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14. ABSTRACT
This Feasibility Study (FS) was developed to evaluate remedial action alternatives that address contamination presenting unacceptable risks at RVAAP-34 Sand Creek Disposal Road Landfill (Sand Creek Site) that are protective of human and environmental receptors in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This FS evaluates the necessary CERCLA remediation requirements with respect to chemical contamination in surface and subsurface soils at the Sand Creek Site only. This FS was prepared under Delivery Order 0002 for Architectural/Engineering Environmental Services at the Ravenna Army Ammunition Plant under the Indefinite Delivery/Indefinite Quantity Contract No. W912QR-08-D- 0013. The Delivery Order was issued by the United States Army Corps of Engineers on September 22, 2008.

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Shaw Environmental & Infrastructure, Inc., a CB&I Company, has completed the *Draft Feasibility Study for RVAAP-34 Sand Creek Disposal Road Landfill* 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, principles, and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets customer's needs consistent with law and existing Corps policy.

Reviewed/Approved by: [signature] Date: September 16, 2013

David Cobb
Project/Program Manager

Reviewed/Approved by: [signature] Date: September 16, 2013

David Crispo, P.E.
Technical/Regulatory Lead

Draft Feasibility Study for
RVAAP-34 Sand Creek Disposal Road Landfill
Version 1.0

Ravenna Army Ammunition Plant
Ravenna, Ohio

Contract No. W912QR-08-D-0013
Delivery Order 0002

Prepared for:

US Army Corps
of Engineers ®
Louisville District

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ARNG—Army National Guard
BRACD—Base Realignment and Closure Division
OHARNG—Ohio Army National Guard
RVAAP—Ravenna Army Ammunition Plant
Shaw—Shaw Environmental & Infrastructure, Inc.
USACE—U.S. Army Corps of Engineers
USAEC—U.S. Army Environmental Command

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Acronyms and Abbreviations

ACM	asbestos-containing material
AMEC	AMEC Earth & Environmental, Inc.
amsl	above mean sea level
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
bgs	below ground surface
BHC	benzene hexachloride
BRACD	Base Realignment and Closure Division
BSV	background screening value
C&D	construction and debris
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CMCOPC	contaminant migration chemical of potential concern
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CRJMTC	Camp Ravenna Joint Military Training Center
CSM	conceptual site model
DERR	Division of Environmental Response and Revitalization
DGM	digital geophysical mapping
DPT	direct-push technology
DQO Report	*Final Data Quality Objectives Report for the RVAAP-34 Sand Creek Disposal Road Landfill, Version 1.0, Ravenna Army Ammunition Plant, Ravenna, Ohio*
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FR	Federal Register
FS	feasibility study
ft^2	square foot/feet
ft^3	cubic foot/feet
FWBWQS	Facility-Wide Biological and Water Quality Study
FWCUG	Facility-Wide Cleanup Goal
GRA	general response action
HAP	hazardous air pollutant
HHRA	human health risk assessment
HHRAM	*Facility-Wide Human Health Risk Assessor Manual, Amendment 1*
HQ	hazard quotient
IRP	Installation Restoration Program
ISM	incremental sampling methodology
LDR	land disposal restriction

Acronyms and Abbreviations (continued)

LTM	long-term monitoring
LUC	Land Use Control
MC	munitions constituents
MD	munitions debris
MDC	maximum detected concentration
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
MKM	MKM Engineers, Inc.
MMRP	Military Munitions Response Program
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operation and maintenance
OAC	Ohio Administrative Code
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PA	preliminary assessment
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PPE	personal protective equipment
RA	removal action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
redox	reduction/oxidation
RGO	remedial goal objective
RI	remedial investigation
ROD	record of decision
RRSE	relative risk site evaluation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
Sand Creek Site	RVAAP-34 Sand Creek Disposal Road Landfill
SARA	Superfund Amendments and Reauthorization Act
SESOIL	Seasonal Soil Compartment
Shaw	Shaw Environmental & Infrastructure, Inc.
SLERA	screening-level ecological risk assessment
SRC	site-related chemical
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBC	to be considered
TERP	Transportation and Emergency Response Plan
U.S.	United States

Acronyms and Abbreviations (continued)

USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
USC	United States Code
UXO	unexploded ordnance
VOC	volatile organic compound
yd^3	cubic yard

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EXECUTIVE SUMMARY

Shaw Environmental & Infrastructure, Inc. (Shaw), a CB&I company, was contracted by the United States Army Corps of Engineers (USACE), Louisville District, to complete a feasibility study (FS) for the area of concern (AOC) RVAAP-34 Sand Creek Disposal Road Landfill (hereafter referred to as the Sand Creek Site) at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. This FS is being prepared under Delivery Order 0002 for Architectural/Engineering Environmental Services at the RVAAP under the Indefinite Delivery/Indefinite Quantity Contract No. W912QR-08-D-0013. The Delivery Order was issued by the USACE on September 22, 2008.

This FS was developed to evaluate remedial action alternatives that address contamination presenting unacceptable risks at the Sand Creek Site that are protective of human and environmental receptors in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This FS evaluates the necessary CERCLA remediation requirements with respect to chemical contamination in surface and subsurface soils at the Sand Creek Site. In addition, the surface and subsurface soils are evaluated to demonstrate the selected remedy is protective of groundwater with respect to the anticipated future land use. Evaluation of surface water and sediment at the Sand Creek Site was performed during the *Final Phase I Remedial Investigation Report for RVAAP-34 Sand Creek Disposal Road Landfill* (Shaw, 2013), hereafter referred to as the Phase I Remedial Investigation (RI) Report, that was conducted in accordance with the CERCLA process. These environmental media were not determined to present risks to human or environmental receptors and are not evaluated further in this FS. Remediation of groundwater is not included in the scope of this FS, since groundwater is addressed on a facility-wide basis.

ES.1 AOC Description

The Sand Creek Site is located in the eastern portion of the RVAAP and is a former open dump area. The operational history of disposal activities at the site is incomplete. Construction and debris materials were delivered to the site and dumped over an embankment located immediately adjacent to Sand Creek. The dump site extended along the embankment for approximately 1,200 feet and varied in width from 20 to 40 feet from the top of the bank to the bottom. The size of the defined AOC is approximately 1 acre. The bank slopes from east to west towards Sand Creek at 40 to 60 degrees from horizontal. There are no records indicating the quantities or materials dumped at the site. The dates of operation for the landfill are unknown.

The future activities at the AOC will be Military Training Land Use based on the anticipated Ohio Army National Guard (OHARNG) training mission and utilization of the Camp

Ravenna Joint Military Training Center. The anticipated future land use, in conjunction with the evaluation of Unrestricted Land Use and associated receptors, form the basis for identifying and evaluating remedial alternatives in this FS.

ES.2 Impacts to Human and Environmental Receptors

Given the future use of the site for Military Training Land Use, the National Guard Trainee and the Range Maintenance Soldier are considered the most likely receptors. Both of these receptors were conservatively evaluated in the Phase I RI Report (Shaw, 2013) for potential exposure to deep surface soil (0 to 4 feet below ground surface [bgs]); however, in accordance with the exposure scenarios presented in the *Final Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (Science Applications International Corporation [SAIC], 2010), only the National Guard Trainee was further evaluated for potential exposures associated with subsurface soils (4 to 7 feet bgs), sediment, and surface water. The National Guard Trainee is the OHARNG receptor evaluated in this FS, since it is the most stringent receptor that is protective of all Military Training Land Use receptors that has the potential to be exposed to surface and subsurface soils at the AOC, including the Range Maintenance Soldier (SAIC, 2010).

Arsenic, benzo(a)pyrene, and benzo(b)fluoranthene were identified as chemicals of concern (COCs) for the National Guard Trainee in deep surface soil. However, only arsenic has concentrations that exceed its Facility-Wide Cleanup Goal (FWCUG). The exposure risks associated with benzo(a)pyrene and benzo(b)fluoranthene are from the evaluation of potential additive effects calculated from the maximum exposure point concentrations at the AOC from exposure to multiple chemicals or exposure to multiple chemicals that can cause the same effect (i.e., cancer) or affect the same target organ. Arsenic and lead were identified as COCs in subsurface soil for the National Guard Trainee, as the concentrations for these inorganics exceed the final FWCUGs. No COCs were identified for sediment and surface water for the National Guard Trainee.

Evaluation for Unrestricted Land Use is a CERCLA requirement, and the receptors identified at the RVAAP include the Resident (Adult and Child) receptor in accordance with the *Facility-Wide Human Health Risk Assessor Manual, Amendment 1,* (USACE, 2005a). The COCs identified in surface soil (0 to 1 foot bgs) for the Unrestricted Land Use consist of antimony, arsenic, copper, mercury, silver, thallium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene. Copper, silver, and thallium were identified as COCs in surface soil based on a sum of ratios for gastrointestinal effects. Arsenic and benzo(a)pyrene were identified as COCs in subsurface soils (1 to 13 feet bgs) for the Unrestricted Land Use.

The American robin is a worm-eating and insectivorous avian species that may forage at the AOC and is, therefore, potentially exposed to chemicals of potential ecological concern, in particular mercury, in soil. Weight of evidence suggests that it would be highly unlikely that sufficient exposure would occur to local populations of American robins such that adverse populations would occur at the AOC.

ES.3 Phase I Remedial Investigation Recommendations

Based on the Phase I RI results, it was determined that the Sand Creek Site was adequately characterized and the recommended path forward was to proceed to the FS phase of the CERCLA process. The Phase I RI Report recommended an analysis of remedial alternatives for surface and subsurface soils based on fate and transport results of the leaching potential to groundwater that is associated with the identified contaminant migration chemical(s) of potential concern for these media. Copper, silver, and thallium were identified as COCs for the Unrestricted Land Use in surface soil based on a sum of ratios for gastrointestinal effects of slightly greater than 1 (1.4), and all three inorganics contributing greater than 5 percent to the sum of ratios. The maximum detected concentrations for all three inorganics are less than the applicable final FWCUGs. The recommended approach to reducing the number of COCs was to reduce silver concentrations such that the sum of ratios does not exceed 1, as silver contributed the most to the sum of ratios. A reduction of silver concentrations to a maximum of 95 milligrams per kilogram (with no change to copper and thallium) reduces the sum of ratios to less than 1, thus eliminating thallium and copper as COCs, and eliminating health concerns associated with gastrointestinal effects.

ES.4 Remedial Action Objective

The remedial action objective (RAO) is protective of human health and the environment, and can be achieved by reducing exposure as well as by reducing contaminant levels. A RAO has been established within this FS to address contamination associated with the Sand Creek Site:

- Prevent direct human contact with COCs in surface and subsurface soil; and
- Comply with chemical-specific, location-specific, and action-specific applicable or relevant and appropriate requirements (ARARs) and to-be-considered guidance.

This FS does not address any munitions and explosives of concern (MEC) issues that may remain at the Sand Creek Site, as any MEC and associated munitions constituents issues would be investigated under a separate program (i.e., the Military Munitions Response Program). Therefore, the RAO was not inclusive of MEC and/or munitions constituents.

ES.5 Area and Volume of Contamination

Estimated volumes of impacted soils were calculated for the Sand Creek Site where COCs were identified to be evaluated further in the FS. The area and volume of contamination were calculated based on the FWCUGs that are considered to be protective of human health. The volumes of soils exceeding the FWCUGs for the receptors identified for the Military Training and the Unrestricted Land Use scenarios are summarized in **Table ES-1**.

Table ES-1
Estimated Volume of Impacted Soil for the Sand Creek Site

Land Use Scenario	Surface Area (ft^2)	In Situ		In situ with Constructability[a]		Ex Situ[a,b]	
		Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
Military Training	50,705	83,287	3,085	104,108	3,856	124,930	4,627
Unrestricted	66,604	181,035	6,290	212,301	7,863	254,761	9,436

[a] includes 25 percent constructability factor.
[b] includes 20 percent swell factor.
ft^2 denotes square foot/feet.
ft^3 denotes cubic foot/feet.
yd^3 denotes cubic yard.

ES.6 Development and Screening of Alternatives

This FS identifies and screens remedial technologies and associated process options that may be appropriate for satisfying the RAO for the Sand Creek Site with respect to effectiveness, implementability, and cost. Select remedial technologies and process options were carried forward after the initial screening and were combined to develop the following evaluation of remedial alternatives for the Sand Creek Site:

- **Alternative 1, No Action—**Leaves the contaminated soil in place with no remedial action or additional measures to prevent exposure to the COCs, and serves as a baseline for comparison with the other alternatives. “No Action” is an evaluation requirement under CERCLA.
- **Alternative 2, Land Use Controls (LUCs)—**Under this alternative, contaminated soil would remain in place. No action would be taken to reduce the hazards present at the AOC to potential human or ecological receptors. There would be no measured reduction in toxicity, mobility, or volume of the contaminated media. LUCs and long-term monitoring (LTM) would be implemented, which would reduce the potential for direct exposure to contaminated soil at the Sand Creek Site.

- **Alternative 3, Containment with LUCs—**This alternative consists of installing a geosynthetic clay liner with a soil cover cap to act as a physical barrier against direct exposure of receptors to contaminants in surface and subsurface soil and to prevent infiltration and erosion. This alternative would require frequent operation and maintenance (O&M) to ensure the integrity of the cap is maintaining its effectiveness, and LUCs would be required to prevent access and invasive activities in the capped area.
- **Alternative 4, Excavation, Off-Site Disposal, and LUCs (Military Training Land Use)—**All contaminated soil contributing to unacceptable human health risk to the National Guard Trainee would be removed and transported off site for disposal. LUCs would be implemented to prevent human exposure to contaminated groundwater. O&M of the AOC is expected to occur in perpetuity due to the remaining contaminated soils.
- **Alternative 5, Excavation and Off-Site Disposal (Unrestricted Land Use)—**All contaminated soil contributing to unacceptable human health risk to the Resident (Adult and Child) receptors will be removed and transported off site for disposal. Implementation of this scenario attains Unrestricted Land Use and eliminates the requirements for LUCs, LTM, and O&M.

Each of the alternatives was evaluated against the CERCLA criteria to provide a basis for selecting a preferred alternative in the follow-on proposed plan and record of decision documents. **Table ES-2** summarizes the comparative analysis of the alternatives presented in this FS.

ES.7 Recommended Alternative

Based on the evaluation of alternatives, Alternative 4 is chosen as the remedy for the Sand Creek Site because it will protect human health and the environment, complies with ARARs, and is the most cost-effective alternative with regards to the actual anticipated future land use. Although the proposed remedy does not allow for the AOC to be used for Unrestricted Land Use, the recommended alternative is protective of the Military Training Land Use receptors. The LUCs will include LTM and O&M to evaluate the effectiveness of the remedy and to ensure that any remaining in situ contamination is not migrating from the AOC.

The institutional controls required by this remedy will include LTM of groundwater. If COC concentrations are shown through monitoring, a human health risk assessment could be conducted to determine if the groundwater poses any unacceptable risks. Additionally, there is currently no use of shallow groundwater in the area, and the future use of shallow groundwater at the site as a potable source is highly unlikely because potable water at the RVAAP locations near the Sand Creek Site is from a municipal water source provided by the

Village of Windham. There is currently no existing data for groundwater; however, the COCs identified in surface and subsurface soils are highly immobile and the subsurface conditions consist primarily of dense clay that will likely limit the ability of the COCs to substantially migrate and impact groundwater beneath the AOC.

