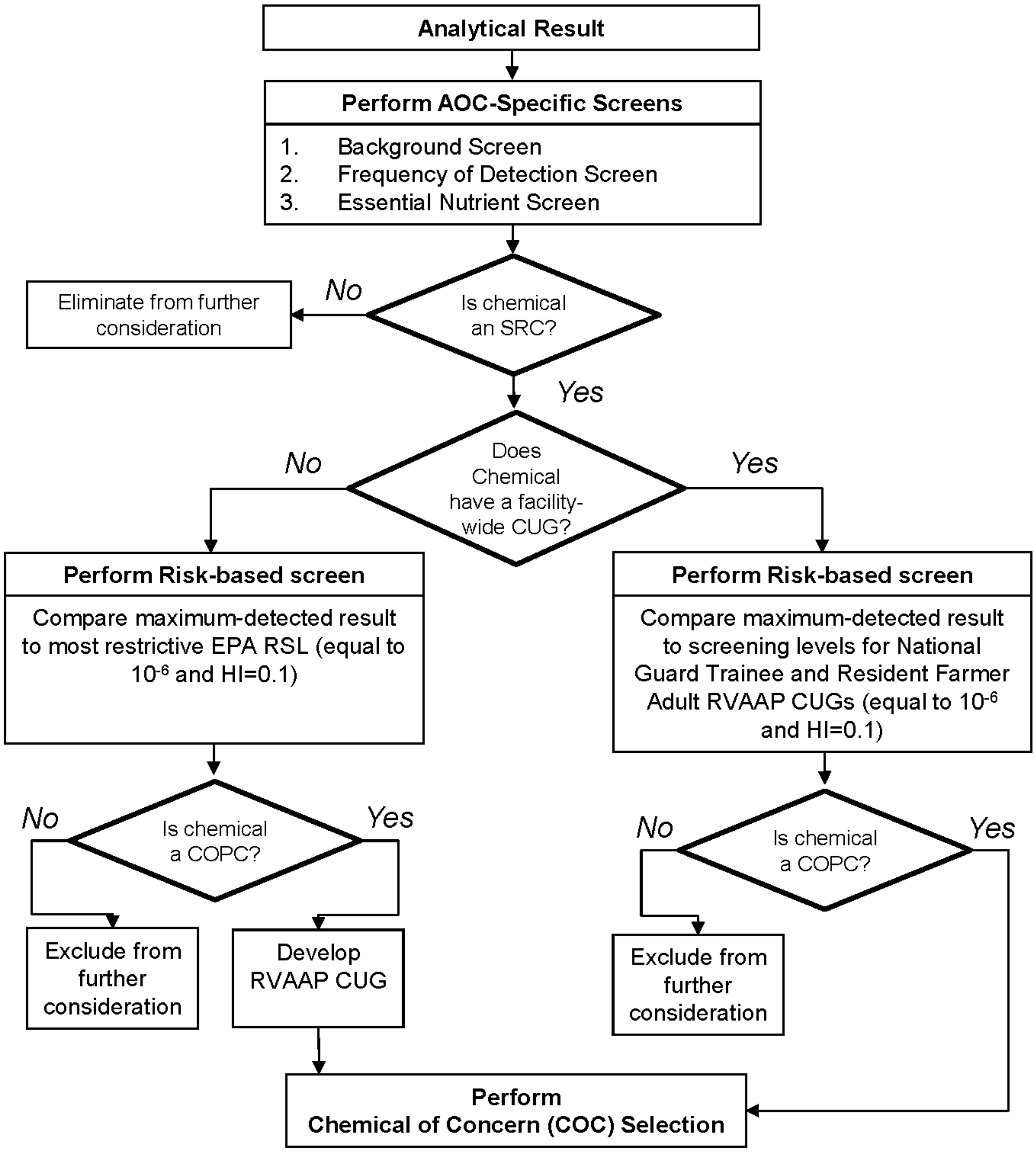
Figure 5-1: Process to Identify RVAAP Chemicals of Concern