Table ES-2
Comparative Analysis of Remedial Action Alternatives for the Sand Creek Site

	Remedial Alternatives				
	1	2	3	4	5
Evaluation Criteria	**No Action**	**LUCs**	**Containment with LUCs**	**Excavation, Off-Site Disposal, and LUCs (Military Training Land Use)**	**Excavation and Off-Site Disposal (Unrestricted Land Use)**
Protective of Human Health and Environment	No	Yes	Yes	Yes	Yes
Complies with ARARs	No	Yes	Yes	Yes	Yes
Effective and Permanent	No	No	Yes	Yes	Yes
Reduces Toxicity, Mobility, or Volume	None (no treatment)				
Short-Term Effectiveness	Unacceptable	Acceptable	Acceptable	Acceptable	Acceptable
Implementable	Yes	Yes	Yes	Yes	Yes
Costs					
Capital	$0	$215,127	$671,833	$2,203,734	$4,029,911
Nondiscounted O&M	$0	$1,742,294	$1,471,273	$1,743,671	$0
Total Present Worth	$0	$1,661,109	$2,629,922	$2,809,095	$4,029,911

ARAR denotes applicable or relevant and appropriate requirement.
LUC denotes Land Use Control.
O&M denotes operation and maintenance.

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1.0 INTRODUCTION

Shaw Environmental & Infrastructure, Inc. (Shaw), a CB&I company, was contracted by the United States (U.S.) Army Corps of Engineers (USACE), Louisville District, to complete a feasibility study (FS) for the area of concern (AOC) RVAAP-34 Sand Creek Disposal Road Landfill (hereafter referred to as the Sand Creek Site) at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. This FS is being prepared by under Delivery Order 0002 for Architectural/Engineering Environmental Services at the RVAAP under the Indefinite Delivery/Indefinite Quantity Contract No. W912QR-08-D-0013. The Delivery Order was issued by the USACE on September 22, 2008.

1.1 Purpose

Environmental cleanup decision making at the RVAAP is conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and follows a prescribed sequence of remedial investigation (RI), FS, proposed plan, and record of decision (ROD). The RI is a mechanism for collecting data to characterize site conditions, determine the nature and extent of contamination, and assess risks to human health and the environment. The *Final Phase I Remedial Investigation Report for RVAAP-34 Sand Creek Disposal Road Landfill* (Shaw, 2013), hereafter referred to as the Phase I RI Report, documents the nature and extent of contamination and the media of concern that present risks to likely receptors at the Sand Creek Site.

The FS takes the next step of identifying and evaluating remedial solutions to the contaminated environmental media identified at the Sand Creek Site. This step begins with the formulation of viable alternatives, which involves defining the remedial action objective (RAO), volume or area of media to be addressed, and potentially applicable technologies and process options. After a reasonable number of appropriate alternatives have been formulated, the alternatives undergo a detailed analysis using nine established evaluation criteria. The detailed analysis profiles individual alternatives against the criteria and compares them with each other to gauge their relative performance. Each alternative that emerges, with the exception of the No Action alternative, is expected to be protective of human health and compliant with applicable or relevant and appropriate requirements (ARARs) and or to-be-considered (TBC) guidance that are threshold requirements under CERCLA. The RAOs are developed in the FS to protect receptors from impacted environmental media and chemicals of concern (COCs) identified in the Phase I RI Report (Shaw, 2013).

Depending on the outcome of the evaluation in this FS, a preferred alternative will be submitted for public review and comment. Public comments will be considered in the final selection of an interim remedy, which will be documented in the ROD phase of the CERCLA process. Responses to public comments will be addressed in the responsiveness summary of the ROD.

Other supporting documents used in the preparation of this FS included the *Final Sampling and Analysis Plan Addendum No. 1 for Environmental Services at RVAAP-34 Sand Creek Disposal Road Landfill, RVAAP-03 Open Demolition Area #1, and RVAAP-28 Mustard Agent Burial Site Version 1.0, Ravenna Army Ammunition Plant, Ravenna, Ohio* (Shaw, 2010) and the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. Environmental Protection Agency [EPA], 1988a).

1.2 Scope

This FS was developed to evaluate remedial action alternatives that address contamination presenting unacceptable risks at the Sand Creek Site that are protective of human and environmental receptors in accordance with CERCLA. This FS evaluates the necessary CERCLA remediation requirements with respect to chemical contamination in surface and subsurface soils at the Sand Creek Site. In addition, the surface and subsurface soils are evaluated to demonstrate the selected remedy is protective of groundwater with respect to the anticipated future land use. Evaluation of surface water and sediment at the Sand Creek Site was performed during the Phase I RI that was conducted in accordance with the CERCLA process and was not determined to present risks to human or environmental receptors and are not evaluated further in this FS. Remediation of groundwater is not included in the scope of this FS, since groundwater is addressed on a facility-wide basis.

The Ohio Army National Guard (OHARNG) has established future activities at the Sand Creek Site as Military Training Land Use based on anticipated training mission and utilization of the Camp Ravenna Joint Military Training Center (CRJMTC). The anticipated future land use, in conjunction with the evaluation of Unrestricted Land Use and associated receptors, form the basis for identifying and evaluating remedial alternatives in this FS.

This FS contains an evaluation of the anticipated likely future land use receptors that were identified for the Sand Creek Site in the *RVAAP Facility-Wide Human Health Risk Assessor Manual, Amendment 1* (HHRAM; USACE, 2005a). The most representative OHARNG receptors are the National Guard Trainee and the Range Maintenance Soldier. The Resident (Adult and Child) receptors were evaluated to supplement the baseline human health risk assessment (HHRA) detailed in the Phase I RI Report (Shaw, 2013) per the HHRAM (USACE, 2005a) to provide risk managers with information to support determination of the need for continued security at the facility.

In 2001, the U.S. Department of Defense established the Military Munitions Response Program (MMRP) to manage the environmental, health, and safety issues presented by munitions and explosives of concern (MEC) as a result of historical activities at a site. An inventory of the closed, transferring, and transferred ranges or AOCs at the RVAAP completed in November 2003 identified 19 MMRP munitions response sites at the RVAAP that are known or suspected to contain MEC, including the Sand Creek Site. Therefore, removal actions (RAs) specifically addressing MEC issues, munitions constituents (MC) associated with MEC, or the potential environmental impact from any future MEC or MC removal are not included in the scope of this FS.

1.3 Report Organization

This FS is organized to meet Ohio Environmental Protection Agency (Ohio EPA) requirements in accordance with CERCLA guidance:

- **Section 1.0**—Introduction
- **Section 2.0**—Background Information
- **Section 3.0**—Remedial Action Objective and Applicable or Relevant and Appropriate Actions
- **Section 4.0**—Identification and Screening of Technologies
- **Section 5.0**—Development and Screening of Alternatives
- **Section 6.0**—Detailed Analysis of Alternatives
- **Section 7.0**—Comparative Analysis of Alternatives
- **Section 8.0**—References

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2.0 BACKGROUND INFORMATION

This section presents the background information of the RVAAP and the Sand Creek Site and the physical characteristics of the surrounding environment that are factors in understanding potential contaminant transport pathways, receptors, and exposure scenarios for human health and ecological risks. The physiographic setting information for the RVAAP and more specifically, the Sand Creek Site, were primarily compiled from information originally presented in the *Phase I Remedial Investigation Report for the Phase I Remedial Investigation of High-Priority Areas of Concern at the Ravenna Army Ammunition Plant* (USACE, 1998), the *Integrated Natural Resources Management Plan (INRMP)* (AMEC Earth & Environmental, Inc. [AMEC], 2008), and the *Facility-Wide Groundwater Monitoring Program Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE, 2004).

2.1 Facility-Wide Background Information

This section presents the historical background, current status, demography and current and anticipated land use for the RVAAP. The physiographical setting discussed in this section provides a general description of the facility.

2.1.1 General Facility Site Description

The RVAAP (Federal Facility Identification [ID] No. OH213820736) is located in northeastern Ohio within Portage County and Trumbull County, approximately 3 miles east-northeast of the city of Ravenna (**Figure 2-1**). The installation is approximately 11 miles long and 3.5 miles wide. It is 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 (**Figure 2-2**). The installation is surrounded by several communities: Windham on the north, Garrettsville 6 miles to the northwest, Newton Falls 1 mile to the southeast, Charlestown to the southwest, and Wayland 3 miles to the south.

2.1.2 Historical Mission

Constructed in 1940, production at the RVAAP began in December 1941, with the primary missions of depot storage and ammunition loading. The installation was divided into two separate units: the Portage Ordnance Depot and the Ravenna Ordnance Plant. The depot's primary mission was storage of munitions and components, while the mission of the ordnance plant was loading and packing major caliber artillery ammunition and the assembly of munitions-initiating components that included fuzes, boosters, and percussion elements. In

August 1943, the installation was redesignated as the Ravenna Ordnance Center, and in November 1945, it was redesignated as the Ravenna Arsenal.

The plant was placed in standby status in 1950 and reactivated during the Korean Conflict to load and pack large-caliber shells and components. All production ended in August 1957; and in October 1957, the installation again was placed in a standby condition. In October 1960, the ammonium nitrate line was renovated for demilitarization operations, which involved melting explosives out of bomb casings for subsequent recycling. These operations began in January 1961. In July 1961, the plant was deactivated again. In November 1961, the installation was divided into the Ravenna Ordnance Plant and an industrial section, with the entire installation designated as the RVAAP.

In May 1968, the RVAAP began loading, assembling, and packing munitions on three load lines and two component lines to support the Southeast Asia conflict. These facilities were deactivated in August 1972. The destruction of M71A1 series 90-millimeter projectiles extended from June 1973 until March 1974. Destruction of various munitions was conducted from October 1982 through 1992.

Until 1993, the RVAAP maintained the capability to load, assemble, and pack military ammunition. As part of the RVAAP mission, the U.S. Army maintained inactive facilities in a standby status by keeping equipment in a condition to allow resuming production within prescribed limitations. In September 1993, the U.S. Army placed the RVAAP in inactive caretaker status, which subsequently changed to modified caretaker status. The load lines and associated real estate were determined to be excess by the U.S. Army.

2.1.3 Current Status

Administrative control of 20,423 acres of the former 21,683-acre RVAAP have been transferred to the Army National Guard (ARNG) and subsequently licensed to the OHARNG for use as a training site. Currently, the RVAAP consists of 1,260 acres in several distinct parcels scattered throughout the confines of the CRJMTC. The RVAAP's remaining parcels of land are located completely within the CRJMTC. The CRJMTC did not exist when the RVAAP was operational, 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 21,683-acre former RVAAP. Therefore, references to the RVAAP in this document are considered to be inclusive of the historical extent of the RVAAP, which is inclusive of the combined acreages of the current CRJMTC and the RVAAP, unless otherwise specifically stated. The Ohio EPA is the lead regulatory agency for the investigation and remediation conducted by the U.S. Army under the IRP.

2.1.4 Demography and Land Use

The 2010 Census (U.S. Census Bureau, 2010) lists the total populations of Portage County and Trumbull County as 161,419 and 210,312, respectively. Population centers closest to the RVAAP are Ravenna, Ohio, with a population of 11,724, and Newton Falls, Ohio, 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 percent of Portage County, in which the majority of the RVAAP is located, consists of either woodland or farm acreage. The Michael J. Kirwan Reservoir (also known as West Branch Reservoir) is the closest major recreational area and is located adjacent to the western half of the RVAAP, south of State Route 5.

The RVAAP is operated by the Base Realignment and Closure Division (BRACD) of the U.S. Army. The BRACD manages the restoration activities of environmental AOCs at the RVAAP. The ARNG Directorate owns most of the non-AOC areas at the RVAAP and has licensed these areas to the OHARNG for training. Training and related activities at the CRMJTC include: field operations and bivouac training, convoy training, equipment maintenance, C-130 aircraft drop zone operations, helicopter operations, and storage of heavy equipment. The U.S. Army intends to complete the required CERCLA remedy selection process and evaluate alternatives in order to attain regulatory closure status for the Sand Creek Site allowing this area to be used by the OHARNG for Military Training Land Use.

2.1.5 RVAAP Physiographic Setting

The RVAAP is located within the southern New York section of the Appalachian Plateaus physiographic region of northeastern Ohio. Although the land within this region was uplifted as part of the Appalachian Mountain building process, the glaciers were able to override the gentle hills of the plateau. Huge ice blocks broke free from the glaciers, and kettle lakes formed as the blocks melted. Eventually, these lakes filled with sediment leaving boggy wetlands with unique assemblages of plants. Ridges and flat uplands, which are covered with thin drift and dissected by steep valleys, occur gently about 1,200 feet above mean sea level (amsl). Valley segments, ranging in elevation from 600 to 1,500 feet amsl, alternate between broad drift-filled and narrow rock-walled reaches (USACE, 1998).

The RVAAP is located in the Mahoning River Basin. Three major streams, the South Fork Eagle Creek, Sand Creek, and Hinkley Creek, drain approximately 65 percent of the facility. The northern and central portions of the RVAAP, including the site, are drained by Sand Creek. Sand Creek subsequently drains to South Fork Eagle Creek and runs into Eagle Creek and finally the Mahoning River. The western portions of the RVAAP drain to Hinkley Creek and subsequently to the West Branch of the Mahoning River. The easternmost portion of the installation drains to the West Branch of the Mahoning River near its confluence with the main trunk of the Mahoning River. The southern areas drain directly into the Michael J. Kirwan Reservoir. A number of smaller, unnamed creaks drain other areas of the installation (USACE, 1998).

Overall, the RVAAP can be considered flat land, although there are occasional steep slopes. Many of the steep slopes are due to modifications of the landscape from cut and fill operations during the construction of the ammunition plant in the 1940s. The topographic relief across the installation is approximately 290 feet, with the elevation high point located in the northwest portion of the RVAAP, at approximately 1,220 amsl. The lowest point elevation of the installation is at the southeast corner, at approximately 930 amsl (AMEC, 2008).

2.2 Sand Creek Disposal Road Landfill Site Description

This section presents the historical background information that is specific to the Sand Creek Site. This historical discussion includes the past activities that are known to have taken place at the site and previous investigations and RA that occurred. Analytical data that was collected during the investigation and RA were evaluated in the Phase I RI Report (Shaw, 2013) for nature and extent of contamination, fate and transport analysis, and evaluation of risk for human and environmental receptors and are summarized in this section as well.

2.2.1 Operational History

The Sand Creek Site is located in the eastern portion of the RVAAP and is a former open dump area (**Figure 2-2**). The operational history of disposal activities at the site is incomplete. Construction and debris (C&D) materials were delivered to the site and dumped over an embankment located immediately adjacent to Sand Creek. The dump site extended along the embankment for approximately 1,200 feet and varied in width from 20 to 40 feet from the top of the bank to the bottom (**Figure 2-3**). The size of the defined AOC is approximately 1 acre. The bank slopes from east to west towards Sand Creek at 40 to 60 degrees from horizontal. There are no records indicating the quantities or materials dumped at the site and the dates of operation for the landfill are unknown. Several buildings associated with the former Sand Creek Sewage Treatment Plant are located northeast of the site. Surface water runoff follows the topography of the site and flows in a westerly direction where it enters Sand Creek. A very narrow floodplain occupies the land between the bottom of the embankment and Sand Creek. An inactive railroad bed bisects the AOC (MKM Engineers, Inc. [MKM], 2004).

Preliminary site assessments found the AOC very overgrown with mature trees and ground level vegetation. The entire site was littered with C&D materials with large piles of debris concentrated mostly in the southern portion of the AOC. Some of the types of C&D materials identified during the preliminary site assessment included the following:

- Asbestos-containing material (ACM) (i.e., large piles of corrugated transite roofing and flat transite siding)
- Rubble (i.e., concrete, brick, and masonry fragments)
- Drywall and plaster
- Glass bottles, fluorescent light tubes, and broken glass
- Scrap metal items including wire fencing
- Wooden debris

A corrugated iron culvert associated with a former railroad bed that crossed over Sand Creek previously collapsed. The culvert structure and associated railroad ballast have since been removed from Sand Creek, and the area along the banks of the former railroad bed has been restored.

2.2.2 Previous Investigations and Removal Actions

Between 1996 and 2010, investigations and activities conducted under the IRP were documented in the following reports:

- *Preliminary Assessment for the Characterization of Areas of Contamination, Ravenna Army Ammunition Plant, Ravenna, Ohio* (Science Applications International Corporation [SAIC], 1996)
- *Relative Risk Site Evaluation for Newly Added Sites at the Ravenna Army Ammunition Plant, Ravenna, OH* (U.S. Army Center for Health Promotion and Preventative Medicine [USACHPPM], 1998)
- *Remedial Design/Removal Action Plan for RVAAP-34 Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, Ohio* (MKM, 2004)
- *RVAAP Facility-Wide Biological and Water Quality Study 2003* (USACE, 2005b)
- *Final Digital Geophysical Mapping Report for the RVAAP-34 Sand Creek Disposal Road Landfill, RVAAP-03 Open Demolition Area #1, and RVAAP-28 Mustard Agent Burial Site, Version 1.0* (Shaw, 2011), hereafter referred to as the Digital Geophysical Mapping (DGM) Report

- *Final Phase I Remedial Investigation Report for RVAAP-34 Sand Creek Disposal Road Landfill, Version 1.0* (Shaw, 2013)

A summary of these activities is as follows.

2.2.2.1 1996 Preliminary Assessment

In 1996, SAIC was contracted by the USACE to conduct a preliminary assessment (PA) at various AOCs at the RVAAP. The purpose of the PA was to collect information concerning conditions at the RVAAP sufficient to assess the potential threat posed to human health and the environment and to determine the need for additional characterization at areas identified at the RVAAP containing potentially hazardous materials from former munitions assembly and demilitarization operations at the installation. The scope of the PA included review of available information, interviews with former employees, and field visits to review and identify potential sites. The PA reported that the site contained concrete, wood, several tons of asbestos and spent fluorescent light bulbs. The waste was characterized as containing asbestos and heavy metals (mercury), although no characterization data were available (SAIC, 1996).

2.2.2.2 1996 Relative Risk Site Evaluation

The USACHPPM conducted a relative risk site evaluation (RRSE) for previously uninvestigated sites at the RVAAP in 1996. From the 19 sites that were evaluated, 4 were classified as “high” priority AOCs and the others were classified as “low” or ”medium.” The four high-priority AOCs included the Sand Creek Site.

The 1996 RRSE identified surface soil and sediments to be potential media for contaminant migration at the Sand Creek Site due to the lack of any physical barriers/fence around the site and its proximity to Sand Creek. Three shallow soil samples and one sediment sample were collected from the site during the RRSE. The study identified arsenic as exceeding RRSE screening values for sediments and identified the potential for arsenic to migrate into Sand Creek. The RRSE for this AOC was scored “high,” since Sand Creek is a habitat for State endangered species (mountain brook lamprey and river otter). Under the CERCLA process, a site which registers a RRSE rating of “high” requires further investigation and/or removal (USACHPPM, 1998).

2.2.2.3 Additional Investigations

Site evaluations following the USACHPPM sampling event determined the area used for dumping at the Sand Creek Site was larger than originally defined. In addition, observations identified multiple potential sources of chemical contamination, such as solvent drums, gas cylinders, open canisters, broken lab bottles, and construction debris.

At the recommendation of the U.S. Army Operations Support Command, the USACE, Louisville District, collected additional surface soil samples to further characterize the dump site. Samples were collected and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, cyanide, pesticides, polychlorinated biphenyls (PCBs), explosives, and nitroguanidine. Sample results indicated that metals and SVOCs were present at levels that represent a potential threat to human health and the environment.

These sample results indicated that the contaminants had migrated to the sediments of Sand Creek. Additional contamination in soils beneath sediment along Sand Creek was a concern. However, unexploded ordnance (UXO) concerns prevented additional sampling before debris removal. As such, a remedial design (RD)/RA was the selected alternative for the Sand Creek Site as detailed in the *Decision Document for a Removal Action at Sand Creek Dump Site* (MKM, 2004).

2.2.2.4 2003 Facility-Wide Biological and Water Quality Study

In 2003, the USACE performed surface water and sediment sampling and biological monitoring at 26 stream sites at the RVAAP that included that included sample locations at the intersection of Sand Creek and the railroad that transects the site (**Figure 2-4**). Biological monitoring included fish and macroinvertebrate community assessments. Two surface water samples from each location at different collection dates during the summer of 2003 (June and September) were analyzed for Target Analyte List (TAL) metals, pesticides, PCBs, explosive compounds, SVOCs, and several nutrient parameters. One sediment sample was collected using the incremental sampling methodology (ISM) at the collocated biological sampling sites. Sediments were analyzed for TAL metals, SVOCs, pesticides, PCBs, explosive compounds, percent solids, and cyanide as well as several nutrient parameters. The collection of the aforementioned data provided (1) aquatic life use attainment status of streams regarding the Warm Water Habitat or other applicable aquatic life use designation codified in the Ohio Water Quality Standards, (2) an assessment if chemical contamination within the streams was adversely affecting the biological communities, and (3) an ecological assessment report summarizing the sediment, surface water, and aquatic biological results. A summary of the results are as follows:

- **Sediment**—Cadmium and antimony were the only inorganics in the sediment sample that exceeded the RVAAP background screening value (BSV) of 0 milligrams per kilogram (mg/kg). A low SVOC concentration of di-n-butyl phthalate was also detected. No PCBs, pesticides, cyanide, or explosives compounds were detected in the sediment sample.

- **Surface Water**—The only detected metal that exceeded an RVAAP-calculated BSV was arsenic in the September 2003 sampling event. Concentrations of chromium, cobalt, silver, and vanadium were detected between the two sampling events and exceeded the BSV of 0 micrograms per liter. All other detected metals were either essential nutrients (calcium, iron, magnesium, potassium, and sodium), or the maximum detected concentration (MDC) was less than the RVAAP surface water BSV (aluminum, barium, copper, manganese, and zinc). A low concentration of bis(2-ethylhexyl)phthalate was detected in surface water during the first round of sampling, and di-n-butyl phthalate was detected in the second round of sampling. No PCBs, pesticides, or explosive concentrations were detected in the surface water samples.

The results indicated that historical activities at the Sand Creek Site have not impacted surface water or sediment quality within the portion of Sand Creek that is adjacent to the AOC. Furthermore, evaluation of the surface water and sediment data at the nearest downstream sample location (approximately 1,000 feet downstream of the site) provides support that historical activities at the Sand Creek Site have not impacted downstream conditions. In general, the *RVAAP Facility-Wide Biological and Water Quality Study 2003* (FWBWQS; USACE, 2005b) concluded that surface water quality throughout the installation was generally good to excellent with very few exceedances of Ohio aquatic life water quality criteria. Sediment samples generally reflected noncontaminated conditions and stream habitat was good at most sites.

2.2.2.5 2003 Removal Action

A RA was conducted at the Sand Creek Site by MKM between August and September 2003. The removal effort at the site consisted of removing all existing unconsolidated surface debris, the limited removal of subsurface debris, transportation and disposal of debris and restoration activities. Due to the presence of transite, all debris was disposed of as ACM special waste. Approximately 1,118 tons of ACM, including the subsurface transite, glass, and miscellaneous debris were removed from the AOC (MKM, 2004).

Confirmatory soil, surface water, and sediment samples were collected in and around the site by MKM following the removal efforts to evaluate the success of the RA and characterize potential impact to Sand Creek and the neighboring floodplain (**Figure 2-5**). Prior to sampling, the dump area was divided into 30 sampling grids to facilitate collection of the soil discrete samples. One shallow soil sample (0 to 1 foot), not including duplicates and quality control samples, was collected from each grid (30 total) measuring approximately 40 feet by 40 feet. Surface water was collected at 3 locations, and sediment samples were collected at 12 locations within Sand Creek and neighboring floodplains, respectively, to characterize potential impact associated with surface water runoff from the site. A summary of results for the samples collected during the RA is as follows:

- **Surface Soil**—Multiple inorganics concentrations were detected in the ISM surface soil samples in excess of the facility-wide BSVs. Although sporadic, numerous SVOCs consisting of polynuclear aromatic hydrocarbons (PAHs), three explosives (2,4-trintrotoluene, 2,4-dinitrotoluene, and 2,6-dinitrotoluene), one propellant (nitrocellulose), and one VOC concentration (chloroethane) were detected at two surface soil sample locations.
- **Sediment**—Multiple inorganics were detected in the discrete sediment samples in excess of the facility-wide BSVs, and one VOC (acetone) were detected at two sample locations. No SVOCs were detected.
- **Surface Water**—No VOCs, SVOCs, explosives, or propellants were detected in surface water. All detected metals were either essential nutrients (calcium, iron, magnesium, potassium, and sodium), or the MDC was less than the RVAAP surface water BSVs (arsenic, aluminum, barium, copper, manganese, and zinc).

Initial evaluation of the results indicated that there may have be some impact to environmental media at the AOC as a result of historical activities, in particular surface soil. During confirmation sampling following the RA, two 75-millimeter projectile shells (i.e., munitions debris [MD]) were discovered at the northern portion of the site.

2.2.2.6 2010 Digital Geophysical Mapping Survey

Between April and May 2010, Shaw conducted a DGM survey at and in the immediate vicinity of the Sand Creek Site where historical dumping activities occurred. The primary purpose of the survey was determine the horizontal extent of potential MEC and other suspected buried anomalies without performing intrusive activities at the site. The secondary objective was to evaluate the data to characterize the anomaly density at the site. Geophysical data were collected south and north of the access road adjacent to the stream, along the steep slopes of the embankment in the central portion of the Sand Creek Site and east of the steep embankment in the open area. During this effort, data were acquired in accessible areas void of thick vegetation and fallen trees and where the embankments and other localized slopes were navigable by the field crew (**Figure 2-6**).

The DGM data collected at the Sand Creek Site were able to determine the broader limits of metallic waste materials as well as to define more localized regions within and outside the AOC footprint that contain relatively higher metal content. The survey data indicated that the largest portion of the metal debris at the site is present northeast of the former railroad bed. Several areas characterized by relatively higher density of anomalies are located between the stream and the edge of the eastern plateau. The large oval-shaped area that trends southwest–northeast in the northeastern portion of the survey area and outside of the AOC (contiguous pink colors on **Figure 2-6**) is approximately 0.8 acres in size. Areas characterized by relatively lower density of anomalies are present throughout the southern portion of the survey area. During the survey of the area, the field crew noticed several areas where concrete rubble was present along and at the bottom of the embankment at the northern portion of the AOC.

2.2.2.7 2010 Phase I Remedial Investigation

The Phase I RI field activities were conducted at the Sand Creek Site between September 21 and November 9, 2010, and included the collection of surface soil and sediment samples using the ISM and subsurface soil samples using a modified version of the ISM. Sampling locations for these activities were based on data gaps identified in the *Final Data Quality Objectives Report for the RVAAP-34 Sand Creek Disposal Road Landfill, Version 1.0, Ravenna Army Ammunition Plant, Ravenna, Ohio* (Shaw, 2009), hereafter referred to as the Data Quality Objectives (DQO) Report, and the results of the DGM Report (Shaw, 2011). Surface water samples were not collected during the Phase I RI based on the recommendations made in the DQO Report. Groundwater sampling is performed on a facility-wide basis and was not included in Shaw's scope of work for the Phase I RI at the Sand Creek Site. Based on the data gaps and need for additional information regarding contaminants identified during the previous investigations at the AOC, the following samples were collected for the Phase I RI:

- 18 ISM surface soil samples from 0 to 1 foot below ground surface (bgs) from along the AOC source area slopes and upgradient locations at the top of slope where historical dumping activities occurred
- 2 ISM sediment samples from 0 to 0.5 feet bgs along the floodplain downgradient of the AOC source area slopes and adjacent to Sand Creek
- 58 modified ISM subsurface soil samples using direct-push technology (DPT) and manual hand augers. The DPT samples were collected at the top of slope upgradient of the AOC source areas at the following intervals: 1 to 5 feet, 5 to 9 feet, 9 to 13 feet, 13 to 17 feet, and 17 to 20 feet. The hand-augered samples were collected at the 1- to 5-foot sample intervals along the sloped areas of the AOC where DPT sampling could not be performed.)

Each surface soil and subsurface soil sample location was analyzed for TAL metals, SVOCs, and explosives. Approximately 10 percent of the samples and both sediment samples were analyzed for the RVAAP full suite that included VOCs, pesticides, PCBs, total cyanide, and propellants. Five samples for surface and subsurface soil samples each, were submitted for hexavalent chromium analysis.

The locations of the samples collected during the Phase I RI field activities are presented on **Figure 2-7**. The results of the samples collected during the RI field activities were then aggregated with the qualified historical data to identify site-related chemicals (SRCs) in accordance with the evaluation process presented in the *Final Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC, 2010), hereafter referred to as the FWCUG guidance. The SRCs were then used to evaluate for contaminant fate and transport and were carried forward into the risk assessments for human and environmental receptors.

2.3 Nature and Extent of Contamination

The majority of the SRCs identified in the environmental media evaluated for nature and extent of contamination (surface soil, subsurface soil, sediment, and surface water) occurred at the northern portion of the AOC. Between the 2003 RA and the Phase I RI data, a total of 58 SRCs was identified in surface soil (0 to 1 foot). Subsurface soils were collected during the Phase I RI only, and a total of 64 SRCs were identified in the five sample intervals between 1 and 20 feet bgs. A total of 50 SRCs were identified in sediment between the 2003 RA (0 to 1 foot), the 2003 FWBWQS (0 to 0.5 feet), and the Phase I RI data sets (0 to 0.5 feet). Eleven SRCs consisting of inorganics, SVOCs, and two nutrient parameters were identified in surface water between the two samples collected for the 2003 FWBWQS. The spatial distribution of the SRCs, particularly inorganics, is consistent among the environmental media and the types of methods used to collect the samples (i.e., discrete vs. ISM).

- **Surface Soil**—In surface soils collected during the Phase I RI, the greatest concentrations of inorganic, SVOCs, and explosives and propellants SRCs occurred at the northern portion of the AOC where historical disposal activities occurred and where the majority of the RA was conducted in 2003. Explosives were detected at two locations at the northern portion of the AOC. The detections of inorganics and SVOCs were well distributed across the site; however, the greatest concentrations also occurred in the northern portion of the site. The number of detected inorganics and SVOCs and elevated concentrations generally decreased the further south the samples were collected at the AOC.

- **Subsurface Soil—**A total of 22 soil borings was advanced during the Phase I RI field activities. Bedrock was not encountered at any of the borings, which were advanced to a maximum depth of 20 feet bgs. Three explosives concentrations were detected at one soil boring location at 1 to 5 feet bgs along the slope at the northern portion of the AOC. The spatial distribution of inorganics and SVOCs was similar to that observed in surface soil samples with the greatest concentrations detected along and adjacent to the slope at the northern portion of the AOC. The greatest number of detects and the greatest concentrations for both inorganics and SVOCs were typically found in the 1 to 5 feet, 5 to 9 feet, and 9 to 13 feet sample intervals; however, the number of detections and concentrations generally decreased with the sample distance to the south at the AOC and with boring depth. Concentrations of VOCs, pesticides, and PCBs that were detected were at two boring locations at the northern portion of the AOC at the 1- to 5-foot sample intervals.

- **Sediment—**Similar to surface soils, the greatest concentrations of SRCs in the two ISM sediment samples collected for the Phase I RI occurred at the northern portion of the AOC. The SRCs included primarily inorganics, SVOCs, and pesticides. Two PCB analytes were detected in the northern floodplain sediment sampling unit. One explosive/propellant (nitroguanidine) was detected in both sediment sampling units. The majority of the SRCs identified in sediment during the 2003 RA were detected north of the former rail bed and correlate with the results from the Phase I RI. The exact location of the 2003 FWBWQS sediment sample collected using ISM is not known; therefore, a distribution comparison to the sediment samples from the other investigations could not be made.