COC – Chemical of concern
COPC – Chemical of potential concern
RVAAP – Ravenna Army Ammunition Plant
CUG – Cleanup goal
EPA – Environmental Protection Agency
HI – Hazard Index
RSL – Regional screening level
SRC – Site-related chemical
AOC – Area of Concern

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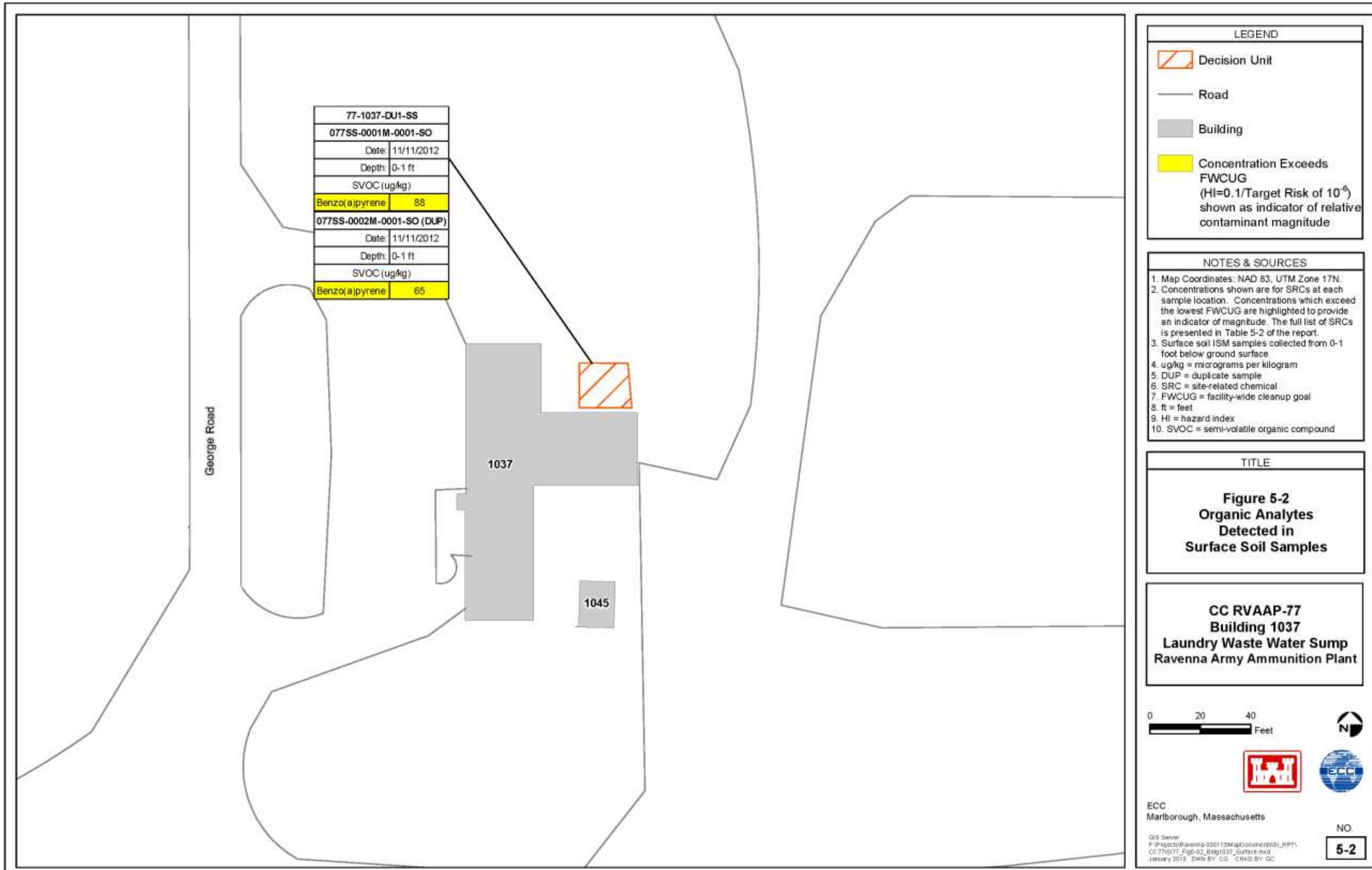
77-1037-DU1-SS
077SS-0001M-0001-SO
Date: 11/11/2012
Depth: 0-1 ft
SVOC (ug/kg)
Benzo(a)pyrene 88
077SS-0002M-0001-SO (DUP)
Date: 11/11/2012
Depth: 0-1 ft
SVOC (ug/kg)
Benzo(a)pyrene 65
George Road
1037
1045
LEGEND
Decision Unit
Road
Building
Concentration Exceeds FWCUG (HI=0.1/Target Risk of 10-6) shown as indicator of relative contaminant magnitude
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N.
2. Concentrations shown are for SRCs at each sample location. Concentrations which exceed the lowest FWCUG are highlighted to provide an indicator of magnitude. The full list of SRCs is presented in Table 5-2 of the report.
3. Surface soil ISM samples collected from 0-1 foot below ground surface
4. ug/kg = micrograms per kilogram
5. DUP = duplicate sample
6. SRC = site-related chemical
7. FWCUG = facility-wide cleanup goal
8. ft = feet
9. HI = hazard index
10. SVOC = semi-volatile organic compound
TITLE
Figure 5-2
Organic Analytes
Detected in
Surface Soil Samples
CC RVAAP-77
Building 1037
Laundry Waste Water Sump
Ravenna Army Ammunition Plant
0 20 40
Feet
N
ECC
Marlborough, Massachusetts
NO.
5-2