- **Surface Water—**Although 11 SRCs were detected in the surface water samples collected adjacent to the AOC for the 2003 FWBWQS, a cursory review of the overall surface water data collected along Sand Creek as part of the 2003 survey indicates that detected analyte concentrations in the samples collected adjacent to the AOC are consistent with the other surface water samples collected both upstream and downstream of the site. Based on these results, it appears that surface water conditions downstream of the AOC have not been impacted by historical disposal activities at the Sand Creek Site.

2.4 Fate and Transport Analysis

Contaminant fate and transport modeling was performed to evaluate the potential for the SRCs in surface and subsurface soils to migrate vertically downward and impact groundwater quality and eventually surface water. Any SRCs identified would require further evaluation in the FS.

Seasonal Soil Compartment (SESOIL) modeling (Waterloo Hydrogeologic, Inc., 2004) was performed for constituents identified in potential source surface soils as contaminant migration chemicals of potential concern (CMCOPCs) after screening against the 1,000-year travel time criteria. The SESOIL model defines the soil compartment as a soil column extending from the ground surface through the unsaturated zone and to the upper level of the saturated zone. Processes simulated in SESOIL are categorized in three cycles: (1) the hydrologic cycle (rainfall, surface runoff, infiltration, soil-water content, evapotranspiration, and groundwater recharge), (2) the sedimentation cycle, and (3) the pollutant cycle (convective transport, volatilization, adsorption/desorption, and degradation/decay).

The CMCOPCs identified as having the potential for impacting groundwater and surface water include 2,4,6-trinitrotoluene (TNT) and 2-amino-4,6-dinitrotoluene, 1,4-dichlorobenzene, carbazole, pentachlorophenol, benzene, alpha-benzene hexachloride (BHC), and beta-BHC. The CMCOPCs identified represent a conservative comparison, since groundwater at the site has not been investigated and the hydrogeologic parameters are either assumed values or literature values for comparable lithologies.

2.5 Human Health Risk Assessment

A HHRA was performed to evaluate whether site conditions may pose a risk to current or future human receptors and to identify which, if any site conditions need to be addressed in the FS. The HHRA included data to evaluate the need for restrictions or potential Land Use Controls (LUCs) based on the planned future Military Training Land Use.

The Sand Creek Site was considered as a single exposure unit based on the future Military Training Land Use. Although the site was evaluated as a single exposure unit, soil data collected within and adjacent to the AOC were aggregated by depth intervals, since different future use receptors with different depths of potential exposure were required to be evaluated. The HHRA included analyses to assess potential risks at various depths to assess whether or not the most likely receptor for subsurface soil, the National Guard Trainee, would be able to dig and to what depth. The soil intervals for Unrestricted Land Use were also assessed. Sediment samples collected for the RI and previously collected surface water samples were evaluated in the same manner for the identified receptors. The sample intervals evaluated for each of the receptors in the HHRA is identified below:

- Resident (Adult and Child)—Surface soil (0 to 1 foot bgs)
- Resident (Adult and Child)—Subsurface soil (1 to 13 feet bgs)
- National Guard Trainee and Range Maintenance Soldier—Deep Surface soil (0 to 4 feet bgs)
- National Guard Trainee—Subsurface soil (4 to 7 feet bgs)
- Resident (Adult and Child)/National Guard Trainee—Sediment

- Resident (Adult and Child)/National Guard Trainee—Surface water

The HHRA was prepared using the streamlined approach to risk decision making as described in the *Ravenna Army Ammunition Plant (RVAAP) Position Paper for the Application and Use of Facility-Wide Human Health Cleanup Goals* (USACE, 2012). The approach identifies chemicals of potential concern (COPCs) by comparing concentrations to BSVs, eliminating essential nutrients, and comparing site concentrations to the FWCUGs. The COCs are identified through additional screening of the COPCs by comparing site concentrations to specific FWCUGs and using a "sum of ratios" approach to account for accumulative effects.

The HHRA process identified both COPCs and COCs in surface soil for the Unrestricted Land Use. The COPCs identified were antimony, arsenic, cadmium, copper, lead, mercury, silver, thallium, 2,4,6-trinitrotoluene, and several PAHs. Various COPCs were screened out through the risk assessment approach and the chemicals that remained as COCs for the Unrestricted Land Use receptors in surface soil were antimony, arsenic, copper, mercury, silver, thallium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene.

The HHRA process identified both COPCs and COCs for the Unrestricted Land Use receptors in subsurface soil. The COPCs identified were antimony, arsenic, copper, lead, thallium, vanadium, Arochlor-1254, various PAHs, and 1,2-dimethylbenzene. Of these, arsenic and benzo(a)pyrene were identified as COCs for the Unrestricted Land Use receptors in subsurface soil through the COPC screening process.

The HHRA process identified both COPCs and COCs for the reasonably anticipated Military Training Land Use receptors in deep surface soil that include the National Guard Trainee and the Range Maintenance Soldier. The COPCs included arsenic, barium, cadmium, cobalt, lead, manganese, various PAHs, and 1,2-dimethlybenzene. Various COPCs were screened out through the risk assessment approach and the COCs identified in deep surface soil for the Military Training Land Use receptors were arsenic, benzo(a)pyrene, and benzo(b)fluoranthene.

The HHRA process identified both COPCs and COCs for the National Guard Trainee, the reasonably anticipated Military Training Land Use receptor in subsurface soil. The COPCs identified were arsenic, lead, and phenanthrene. Only arsenic and lead were identified as COCs for the National Guard Trainee in subsurface soil.

The HHRA process identified COPCs in sediment for the Unrestricted Land Use and the Military Training Land Use receptors. The COPCs were the same for all the receptors and consisted of antimony, silver, thallium, Arochlor-1254, benzo(a)pyrene, and phenanthrene. No COCs were identified in sediment for any of the receptors following additional screening of the COPCs. The risk assessment process identified COPCs in surface water for the Unrestricted Land Use and Military Training Land Use receptors. No COCs were identified in surface water for any of the receptors following additional screening of the COPCs.

A summary of the HHRA results are presented in **Table 2-1**.

Table 2-1
Summary of HHRA Results for the Sand Creek Site

Receptor/Exposure Point	COPCs Identified[a]		COCs Identified[b]
Surface Soil (0 to 1 foot bgs)			
Unrestricted Land Use	Antimony	Benzo(a)anthracene	Antimony Arsenic Copper Mercury Silver Thallium Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene
	Arsenic	Benzo(a)pyrene	
	Cadmium	Benzo(b)fluoranthene	
	Copper	Dibenzo(a,h)anthracene	
	Lead	Indeno(1,2,3-cd)pyrene	
	Mercury	Phenanthrene	
	Silver	2,4,6-Trinitrotoluene	
	Thallium		
Deep Surface Soil (0 to 4 feet bgs)			
Military Training Land Use	Arsenic	Benzo(a)anthracene	Arsenic Benzo(a)pyrene Benzo(b)fluoranthene
	Barium	Benzo(a)pyrene	
	Cadmium	Benzo(b)fluoranthene	
	Cobalt	Dibenzo(a,h)anthracene	
	Lead	Phenanthrene	
	Manganese	1,2-Dimethylbenzene	
Subsurface Soil			
Unrestricted Land Use (1 to 13 feet bgs)	Antimony	Benzo(a)anthracene	Arsenic Benzo(a)pyrene
	Arsenic	Benzo(a)pyrene	
	Copper	Benzo(b)fluoranthene	
	Lead	Dibenzo(a,h)anthracene	
	Thallium	Indeno(1,2,3-cd)pyrene	
	Vanadium	Phenanthrene	
	Arochlor-1254	1,2-Dimethylbenzene	

Table 2-1 (continued)
Summary of HHRA Results for the Sand Creek Site

Receptor/Exposure Point	COPCs Identified[a]		COCs Identified[b]
Subsurface Soil			
Military Training Land Use (4 to 7 feet bgs)	Arsenic		Arsenic Lead
	Lead		
	Phenanthrene		
Sediment (0 to 0.5 feet bgs)			
Unrestricted and Military Training Land Use	Antimony	Aroclor-1254	None
	Silver	Benzo(a)pyrene	
	Thallium	Phenanthrene	
Surface Water			
Unrestricted and Military Training Land Use	Arsenic		None

bgs denotes below ground surface.
COC denotes chemical of concern.
COPC denotes chemical of potential concern.

2.6 Ecological Risk Assessment

An ecological risk assessment (ERA) was conducted to evaluate the potential for adverse ecological effects to ecological receptors from SRCs at the Sand Creek Site and to determine if any ecological receptors need to be recommended for further evaluation in the FS. The ERA included characterizing the ecological communities in the vicinity of the site, determining the particular contaminants present, identifying pathways for receptor exposure, and estimating the magnitude of the likelihood of potential adverse effects to identified receptors. Site-specific analyte concentration data for surface soil, sediment, and surface water from the Sand Creek Site were included in the ERA. The ecological receptor species selected for evaluation in the ERA were identified in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003a).

Consistent with the RVAAP Unified Approach for performing ERAs, a screening-level ERA (SLERA) was performed for the Sand Creek Site. The SLERA under the Unified Approach includes Steps 1 through 3a of the 8-step process for ERAs (EPA, 1997). This is equivalent to a Level I and II evaluation according to the Ohio EPA process, and is also consistent with the ERA approach described in USACE guidance (2003 and 2010). The Level I Scoping is designed to efficiently determine whether further ecological risk should be evaluated at a particular site. The Level II Screen is to be completed after the full nature and extent of the site contamination has been determined. The purpose of a Level II Screen is to select the list of detected chemicals per media as appropriate, evaluate aquatic habitats potentially impacted by the site, and if necessary, revise the conceptual site model (CSM), complete a list of ecological receptors, identify chemicals of potential ecological concern (COPECs) and nonchemical stressors, and other tasks required for further ecological evaluation of the site and impacted habitats. The purpose of a Level III Baseline is to identify the potential for ecological harm at a site. Specifically, the Level III Baseline is a formal ERA process that includes an exposure assessment, toxicity assessment, risk characterization, and an uncertainty analysis. Potential ecological hazards are evaluated by using the COPECs and nonchemical stressors identified in a Level II Screen, generic receptors, direct contact evaluations, and food-web models that are provided in the guidance document.

Mercury in surface soil was the only COPEC recommended to be evaluated under the Level III Baseline evaluation following the Level II Screen. The only species identified as having a hazard quotient (HQ) greater than 1 associated with mercury was the robin, which indicates that potential hazards may exist to omnivorous birds foraging at the site. It is important to state that the finding of HQs greater than 1 does not necessarily indicate that adverse impacts are occurring. Weight of evidence suggests that it would be highly unlikely that sufficient exposure would occur to local populations of robins such that adverse populations would occur at the AOC.

2.7 Conceptual Site Model

This section provides a discussion of the CSM based on the analytical results of the Phase I RI field data, an evaluation of nature and extent of contamination, fate and transport, and risk evaluations associated with human health and ecological receptors. The CSM discussion presents those pathways that have demonstrated to be complete as evidenced by the presence of contamination and are being evaluated in this FS. Those pathways that are likely incomplete or have negligible impact are not being considered for evaluation in this FS. Elements of this revised CSM include the following:

- Primary and secondary contaminant sources and release mechanisms
- Contaminant migration pathways and discharge points
- Potential receptors with unacceptable risk
- Uncertainties

The overall CSM for the Sand Creek Site that are based on the aforementioned elements is presented in **Figure 2-8**.

2.7.1 Primary and Secondary Contaminant Sources and Release Mechanisms

Little information is available regarding the historical operations at the Sand Creek Site except that the AOC was used by the U.S. Army as an open dump for concrete, wood, asbestos debris, lab bottles, 55-gallon drums and fluorescent light tubes. A RA was conducted by MKM in 2003 that included the removing of all existing unconsolidated surface debris, the limited removal of subsurface debris, transportation and disposal of debris and site restoration. The remaining subsurface debris as well as some visible remaining surface debris is identified as the primary contaminant sources for the Sand Creek Site.

Analysis of data collected by MKM following the RA and as part of the Phase I RI identified surface soil (0 to 1 foot bgs) as the primary source of contamination, in particular surface soil at the northern portion of the AOC along the slope and soils adjacent to the top of slope. Inorganics (antimony, arsenic, copper, mercury, silver, and thallium) and PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene) were identified at concentrations that were sufficient TBC COCs. Surface soils appear to be a secondary source of contamination as arsenic, lead, benzo(a)pyrene, and benzo(b)fluoranthene were identified as COCs in subsurface soils (1 to 20 feet bgs) at the northern portion of the site where the COCs in surface soil were identified. No COCs were identified for sediment or surface water situated downgradient of the AOC; however, fate and transport analysis suggested that the SRCs detected in the sediments and surface water may have originated from these soil sources. The mechanisms for releases of contaminants at the site include the following:

- Much of the native soil was reworked, removed, or used as cover material during historical dumping activities. Overland surface flow from the reworked areas following rain events and snowmelt may have contaminated the downgradient surface soils at the AOC.
- The SRCs in the subsurface soil (greater than 1 foot bgs) appear to have originated from the fill material placed after the native soil was disturbed and the fill material were placed along the embankment and slopes of Sand Creek.
- The source of the SRCs measured in the sediment is assumed to be surface soil (0 to 1 foot bgs).
- The SRCs measured in the surface water could potentially have derived from the surface soil and sediment, dissolved in the rainwater and snowmelt running off the land surface and Sand Creek slopes. It could also have originated from the surface and subsurface soils, whose chemical constituents may have been dissolved in the rainwater and snowmelt infiltrating vertically downwards to the groundwater and then discharging to Sand Creek.

Groundwater samples were not collected during the Phase I RI, and no historical groundwater data exists for the site. Fate and transport modeling was used to determine the potential for the SRCs present in surface and subsurface soils to migrate vertically downwards and impact groundwater quality underneath the AOC and eventually the surface water quality in nearby Sand Creek. Although the model is considered conservative and various assumptions were used in place of unknown parameters, 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, 1,4-dichlorobenzene, carbazole, pentachlorophenol, benzene, alpha-BHC, and beta-BHC were identified as SRCs that have to the potential to leach from surface soil to groundwater at the site and ultimately to Sand Creek.

2.7.2 Contaminant Migration Pathways and Discharge Points

One of the principal migration pathways at the Sand Creek Site is infiltration through the unsaturated soil (approximately 13 feet thick) to the underlying groundwater that has the potential to cause SRCs to leach from surface and subsurface soils into groundwater present in the unconsolidated water-bearing zone. Due to the very heterogeneous nature of the unconsolidated glacial materials, groundwater flow patterns within the unconsolidated water-bearing zone are difficult to predict. Site-specific groundwater data are not available at the AOC.

Some of the precipitation falling as rainfall and snow leaves the site as surface runoff to Sand Creek, carrying dissolved SRCs that are present in the surface soil at the site. The fraction of the precipitation that does not leave the AOC as surface runoff infiltrates into the subsurface. Some of the infiltrating water is lost to the atmosphere as evapotranspiration. The remainder of the infiltrating water recharges the groundwater. The rate of infiltration and eventual recharge of the groundwater is controlled by soil cover, ground slope, saturated hydraulic conductivity of the soil, and meteorological conditions.

In theory, the infiltrating water leaches the contaminated soil impacted with SRCs and carries the dissolved SRCs to deeper soil and groundwater. The factors that affect the leaching rate include the amount of infiltration, the SRCs' solubility in water and partitioning between solids and water. The impacted groundwater would eventually discharge to the surface water in Sand Creek, carrying dissolved SRCs with it.

2.7.3 Potential Receptors

The National Guard Trainee and the Range Maintenance Soldier were selected as the receptors for the future Military Training Land Use activities at the AOC. Both of these receptors were conservatively evaluated for potential exposure for deep surface soil (0 to 4 feet bgs); however, in accordance with the FWCUG guidance (SAIC, 2010), only the National Guard Trainee was further evaluated for potential exposures associated with subsurface soils (4 to 7 feet bgs), sediment, and surface water.

Arsenic, benzo(a)pyrene, and benzo(b)fluoranthene were identified as COCs for the Military Training Land Use receptors in deep surface soil. However, only arsenic has concentrations that exceed the FWCUGs. The exposure risks associated with benzo(a)pyrene and benzo(b)fluoranthene are from the evaluation of potential additive effects calculated from the maximum exposure point concentrations at the AOC from exposure to multiple chemicals or exposure to multiple chemicals that can cause the same effect (i.e., cancer) or affect the same target organ. Arsenic and lead were identified as COCs in subsurface soils for the National Guard Trainee as the concentrations for these inorganics exceed the final FWCUGs. No COCs were identified for sediment and surface water for the National Guard Trainee.

Evaluation for Unrestricted Land Use is a CERCLA requirement and the receptors identified at the RVAAP include the Resident (Adult and Child) receptors in accordance with the HHRAM (USACE, 2005a). The COCs identified in surface soil (0 to 1 foot bgs) for Unrestricted Land Use consist of antimony, arsenic, copper, mercury, silver, thallium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene. Copper, silver, and thallium were identified as COCs in surface soil based on a sum of ratios for gastrointestinal effects of slightly greater than 1 (1.4), and all three inorganics contributing greater than 5 percent to the sum of ratios. Arsenic and benzo(a)pyrene were identified as COCs in subsurface soils (1 to 13 feet bgs) for Unrestricted Land Use.

The American robin is a worm-eating and insectivorous avian species that may forage at the AOC and is therefore, potentially exposed to COPECs, in particular mercury, in soil. Weight of evidence suggests that it would be highly unlikely that sufficient exposure would occur to local populations of robins such that adverse populations would occur at the AOC.

2.7.4 Uncertainties

There are various sources of uncertainty that are inherent when evaluating a CSM. Uncertainties identified for the Sand Creek Site include the following:

- Operational records for the site are incomplete. A RA was completed at the AOC in 2003. However, residual waste materials are still visible on the ground surface and evident in the subsurface as a result of the 2010 DGM survey.
- Groundwater beneath the Sand Creek Site was not evaluated as part of the RI field activities; therefore, SRCs for groundwater were not identified. Fate and transport modeling was used to determine the potential for the SRCs present in surface and subsurface soils to migrate vertically downwards and impact groundwater quality underneath the AOC and eventually the surface water quality in the nearby Sand Creek. Throughout the screening and modeling processes, conservative

approaches were used, which may overestimate the contaminant concentration in the leachate for migration from observed soil concentrations.

- There are various sources of uncertainty in the evaluation of exposure and human health risk. These uncertainties generally relate to sampling considerations, the determination of exposure point concentrations, and the selection of appropriate receptors. There are numerous uncertainties related to the FWCUGs, including exposure assumptions and toxicity values. These uncertainties are inherent to the use of these values, and are similar for all assessments using them.
- Uncertainty, with regards to ecological risk evaluation, is associated primarily with deficiency or irrelevancy of effects, exposure, or habitat data to actual ecological conditions at the site. Species physiology, feeding patterns, and nesting behavior are poorly predictable. Therefore, all toxicity information derived from toxicity testing, field studies, or observations have uncertainties associated with them.

2.8 Phase I Remedial Investigation Recommendations

Based on the Phase I RI results, it was determined that the Sand Creek Site was adequately characterized and the recommended path forward was to proceed to the FS phase of the CERCLA process. The Phase I RI recommended an analysis of remedial alternatives for surface and subsurface soil based on fate and transport results of the leaching potential to groundwater that is associated with the identified CMCPOCs for these media. Copper, silver, and thallium were identified as COCs for the Unrestricted Land Use in surface soil based on a sum of ratios for gastrointestinal effects of slightly greater than 1 (1.4), and all three inorganics contributing greater than 5 percent to the sum of ratios. The MDCs for all three inorganics are less than the applicable final FWCUGs. The recommended approach to reducing the number of COCs was to reduce silver concentrations such that the sum of ratios does not exceed 1, as silver contributed the most to the sum of ratios. A reduction of silver concentrations to a maximum of 95 mg/kg (with no change to copper and thallium) reduces the sum of ratios to less than 1, thus eliminating thallium and copper as COCs, and eliminating health concerns associated with gastrointestinal effects.

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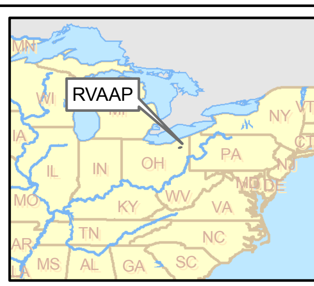
Note:
The Scale is for the Upper Map Only
Showing the RVAAP Location



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RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

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Figure 2-1 Location Map

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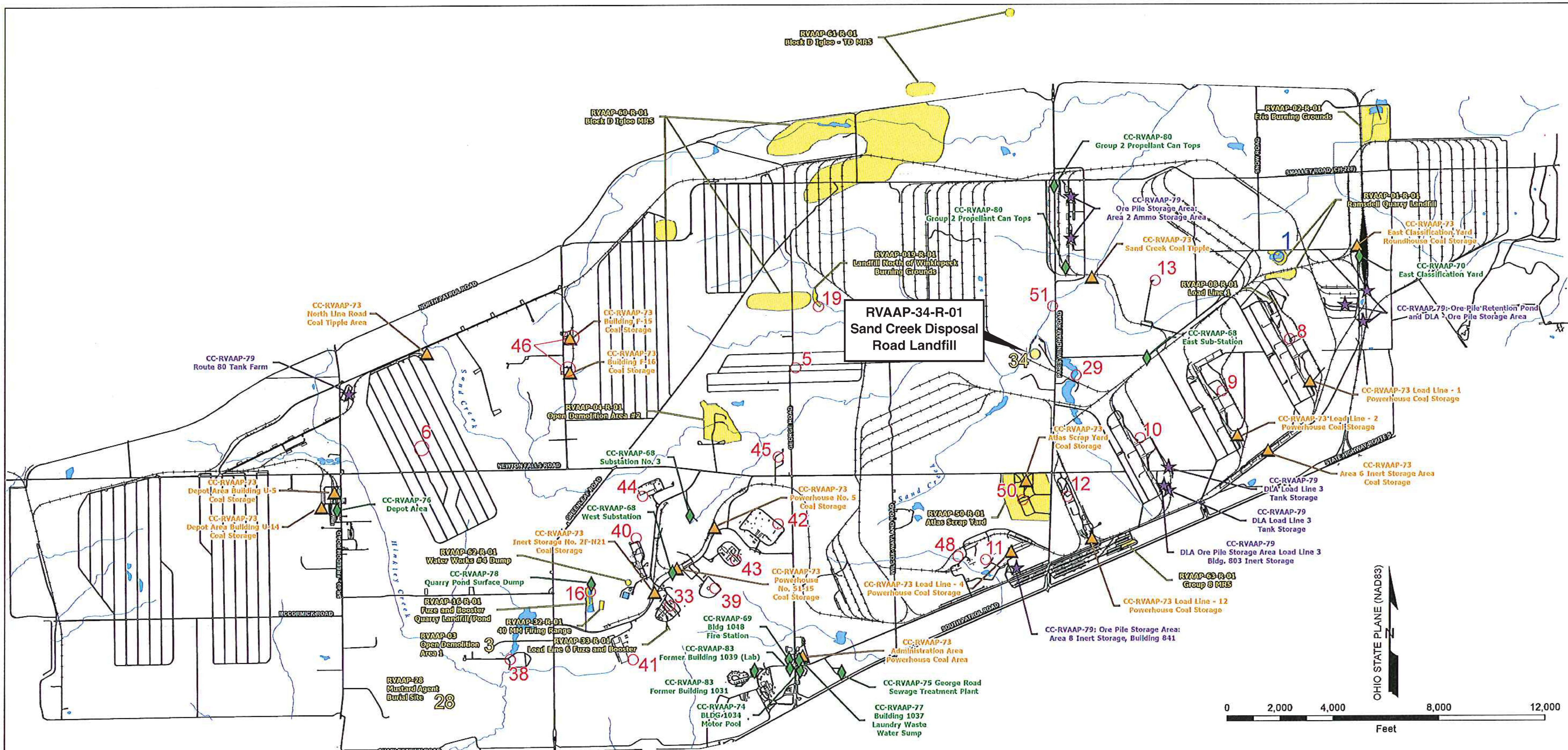

LEGEND OF SITES

IRP SITES (29 SITES)

- RVAAP-01 ....RAMSDELL QUARRY LANDFILL
- RVAAP-03 ....OPEN DEMOLITION AREA 1
- RVAAP-05 ....WINKLEPECK BURNING GROUNDS
- RVAAP-06 ....C BLOCK QUARRY
- RVAAP-08 ....LOAD LINE 1
- RVAAP-09 ....LOAD LINE 2
- RVAAP-10 ....LOAD LINE 3
- RVAAP-11 ....LOAD LINE 4
- RVAAP-12 ....LOAD LINE 12
- RVAAP-13 ....BLDG 1200 AND DILLUTION/SETTLING POND
- RVAAP-16 ....FUZE AND BOOSTER QUARRY LANDFILL/PONDS
- RVAAP-19 ....LANDFILL NORTH OF WINKLEPECK BURNING GROUND
- RVAAP-28 ....MUSTARD AGENT BURIAL SITE
- RVAAP-29 ....UPPER AND LOWER COBBS POND
- RVAAP-33 ....LOAD LINE 6
- RVAAP-34 ....SAND CREEK DISPOSAL ROAD LANDFILL
- RVAAP-38 ....NACA TEST AREA
- RVAAP-39 ....LOAD LINE 5
- RVAAP-40 ....LOAD LINE 7
- RVAAP-41 ....LOAD LINE 8
- RVAAP-42 ....LOAD LINE 9
- RVAAP-43 ....LOAD LINE 10
- RVAAP-44 ....LOAD LINE 11
- RVAAP-45 ....WET STORAGE AREA
- RVAAP-46 ....BUILDINGS F-15 AND F-16
- RVAAP-48 ....ANCHOR TEST AREA
- RVAAP-50 ....ATLAS SCRAP YARD
- RVAAP-51 ....DUMP ALONG PARIS-WINDHAM ROAD
- RVAAP-66 ....FACILITY-WIDE GROUNDWATER
- RVAAP-67 ....FACILITY-WIDE SEWERS

COMPLIANCE RESTORATION SITES (13 SITES)

- CC-RVAAP-68 ....ELECTRIC SUBSTATIONS (E,W,No.3)
- CC-RVAAP-69 ....BUILDING 1048 - FIRE STATION
- CC-RVAAP-70 ....EAST CLASSIFICATION YARD
- 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 BUILDINGS 1031 AND 1039

MMRP SITES (14 SITES)

- RVAAP-001-R-01 ....RAMSDELL QUARRY LANDFILL MRS
- 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 ....40MM 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 MRS

- ○ ....CERCLA
- ○ ....RCRA
- □ ....MMRP SITES
- ◆ ....COMPLIANCE RESTORATION SITES - APPROVED
- ☆ ....DLA ORE STORAGE AREAS (7 SITES)
- △ ....COAL STORAGE AREAS (17 SITES)

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MILITARY MUNITIONS RESPONSE PROGRAM

FIGURE 2-2 RVAAP FACILITY MAP
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

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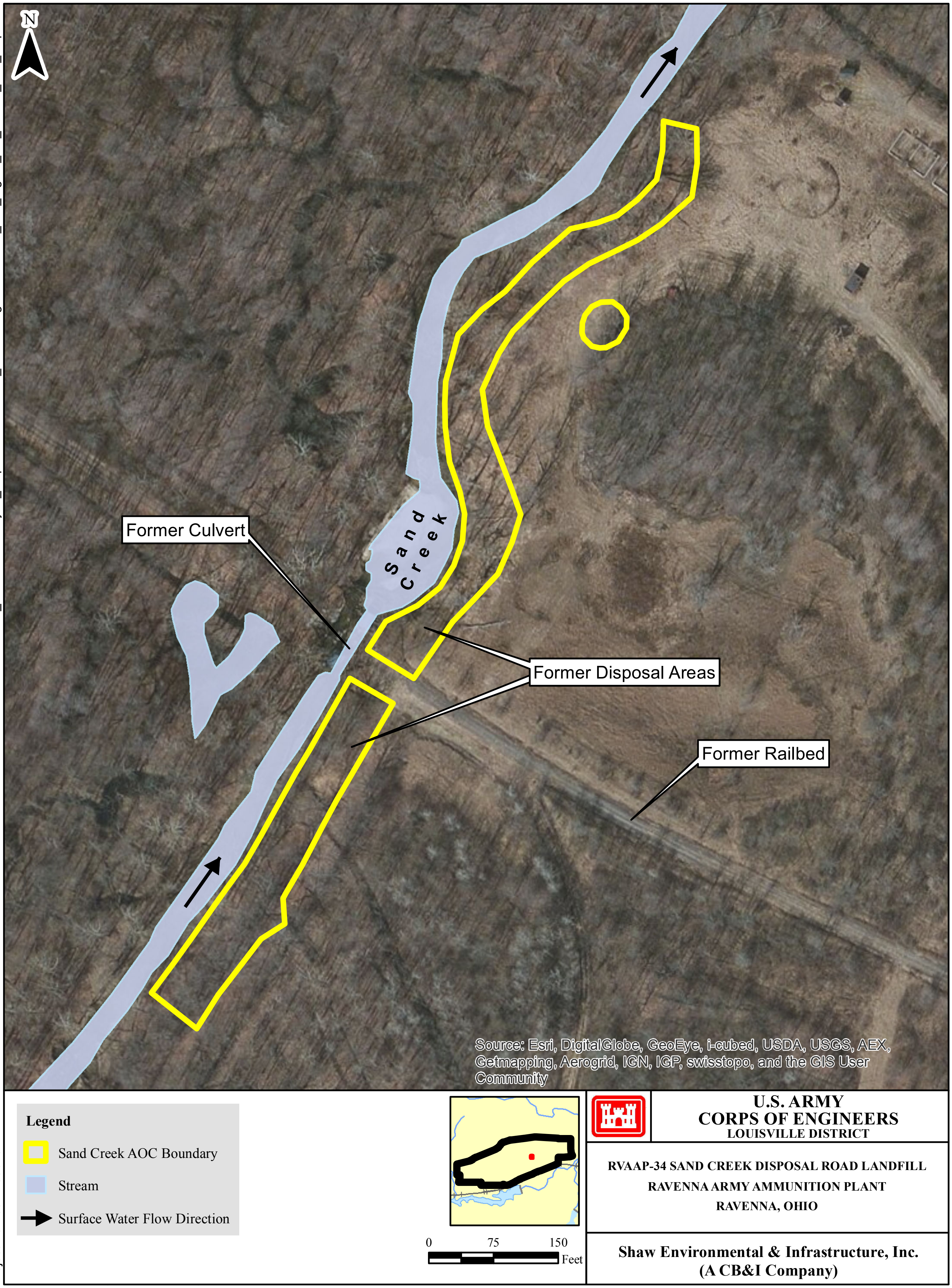