2096

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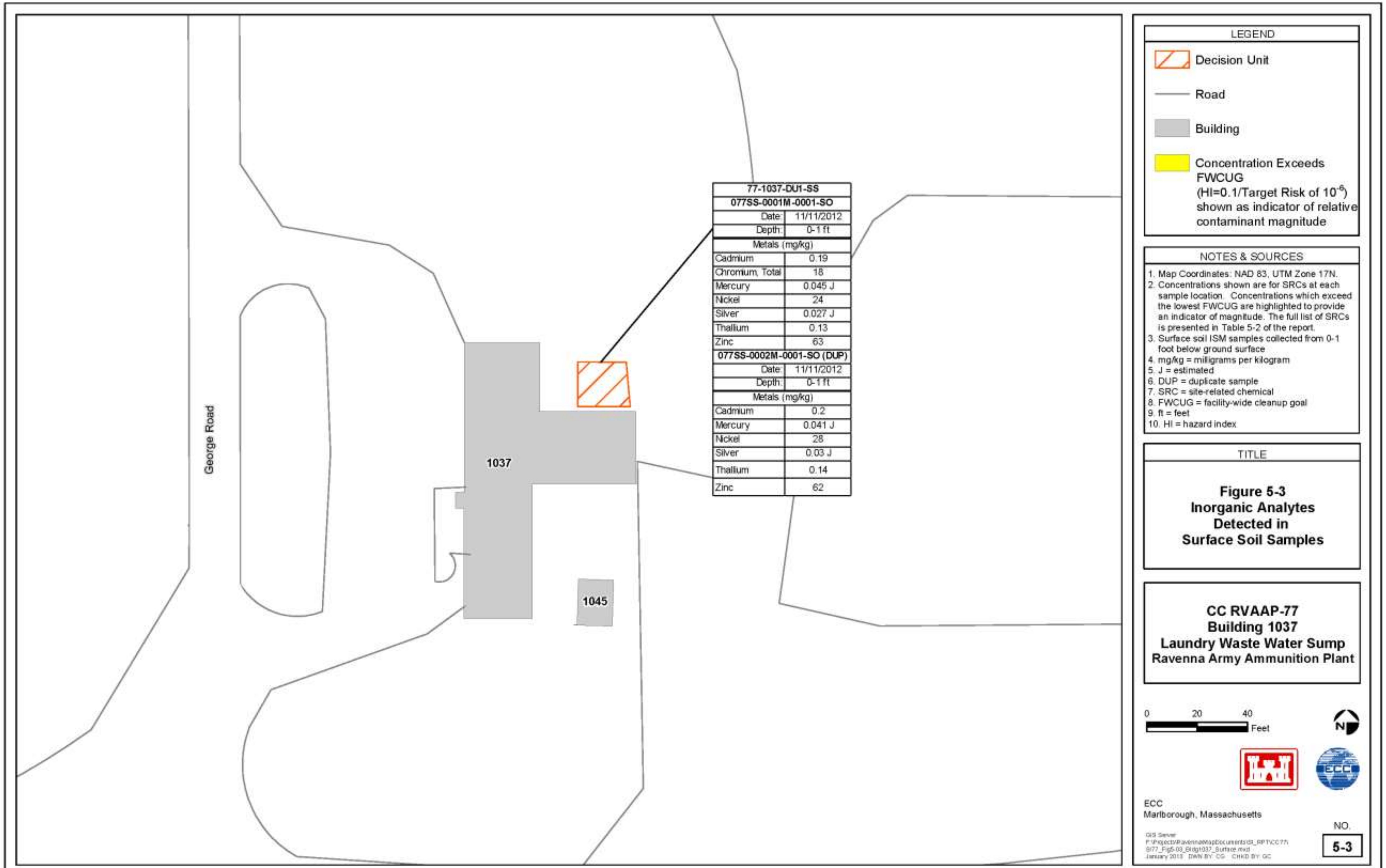
George Road
1037
1045
77-1037-DU1-SS
077SS-0001M-0001-SO
Date: 11/11/2012
Depth: 0-1 ft
Metals (mg/kg)
Cadmium 0.19
Chromium, Total 18
Mercury 0.045 J
Nickel 24
Silver 0.027 J
Thallium 0.13
Zinc 63
077SS-0002M-0001-SO (DUP)
Date: 11/11/2012
Depth: 0-1 ft
Metals (mg/kg)
Cadmium 0.2
Mercury 0.041 J
Nickel 28
Silver 0.03 J
Thallium 0.14
Zinc 62
LEGEND
Decision Unit
Road
Building
Concentration Exceeds FWCUG (HI=0.1/Target Risk of 10-6) shown as indicator of relative contaminant magnitude
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N.
2. Concentrations shown are for SRCs at each sample location. Concentrations which exceed the lowest FWCUG are highlighted to provide an indicator of magnitude. The full list of SRCs is presented in Table 5-2 of the report.
3. Surface soil ISM samples collected from 0-1 foot below ground surface
4. mg/kg = milligrams per kilogram
5. J = estimated
6. DUP = duplicate sample
7. SRC = site-related chemical
8. FWCUG = facility-wide cleanup goal
9. ft = feet
10. HI = hazard index
TITLE
Figure 5-3
Inorganic Analytes
Detected in
Surface Soil Samples
CC RVAAP-77
Building 1037
Laundry Waste Water Sump
Ravenna Army Ammunition Plant
0 20 40
Feet
N
ECC
Marlborough, Massachusetts
NO.
5-3

2109

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6.0 EXPOSURE PATHWAYS

6.1 SOIL EXPOSURE AND AIR PATHWAYS

6.1.1 Physical Conditions

The site is located within Hiram Till glacial deposits. The soil type found at this AOC is the Mahoning silt loam, 0-2% slopes (MgA) (Figure 1-6, Table 1-1). Mahoning silt loam is a gently sloping, poorly drained soil formed in silty clay loam or clay loam glacial till. The Mahoning silt loam has low permeability, with rapid runoff and seasonal wetness (USDA 2010).

The bedrock formation at the AOC based on groundwater well installation logs is the Pennsylvanian-age Pottsville Formation, Sharon Sandstone member, informally referred to as the Sharon Conglomerate (Winslow and White 1966). The elevation of the Sharon Sandstone is approximately 980 ft amsl based on Ohio Department of Natural Resources (ODNR) bedrock topography map (Figure 1-7).