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Project Number: 133616

Figure 2-3 Site Map

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Project Number: 133616

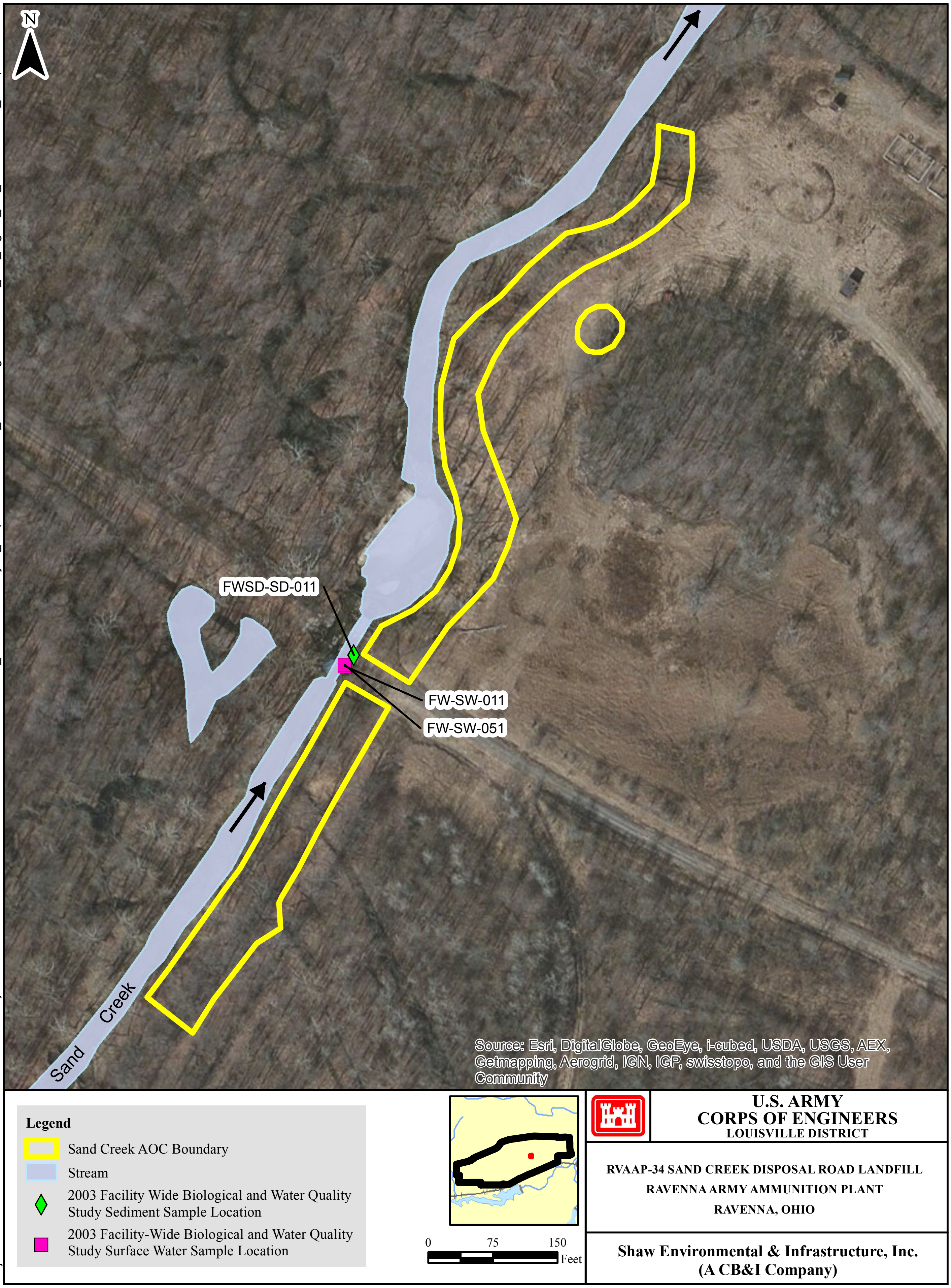

Figure 2-4 2003 Facility-Wide Biological and Water Quality Study Sample Locations

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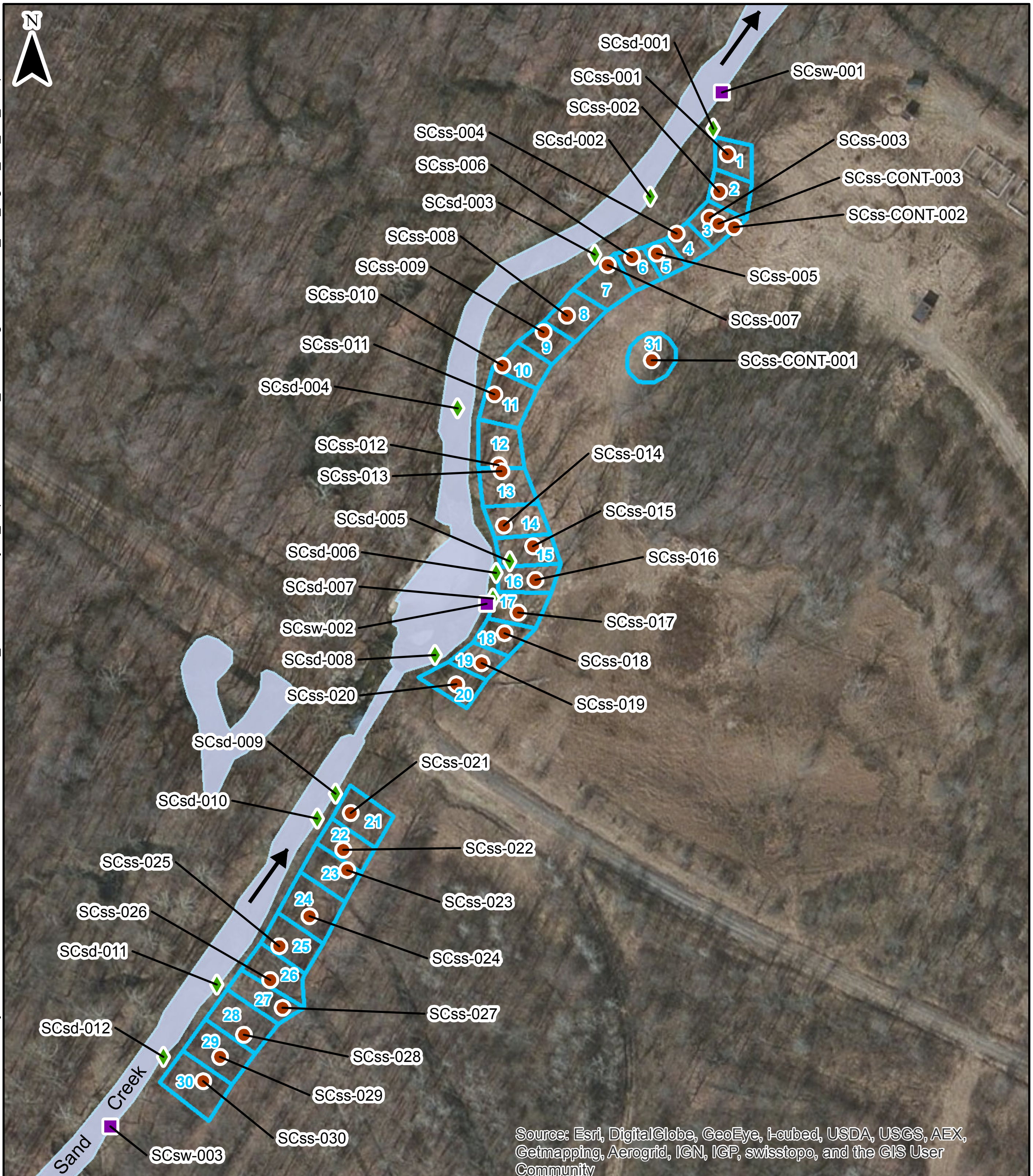

Legend

- Sand Creek Dump-Limits & Sample Grids
- Stream
- Sediment Sample Location
- Shallow Soil Confirmation Sample Location
- Surface Water Sample Location

0 75 150 Feet

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LOUISVILLE DISTRICT

RVAAP-34 SAND CREEK DISPOSAL ROAD LANDFILL
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

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Project Number: 133616

Figure 2-5 2003 Removal Action Sample Locations

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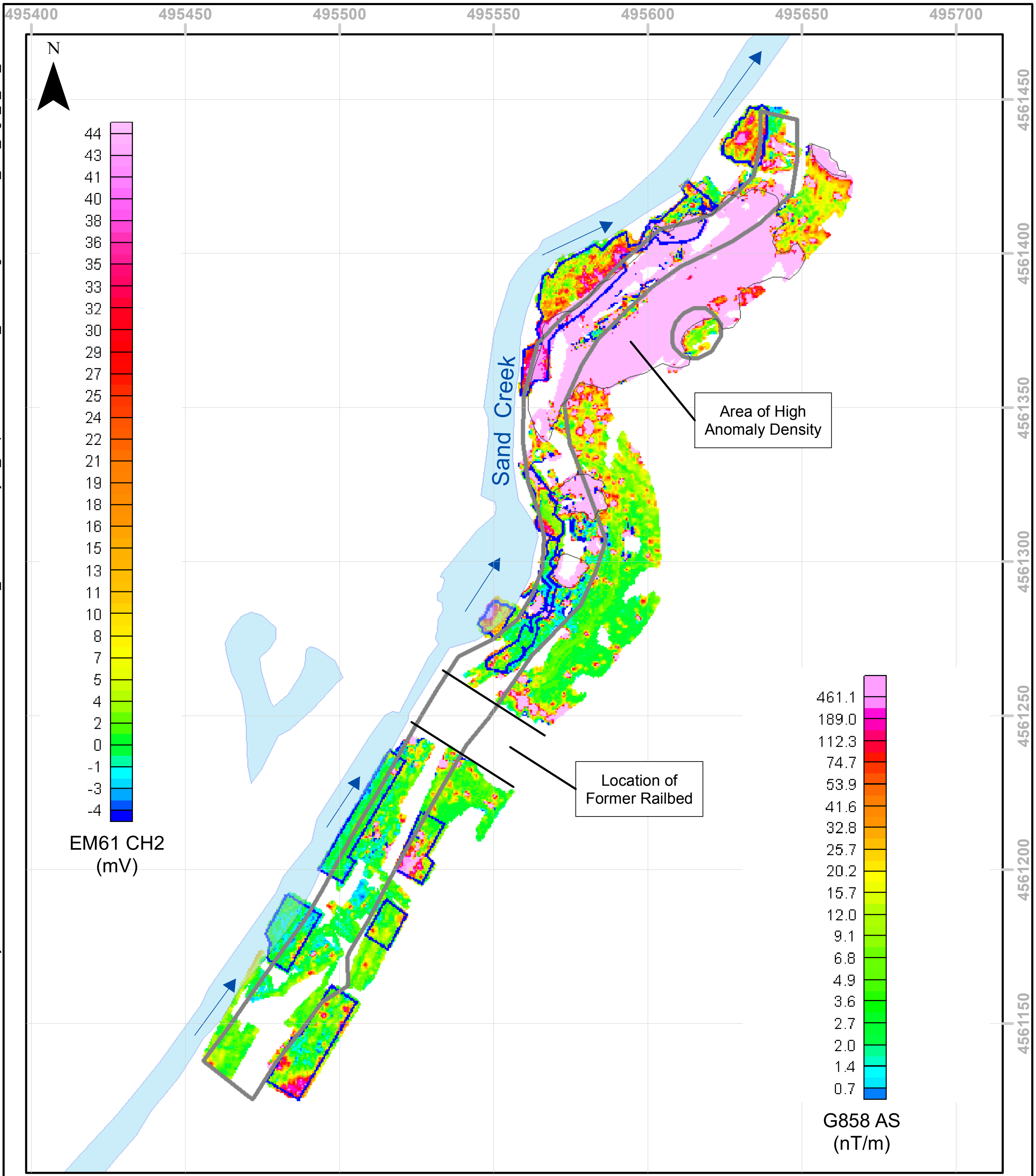
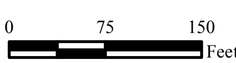


Legend

- Sand Creek Disposal Road Landfill Area of Concern Boundary
- Sand Creek
- Direction of Flow

NOTES:
1) Outlined areas indicate larger contriguous area of increased anomaly density.
2) Dark blue outlined areas indicate areas that were investigated using the Geometrics G-858G cesium vapor magnetometer instrument.



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RVAAP-34 SAND CREEK DISPOSAL ROAD LANDFILL
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

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Figure 2-6 Geophysical Investigation Boundary

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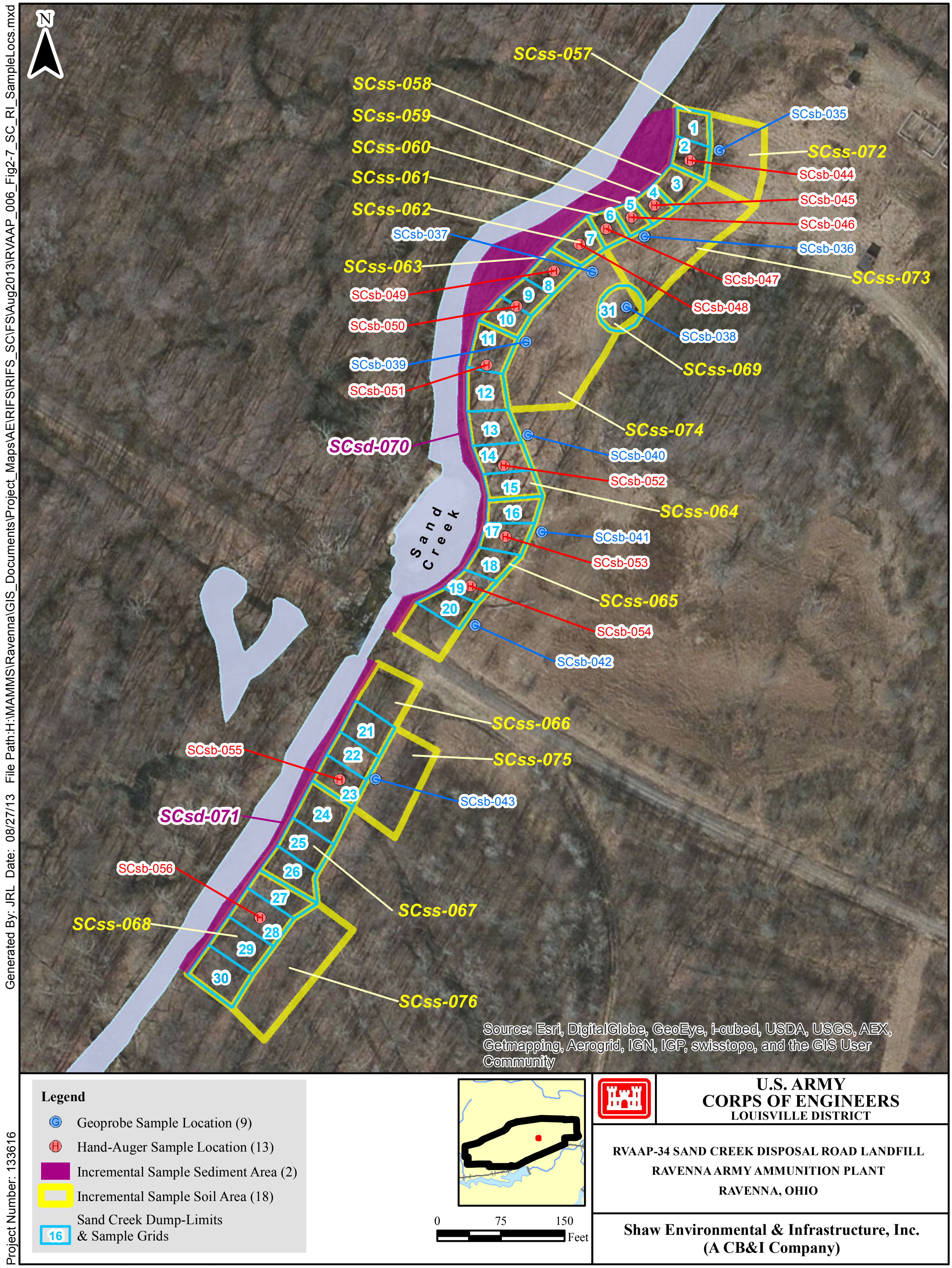