6.1.2 Soil and Air Targets

Current potential soil targets include human and ecological (animal and plant) receptors that may come into contact with surface or subsurface soil, if contaminants are present within or adjacent to the AOC. Ecological receptors present in the AOC vicinity may also be exposed to potential soil contaminants. Likewise, future human exposure to potential soil contaminants associated with the AOC could occur with active use of the AOC (e.g., training activities). Terrestrial and aquatic ecological receptors present in the AOC vicinity may also be exposed to potential soil contaminants. Considering the design of the sump, any releases to soil would most likely have been to subsurface soil.

Airborne contamination (e.g., windblown dust) is not considered a viable migration or exposure pathway at this AOC. The likely contaminants associated with the former Building 1037 Laundry Waste Water Sump (explosives, propellants) have low volatility, and potential releases of contaminants would likely have been to subsurface soil adjacent to the sump. The operational areas are paved, gravel covered, or currently well vegetated. RVAAP is located in a humid climate, and soil moisture content is typically high, which reduces the potential for dust generation.

The concentration of benzo(a)pyrene in surface soil exceeded the FWCUG at DU01. However, this PAH compound is not a site-related chemical, nor a focus of the SI in the context of the HRR report (SAIC 2011b). The presence of PAHs such as benzo(a)pyrene is common in industrialized settings and is considered to be attributable to off-AOC activities such as drainage, runoff of nearby asphalt roadways, and deposition of airborne contaminants. Based on the reported SI data, no AOC-related COPCs were identified in either surface or subsurface soil. The SI sampling results indicate that there are no human or ecological exposure risks associated with this AOC via the soil or air pathway.

6.1.3 Soil and Air Pathway Conclusions

The SI analytical results indicate that neither explosive derivatives nor propellants were detected in surface or subsurface soil samples collected at CC RVAAP-77. No complete pathways for soil or air have been identified at this AOC.

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 on the AOC. The sewer pipe downstream from the sump has been plugged, thereby preventing a discharge to the sewer at the nearby manhole. Additionally, no sediment was observed in the manhole.

There are no perennial surface water features at the AOC. The closest perennial feature to receive drainage from the Administration Area is a tributary to the west branch of the Mahoning River located southeast of the AOC.

Surface water within the Administration Area adjacent to Building 1037 occurs intermittently as storm water runoff overland, through constructed roadside ditches, and into the storm sewer network.

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 AOC. No perennial streams are located at the AOC. There are no observed springs or groundwater discharge points to a surface water body in the immediate vicinity of the AOC. Therefore, there is no direct exposure pathway for human receptors or ecological targets to surface water at this AOC.

6.2.3 Surface Water Pathway Conclusions

There are no identified COPCs at the site in surface soil. 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 Building 1037 Laundry Waste Water Sump AOC as they are not present on the AOC.

6.3 GROUNDWATER PATHWAY

6.3.1 Hydrogeological Setting

Section 1.4.4 presents the general hydrogeological setting for RVAAP. In April 2011, OHARNG installed two bedrock aquifer wells at RVAAP within the Sharon Conglomerate for use as an institutional groundwater supply. These potable wells are located near Buildings 1067 and 1068 within the Administration Area which are approximately 430 ft and 1,500 ft from CC RVAAP-77 AOC, respectively. There is also 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. These groundwater supply wells are used solely for on-site activities and are not used for public distribution, livestock, or commercial groundwater potable supply. Based on a review of the drilling logs prepared for the SI at CC RVAAP-77, the depth to water below the AOC is between 10 and 15 ft bgs.

There are also three monitoring wells located in the vicinity of CC RVAAP-77, south and southwest of Building 1037 and within the Administration Area (referenced as monitoring wells FWGmw-004, FWGmw-015, and FWGmw-016). Monitoring wells FWGmw-004 and FWGmw015 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 Building 1037, 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 Building 1037 (EQM 2012).

Available maps (SAIC 2011b) suggest that the elevation of the potentiometric surface in the unconsolidated aquifer is approximately 1030 ft amsl (Figure 1-8), which is above the ground surface elevation (1020 ft amsl, Figure 2-1). The generalized potentiometric surface elevation of the Sharon Conglomerate bedrock aquifer is inferred to be 1,000 ft amsl (Figure 1-9), based on surrounding facility-wide groundwater monitoring well data. Top of bedrock is estimated to lie at 980 ft amsl. The generalized regional groundwater flow direction beneath CC RVAAP-77 is to the southeast.