Figure 2-7 Phase I Remedial Investigation Sample Locations

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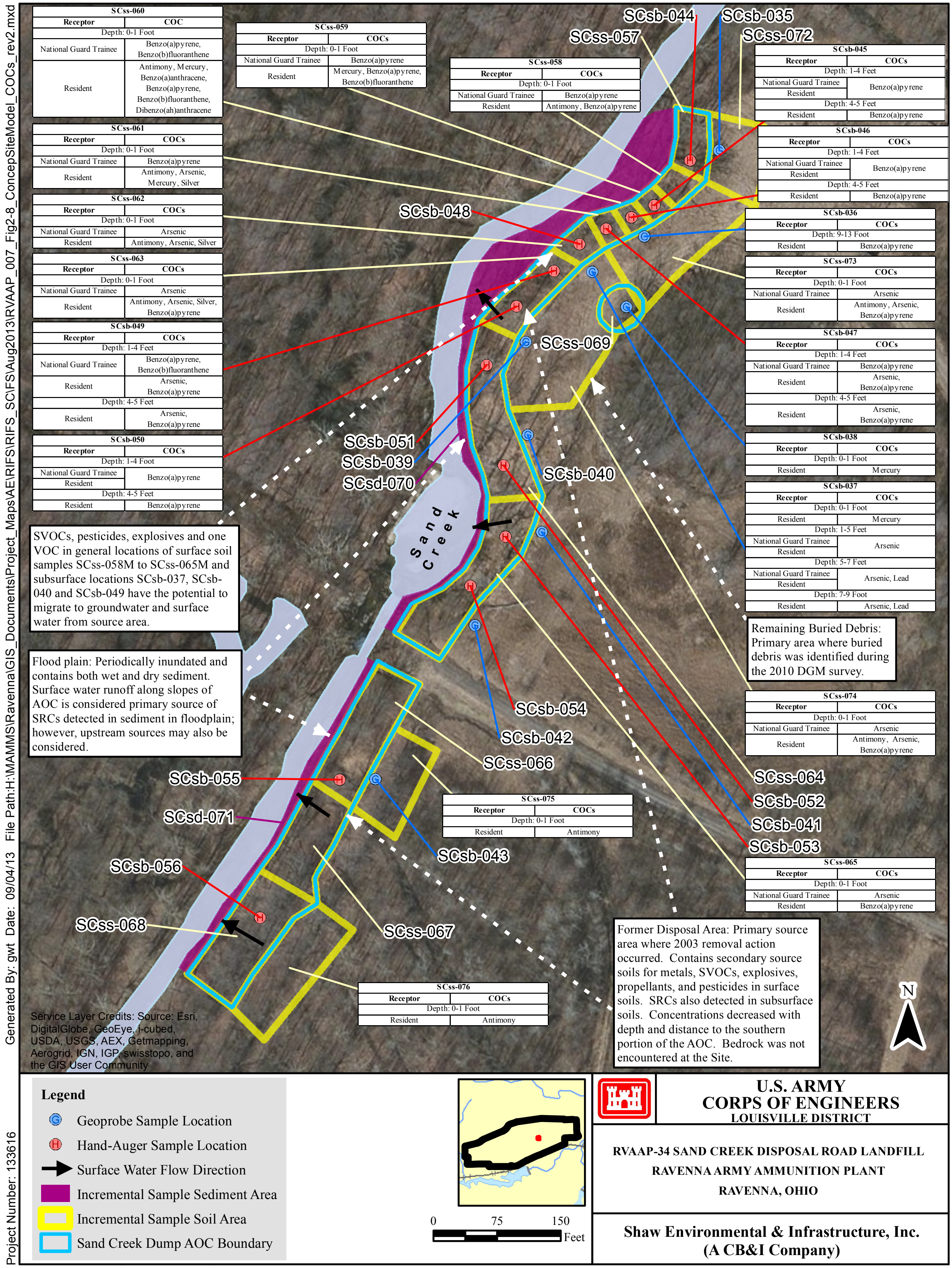

Figure 2-8 Conceptual Site Model and COCs Identified for Evaluation in the FS

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3.0 REMEDIAL ACTION OBJECTIVE AND APPLICABLE OR RELEVANT AND APPROPRIATE ACTIONS

This section identifies the RAO and ARARs for the Sand Creek Site. The RAO identifies the general goals or end points that the selected alternative will accomplish to protect human and environmental receptors from contaminants and must meet the ARARs. The RAO forms the basis for identifying and evaluating remedial alternatives later in this FS.

3.1 Remedial Action Objective

The RAO is protective of human health and the environment, and can be achieved by reducing exposure as well as by reducing contaminant levels. The RAO drives the formulation and development of response actions and are developed based on criteria outlined in Section 300.68(e)(2) of the National Oil and Hazardous Substances Pollution Control Plan (NCP) and Section 121 of the Superfund Amendments and Reauthorization Act (SARA). The RAO specifies the COCs, exposure routes, receptors, and that the cleanup goal is at an acceptable level or range of levels that is protective for the long-term exposure of receptors.

Given the expected future use of the site as Military Training Land Use, the National Guard Trainee was selected as the most representative receptor that has the potential to be exposed to COCs at the AOC. Evaluation of the National Guard Trainee is protective of the Range Maintenance Soldier that was also selected as Military Training Land Use receptor at the AOC. Evaluation for Unrestricted Land Use is a CERCLA requirement and the receptors identified at the RVAAP include the Resident (Adult and Child) receptors in accordance with the HHRAM (USACE, 2005a). These representative receptors are protective of other activities that may occur under the future land use. **Table 3-1** lists the representative receptors for each land use scenario at the Sand Creek Site.

Table 3-1
Representative Receptors for Land Use Scenarios at the Sand Creek Site

Area of Concern	Land Use Scenario	Receptor
Sand Creek Disposal Road Landfill	Military Training	National Guard Trainee
	Unrestricted	Resident (Adult and Child)

Cleanup goals are based on the evaluation of both the Military Training Land Use and Unrestricted Land Use scenarios. The COCs identified for these receptors at the Sand Creek Site are summarized in Section 2.0 of this FS. Further details regarding cleanup goals are discussed in Section 3.2.1 for chemical-specific ARARs.

The ERA performed for the Sand Creek Site in the Phase I RI identifies a variety of ecological receptor populations that could be at risk and identifies the COPECs that could contribute to potential risks from exposure to contaminated media. The American robin was identified as the most sensitive ecological receptor at the Sand Creek Site based on the results of the ERA; however, weight of evidence suggests that it would be highly unlikely that sufficient exposure would occur to local populations of robins such that adverse populations would occur at the AOC. Therefore, no ecological receptors were selected for evaluation in this FS.

All necessary CERCLA remediation requirements with respect to surface and subsurface soils will be performed to select a remedial alternative at the Sand Creek Site. No risks associated with sediments or surface water was identified in the Phase I RI; therefore, these pathways are not evaluated further in this FS. Evaluation of remedial alternatives with respect to groundwater is not included in the scope of this FS; however, the remedial alternative selected with respect to surface and subsurface soils must be protective of groundwater. The following RAO has been developed accordingly for impacted surface and subsurface soils at the Sand Creek Site:

- Prevent direct human contact with COCs in surface and subsurface soil; and
- Comply with chemical-specific, location-specific, and action-specific ARARs and TBC guidance.

As previously stated, this FS does not address any MEC issues that may remain at Sand Creek Site as any MEC and associated MC issues would be investigated under a separate program (i.e., the MMRP). Therefore, the RAO was not inclusive of MEC and/or MC.

3.2 Chemical-, Location- and Action-Specific ARARs

This section summarizes potential federal and State chemical-, location-, and action-specific ARARs and TBC guidance for the selection of remedial alternatives at the Sand Creek Site under the IRP. The concurrent MEC actions at the RVAAP are addressed under a separate U.S. Army protocol in accordance with its applicable requirements governing MEC removal (i.e., UXO Safety Submittals, etc.).

CERCLA Section 121 specifies that remedial actions must comply with requirements or standards under federal or more stringent State environmental laws that are “applicable or relevant and appropriate to the hazardous substances or particular circumstances at the site.” Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

ARARs include those federal and State regulations that are designed to protect the environment. Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental, or State environmental, or facility sighting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (40 Code of Federal Regulations [CFR] 300.5). EPA has stated in the NCP that applicable requirements are those requirements that would apply if the response action were not taken under CERCLA.

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or State environmental or facility sighting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site" (40 CFR 300.5). A relevant and appropriate requirement must be complied with to the same extent as an applicable requirement.

In the absence of federal or State-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding, but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs, but are TBC guidance (40 CFR 300.400[g] [13]).

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation (CERCLA Section 121[e]). EPA reaffirmed this position in the final NCP (55 Federal Register [FR] 8756, March 8, 1990). Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation. EPA recognizes that certain administrative requirements (i.e., consultation with State agencies, reporting, etc.) are accomplished through State involvement and public participation. These administrative requirements should also be observed if they are useful in determining cleanup standards at the site (55 FR 8757).

Although on-site remedial actions at National Priorities List (NPL) sites must comply only with the substantive requirements of federal or State environmental regulations, the Ohio Revised Code does not provide a similar permit waiver for actions conducted under the Ohio EPA Remedial Response Program Policy. The Ohio EPA's Division of Environmental Response and Revitalization (DERR) Policy (DERR-OO-RR-034) states that, "it has been DERR's policy to require responsible parties to acquire and comply with all necessary permits, including the substantive and administrative requirements."

CERCLA Section 120(a)(4) requires federal facilities not on NPL, such as the RVAAP to comply with all State laws concerning removal and remedial action, which are equitably enforced at federal and nonfederal facilities (42 United States Code [USC] §9620[a][4]). CERCLA contains a narrow waiver of sovereign immunity for compliance with State laws regarding removal and remedial actions (42 USC §9620[a][4]). The section provides that, "State laws concerning removal and remedial action, including State laws regarding enforcement, shall apply to removal and remedial action at facilities owned or operated by a department, agency, or instrumentality of the U.S. when such facilities are not included on the [NPL]." This CERCLA statutory mandate differs from the compliance with ARARs mandate under CERCLA Section 120(d)(2)(A) in that the applicable State laws concerning removal or remedial action must be met regardless of the level of risk present at the site. The compliance with ARARs mandate only arises under CERCLA 121 (d)(2)(A) when an on-site remedial action is required due to unacceptable risk. Therefore, regardless of the risk present at the site, the U.S. Army will be required to meet the substantive requirements of any State laws and implementing regulations that require corrective action.

3.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methods, which when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment (EPA, 1988b). In the case for the RVAAP, calculated FWCUGs have been already developed for the identified receptors in order to accelerate the decision-making process for the remaining AOCs. The FWCUGs take advantage of the fact that many of the risk assessment inputs and decisions for the facility have already been agreed to by stakeholders through the application of the CERCLA and Resource Conservation and Recovery Act (RCRA) processes over the years (SAIC, 2010). As specified for the RAO, the cleanup goal must be at an acceptable level or range of levels that is protective for the long-term exposure of receptors and most of the steps of the human health baseline risk assessment process (i.e., identifying future land use, exposure pathways, and toxicity information) are manifested in the FWCUGs, as long as cumulative effects of multiple chemicals are considered when selecting a target risk range/hazard index level. The FWCUGs for the evaluation of COCs are based on a 10^{-5} (one in one hundred thousand) excess cancer risk for carcinogenic effects, and an HQ of 1 for noncarcinogenic effects in accordance with the RVAAP data evaluation process presented in the FWCUG guidance (SAIC, 2010). If a chemical was detected for which there was no FWCUG, the EPA Regional Screening Levels (2012) were used.

As discussed for the RAO in Section 3.1, the National Guard Trainee and the Resident (Adult and Child) receptors are considered the most representative receptors for the Military

Training Land Use and Unrestricted Land Use scenarios, respectively. The chemical-specific ARARs for these receptors are provided in Tables A-1 and A-2 in **Appendix A**.

3.2.2 Action-Specific ARARs

This section summarizes the potential action-specific ARARs that may be pertinent to management of the soils resulting from excavation as described in this FS. Potential action-specific ARARs are identified in Table A-3 in **Appendix A**.

Remedial actions that involve excavation of soils will require site preparation activities such as grubbing, and grading of the site. During these activities, measures will need to be implemented to control fugitive dust emissions so that requirements of the Ohio Administrative Code (OAC) 3745-07-08 will be met. Control measures typically include the application of water or other dust suppressants during clearing, grubbing, and grading.

Under 40 CFR 63, Subpart G, air emissions standards have been proposed for site remediation activities at facilities that are major sources of hazardous air pollutants (HAPs) where the facility has implemented maximum achievable control technology for one of the major sources listed under Section 2 of the Clean Air Act of 1970. Major sources are facilities that emit more than 10 tons per year for an individual HAP or greater than 25 tons per year of a combination of HAPs. Under the proposed rule, emissions limits are set for process vents, remedial materials management units, and work practices. The proposed rule exempts sites being addressed under CERCLA authority and corrective actions initiated under permits and orders.

As of March 10, 2003, construction activities disturbing more than 1 acre of land are subject to the storm water National Pollutant Discharge Elimination System permit requirements of 40 CFR 122.26. General permits are issued by authorized states and incorporate the requirements of EPA's "Core" General Permit for Industrial Activity or the "Core" General Permit for Construction Activities issued by EPA in 1992. The core or baseline permits establish the same terms and conditions for all covered dischargers. State-issued core or baseline permits may also contain requirements in addition to those specified by the federal baseline general permits. Storm water discharges from construction activities are covered under Ohio EPA's General Permit OHCOOOO02. Coverage under the general permit is obtained by submission of a Notice of Intent to the control authority. Dischargers covered under a general permit are also required to develop and implement a storm water pollution prevention plan. The total areas at the Sand Creek Site that may require clearing and grading activities as part of a potential remedial alternative has the potential to disturb greater than 1 acre of land; therefore, preparation of a storm water pollution prevention plan may be necessary.

Under 40 CFR 262.1 (OAC 3745-52), any person who generates a solid waste must determine if that waste is hazardous by evaluation of whether the waste is excluded from Subtitle C regulation, listed under 40 CFR 26; Subpart O; or exhibits one of the hazardous waste characteristics under 40 CFR 261, Subpart C. Since the soil at the Sand Creek Site does not exhibit a reactive characteristic, it does not have to be managed as a K047 waste under the revised mixture and derived from rules (66 FR 27286). This relief is also referred to as the “contained in” policy and has been adopted by the State of Ohio in regulating generators in similar situations.

On May 26, 1998, EPA promulgated a Phase IV land disposal restriction (LDR) rule that established treatment standards for hazardous contaminated soil. Hazardous contaminated soil is defined as soil that contains a listed waste or exhibits a characteristic of a hazardous waste. As indicated above, a portion of the soils may be hazardous contaminated soil. As such, RCRA Subtitle C regulations, such as the LDRs, will be applicable to the extent that the action generates and, subsequently, actively manages (treats, stores, or disposes) these soils.