6.3.2 Groundwater Targets

Groundwater targets include human receptors that use groundwater for potable water supply, as well as ecological receptors (e.g., livestock, fish farms) and physical targets (e.g., springs) that may be affected by potential groundwater contamination on, or adjacent to, the AOC. Section 1.4.4.2 describes groundwater use at RVAAP. Although the newly installed bedrock wells (April 2011) in the vicinity of Building 1037 are for limited potable use, they are not considered public water supply wells as they serve less than 25 people. These wells would act as potential migration pathways to groundwater in the event that the subsurface soils at the water table were identified as impacted with soluble contaminants. Future use of groundwater is anticipated at the facility; therefore, future human receptors may be exposed to groundwater.

6.3.3 Groundwater Pathway Conclusion

No groundwater samples were collected as part of this SI as the groundwater at the facility is undergoing investigation on a facility-wide basis under CC RVAAP-66 Facility-Wide Groundwater.

The SI analytical data did not identify any COPCs for explosive derivatives or propellants in subsurface soil at this AOC, as the reported concentrations were all below the reported detection limits for these constituents.

The SI analytical data did not identify explosive derivative or propellants (or any other chemical) as COPCs in subsurface soil at this AOC, Based on the findings of the SI, further evaluation of groundwater at this AOC is not warranted.

7.0 SUMMARY AND CONCLUSIONS

This SI Report presents the site background and operational history, a summary of previous HRR results, and results of field investigations completed for this SI at CC RVAAP-77 Building 1037 Laundry Waste Water Sump. This SI addresses surface and subsurface soils at this AOC. Since there are no surface water bodies, wetlands, or streams at the AOC only surface soil and subsurface soils were sampled as part of this SI. This SI report summarizes results of surface and subsurface soil sampling conducted in association with this SI and addresses potential air, soil, surface water, and groundwater exposure pathways specific to this AOC. This section provides a summary of findings and conclusions of the SI at CC RVAAP-77 Building 1037 Laundry Waste Water Sump.

7.1 SUMMARY OF RESULTS

A summary of the SI results for this AOC are as follows:

- No VOCs, PCBs, explosives or their derivatives, or propellant compounds were detected above the respective FWCUGs in the ISM surface soil or subsurface soil samples collected. These chemicals were not identified as COPCs at this AOC.

- One PAH (semi-volatile compound), benzo(a)pyrene, was reported at a concentration above the FWCUG for the Resident Farmer Adult; however, PAHs are not associated with the past historical activities at CC RVAAP-77 and are not related to the activities at this AOC, but reflect the off-AOC activities and processes associated with overland drainage from nearby asphalt roadways and other sources adjacent to this AOC such as the former Power House No.6 and the coal storage area for the Power House. PAHs were not identified as COPCs at this AOC.

- Chromium, mercury, nickel and zinc exceeded their respective background values but were below their respective FWCUGs. No other metals exceeded the respective FWCUGs. Metals were not identified as COPCs at this AOC.

- There were no reported detections of explosives derivatives or propellants in the subsurface soil sample collected at CC RVAAP-77 during this SI. Therefore, these groups of chemicals were not identified as COPCs.

7.2 CONCLUSIONS

Based on the SI data evaluation in conjunction with the results of the HRR (SAIC 2011b), the conclusions are as follows:

- No COPCs were identified as a result of this SI performed at CC RVAAP-77 Building 1037 Laundry Waste Water Sump.

- No potential human or ecological exposure risks via air, soil, surface water, or groundwater pathways were identified during the SI. Further evaluation of potential receptor pathways for soil, sediment, surface water, air, and groundwater is not warranted.

- No Further Action (NFA) is warranted for soil, sediment, or surface water at CC RVAAP-77 Building 1037 Laundry Waste Water Sump. Groundwater is currently being addressed separately under RVAAP-66 Facility-Wide Groundwater.

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