If the soils to be excavated exhibit a toxicity characteristic, RCRA Subtitle C standards will be potentially applicable for the screening unit. The process reduces the concentrations of COCs, which may be viewed as treatment by the Ohio EPA. If screening is considered treatment by the Ohio EPA, the unit would be subject to permitting standards for physical, chemical, and biological treatment (40 CFR 265, Subpart Q). Alternately, screening of excavated soils could be performed without meeting the above standards if the wastes were managed in a temporary unit. Temporary units may be used to store or conduct nonthermal treatment on remediation wastes for a period of up to 12 months. Additionally, under 40 CFR 268.3 (OAC 3745-270-03), the process must not dilute the waste as means of achieving compliance with the LDR treatment standards. A determination of the applicability of the LDR treatment standards must be made at the point of generation (upon excavation).

It is assumed that any debris separated from the soils would be accumulated on site in containers for less than 90 days. Containers must be kept closed, constructed of materials that are compatible with the stored waste, and maintained in good condition.

One option for staging of excavated soils is a waste pile. Waste piles that hold hazardous wastes, hazardous debris, or hazardous contaminated soils must have a double-liner system. The bottom liner must be a composite liner with a thickness of at least 3 feet and a hydraulic conductivity of: less than 10^{-7} meters per second. Waste piles used to store RCRA Subtitle C wastes must also have a leachate collection system between the top and bottom liners that is sloped at 1 percent. The leachate collection system must have a minimum thickness of greater than 12 inches and a hydraulic conductivity of 10^{-2} centimeters per second. Both the liners and leachate collection system must be constructed from materials that are compatible with the stored waste. The leachate collection system must be designed with sumps or similar collection systems that keep the leachate head at less than 12 inches. Waste piles must be protected from precipitation, surface water run-on, and wind dispersal. Under DERR policy, this waste pile would require RCRA permitting to receive the excavated soils. Accordingly, Table A-3 in **Appendix A** summarizes the RCRA-permitting standards of 40 CFR 264 Subparts B–G and 40 CFR 270 (and their corollary OAC provisions).

As indicated, a portion of the soils within the hot spots may contain listed wastes or exhibit a toxicity characteristic for antimony, arsenic, lead, mercury, and silver. Accordingly, the LDRs of 40 CFR 268 (OAC 3745-270-40) are potentially applicable to these soils. The LDR program requires hazardous wastes to be treated to meet certain standards prior to land disposal. Under 40 CFR 268.2, the term “land disposal” means placement in or on the land and includes “placement in a landfill, surface impoundment, waste pile, land treatment facility...or concrete vault or bunker intended for disposal purposes.” Treatment standards under the LDR program may be either concentration limits for certain constituents in the waste or specified treatment technologies.

A Phase IV LDR rule, promulgated May 26, 1998, revised treatment standards for metal-bearing wastes and established treatment standards for hazardous contaminated soils. Consistent with CERCLA policy, this Phase IV rule indicated that, “LDRs only attach to hazardous waste or hazardous contaminated soil when it is generated and placed into a land disposal unit. Therefore, if contaminated soil is not removed from the land, LDRs can not apply” (63 FR 28617). Conversely, if any volume of soil contains a listed waste or exhibits a characteristic at its point of generation (excavation), the LDRs must be met prior to placement of such soil in a land disposal unit. The treatment standards specific to hazardous contaminated soils are codified in 40 CFR 268.49 (OAC 3745-270-49) and require the concentrations of all underlying hazardous constituents to be reduced by 90 percent and capped at 10 times the universal treatment standards of 40 CFR 268.48. Therefore, if soils that exhibit a toxicity characteristic or contain listed wastes are excavated, these volumes of soils must meet hazardous contaminated soil treatment standards prior to being placed in a waste pile, or prior to being disposed of in a landfill after management in another unit.

Under the recently promulgated *Hazardous Waste Identification Rule - Media*, EPA created a new unit for the temporary management of remediation wastes, known as the staging pile. The staging pile is an accumulation of solid, nonflowing remediation wastes that may be used for storage of those wastes for 2 years. Placement of remediation wastes into a staging pile does not trigger LDRs because such units are not considered land disposal units. The potential action-specific ARARs for staging piles are the performance criteria of 40 CFR

264.552. These standards require that the staging pile must be designed to prevent, or minimize, releases of hazardous waste or hazardous constituents to the environment:

- The staging pile must be designed to minimize cross-media transfer, as necessary, to protect human health and the environment;
- The staging pile cannot be used for treatment; and
- The 2-year time limitation for storage indicated above.

Specific designation of the unit as a staging pile, and the design and operating specifications to meet these performance standards, are prescribed by the EPA Regional Director, or authorized State, within a RCRA permit. Potential use of a staging pile is a preferable option to use of a waste pile in management of excavated soil. However, Ohio EPA has proposed adoption of these rules, but has not finalized the rulemaking process at this time. Therefore, the provisions for a staging pile are not currently available to the RVAAP.

Soils with concentrations of chemical constituents greater than the remedial goal objectives (RGOs) will be transported off site for disposal. Soils with concentrations of chemical constituents greater than the alternative treatment standards of 40 CFR 268.49 must be treated to meet these alternative LDR standards for soils prior to off-site disposal in a Subtitle C Landfill. Excavation may also result in the generation of limited quantities of hazardous debris (i.e., MEC debris). These wastes must be treated to meet the hazardous debris treatment standards of 40 CFR 268.45 prior to off-site land disposal.

If excavation activities are conducted at the Sand Creek Site as part of a remedial alternative, there is the potential of encountering MEC and MD. Therefore, UXO technicians trained in explosive ordnance disposal will be required to be on site to clear the excavation locations prior to intrusive activities and to inspect any soils removed during the excavation. The UXO technicians would be required to sift through the removed spoils in order to separate and segregate soil from MEC-related items.

3.2.3 Location-Specific ARARs

Location-specific ARARs set restrictions on the types of activities that can be performed based on site-specific characteristics or location. Alternative actions may be restricted or precluded based on proximity to wetlands or floodplains, presence of natural or cultural resources, or to man-made features such as existing disposal areas and local historic buildings. A summary of possible location-specific ARARs is presented in Table A-4 in **Appendix A**.

Final location-specific ARARs (statutes and regulations) will be determined in consultation with EPA, and the appropriate federal and State agencies. These agencies are responsible for administration of programs that implement the potential ARARs listed above.

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4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The primary objective of identifying, screening, and evaluating potentially applicable technology types and process options for the Sand Creek Site is to identify an appropriate range of remedial technologies and process options to be developed into remediation alternatives. The *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988a) established a structured process for this purpose. A series of steps is used to reduce the universe of potential remedial options to a smaller group of viable ones, from which a final remedy may be selected. This series of analytical steps is as follows:

- Identification of the area and volume of contamination based on the RAO;
- Identification of general response actions (GRAs) to achieved the RAO; and
- Identification of technologies and process options based on the GRA options, which are then screened based on effectiveness, implementability, and cost.

The following sections describe each of these activities in detail.

4.1 Area and Volume of Contamination

Estimated volumes of impacted soils were calculated for the Sand Creek Site where COCs were identified to be evaluated further in the FS. The area and volume of contamination were calculated based on the FWCUGs that are considered to be protective of human health and the environment. The volumes of soils exceeding the FWCUGs for the receptors identified for the Military Training Land Use and Unrestricted Land Use scenarios are summarized in **Table 4-1**.

Table 4-1
Estimated Volume of Impacted Soil for the Sand Creek Site

Land Use Scenario	Surface Area (ft^2)	In Situ		In situ with Constructability[a]		Ex Situ[a,b]	
		Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
Military Training	50,705	83,287	3,085	104,108	3,856	124,930	4,627
Unrestricted	66,604	181,035	6,290	212,301	7,863	254,761	9,436

[a] includes 25 percent constructability factor. *yd^3 denotes cubic yard.*
[b] includes 20 percent swell factor.
ft^2 denotes square foot.
ft^3 denotes cubic foot.

4.2 General Response Actions

GRAs describe a variety of remedial measures that can potentially achieve the RAO. A GRA may consist of several technologies that can potentially consist of several process options. The following GRAs, either alone or in conjunction with other response actions, could potentially achieve the RAO:

- **No Action**—The NCP requires that "no action" be included among the GRAs evaluated (40 CFR 300.43[e][6]). The no action response provides a baseline response for comparison to the other remedial response actions.
- **LUCs**—LUCs include institutional and administrative controls that would reduce or eliminate access to the site. The volume, mobility, and toxicity of the contaminants are not reduced through the application of institutional actions. LUCs are generally combined with other GRAs to meet the RAO.
- **Removal**—Removal technologies involve the movement of contaminated material (i.e., soil) from the source area to another location, either on or off site. Removal can mitigate exposure pathways; however, it has no effect on the toxicity or volume of contaminated material. Removal is often used in conjunction with treatment and/or disposal to meet the RAO.
- **Treatment**—Treatment technologies can potentially reduce the toxicity, mobility, or volume of contaminated material. Treatment may be in situ or ex situ. Treatment technologies are often used in conjunction with removal to comprise a remedial alternative.
- **Disposal**—Disposal process options involve the discharge of the contaminated medium. Disposal process options are typically coupled with removal and treatment process options.
- **Containment**—Containment can effectively reduce contaminant mobility and the potential for exposure. However, containment actions do not reduce contaminant volume or toxicity. When consolidation is used in conjunction with containment, the overall area of contamination is reduced, thereby reducing the area of potential exposure to individuals. One of the primary containment mechanisms is capping. Capping involves covering an area with a low-permeability material (e.g., native soil, clay, concrete, asphalt, synthetic liner, or multilayered) to reduce infiltration of water and the migration of COCs.

4.3 Identification and Screening of Technologies

Alternative remedial actions were developed by identifying remedial technology types and process options that are applicable to handling contaminated soil. The technologies considered in selecting remedial action alternatives for contaminated soil included those identified in the NCP (40 CFR Parts 9 and 300). These technology types and process options were screened for applicability to the Sand Creek Site in accordance with EPA guidance (1988a).

4.3.1 Criteria for Identifying and Screening Technologies

The criteria for identifying potentially applicable technology types and process options are provided in EPA guidance (1988a) and the NCP (40 CFR Parts 9 and 300). Technologies identified in this section were screened on the basis of site-specific conditions at the Sand Creek Site. Section 121 of SARA identifies a strong statutory preference for remedial actions that are highly reliable and provide long-term protection. The primary requirements for a selected remedy are that it protects human health and the environment and meets the objectives of the proposed action in a cost-effective manner. Additional selection criteria include the following:

- In preferred remedies, the principal element is treatment to permanently or significantly reduce the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants.
- Where practical treatment technologies are available, off-site transport and disposal without treatment is the least preferred alternative.
- Permanent solutions and alternative treatment technologies or resource recovery technologies should be addressed and used to the maximum extent practicable.

These criteria have been considered in identifying and screening technologies to determine the appropriate components of remedial action alternatives for the Sand Creek Site. The remedial technology types and process options are initially screened in **Table 4-2** based on technical implementability and site-specific conditions. Primary factors in this screening step include applicability of processes to COCs identified at the AOC and generation of residual wastes from treatment. Technologies and process options not considered technically applicable were not retained for further evaluation. The rationale for a technology or process option being eliminated is also presented in **Table 4-2**.

4.3.2 Process Options Retained From Initial Screening

The process options retained through the initial screening process are summarized as follows:

- No Action
- LUCs

  - Access Controls (Covenants and Deed Restrictions, Administrative Controls, Physical Mechanisms)
  - Monitoring (Physical Surveillance, Long-Term Media Monitoring)
- Containment
  - Capping (Geosynthetic Clay Liner, Asphalt Cover, Multilayer Cap)
- Removal
  - Solids Excavation
- Disposal
  - Off-Site Disposal (RCRA Disposal Facility, Industrial Landfill)
  - On-Site Disposal (Consolidation)
- In Situ Treatment
  - Chemical Reduction/Oxidation
- Ex Situ Treatment
  - Chemical Reduction/Oxidation
  - Thermal Treatment (Incineration)
  - Biological Treatment (Composting)

These options are further evaluated (Section 4.4) to identify the best set of options from which to develop remedial alternatives for the Sand Creek Site.

4.4 Evaluation of Technologies and Selection of Representative Technologies

The process options that remained after the initial screening step were further evaluated and compared with respect to relative effectiveness, overall implementability, and cost. The evaluation of effectiveness focuses on the reliability of the process to meet remediation goals for contaminants, and address the volume of impacted media given AOC conditions and the potential impact on human health and the environment during construction and implementation. The implementability evaluation focuses more on the institutional aspects of implementability than the technical and administrative feasibility used in the earlier screening step. The cost evaluation is based on engineering judgment of relative estimates for capital and operation and maintenance (O&M) costs.

The results of this evaluation are summarized in **Table 4-3** and each process option is described in more detail below. Process options that are screened out from further consideration are highlighted with hatch marks in **Table 4-3**.

4.4.1 No Action

The No Action response action does not provide any remediation, maintenance, or security activities at contaminated soil areas at the Sand Creek Site. The lack of LUCs can lead to receptor exposure to the contaminated soil. This GRA is retained as a baseline with which other remediation alternatives are compared.

- **Effectiveness**—This response action could have negative long-term impacts on human health and the environment.
- **Implementability**—No implementation is required for this response action.
- **Cost**—Low.

4.4.2 Land Use Controls

LUCs are used in CERCLA remedies to prevent or control exposures of potential receptors to contamination remaining in place at the site "…to assure continued effectiveness of the response action" (40 CFR 300.430 [e][3][ii]). LUCs include access controls and monitoring. This GRA controls risk by removing the receptor from the source of the risk and provides information to assess future conditions at the site. All LUC process options are applicable to the Sand Creek Site.

4.4.2.1 Access Controls

Access controls would be implemented to regulate access to the contaminated soil areas. The process options for access controls include covenants and deed restrictions, administrative controls, and physical mechanisms.

Covenants and Deed Restrictions

Covenants and deed restrictions to the site can be accomplished through agreements about land use. Legal restrictions can be placed on the use of the contaminated site to protect human health. These restrictions are only effective as long as they are enforced by the property owners and local authorities

- **Effectiveness**—Covenants and deed restrictions are effective, if enforced, in controlling human activities such as construction activities. These actions can limit or prevent exposure to contaminants remaining on the site after remediation and can be implemented on a temporary basis. However, their effectiveness declines with time as institutional knowledge is lost.

- **Implementability**—These options can be readily implemented.
- **Cost**—Low.

Administrative Controls

Administrative controls consist of the use of training or procedures to limit access to sites to control access to both surface and subsurface contamination. Permits for subsurface penetration or excavation can be used. Notices can be filed with local authorities defining the presence of hazardous waste. These are controls the U.S. Army can use while they maintain control of the site.

- **Effectiveness**—Administrative controls are effective in controlling human intrusion into contaminated areas during and after remediation. The training required for access to the site limits exposure as do procedures that limit certain activities in the vicinity of the wastes. Administrative controls can be used in conjunction with barriers and deed restrictions. This option is effective only while institutional controls are maintained.
- **Implementability**—Training and procedures are readily available and implemented. They may need to be modified for the Sand Creek Site.
- **Cost**—Low.

Physical Mechanisms

Barriers or other devices (fences, signs, etc.) and security personnel can be used to physically prevent access to surface and subsurface contamination. Gates, installation fences, and security guards control access to the entire facility.

- **Effectiveness**—Physical barriers and security are effective in controlling human intrusion into contaminated areas during and after remediation. This option is only effective as long as the physical mechanisms are maintained.
- **Implementability**—This option is readily implemented with available equipment and personnel.
- **Cost**—Low.

4.4.2.2 Monitoring

Monitoring is used to assess the performance of remedial actions and verify compliance with the established RAO. Process options for monitoring are physical surveillance and long-term media monitoring.

Physical Surveillance

Visual and physical inspections of engineered remedial action components can detect physical changes (e.g., cracks in caps, erosion, unwanted vegetation, holes in fences, etc.) that may ultimately lead to the failure or unsatisfactory performance of that component. Repairs and/or revised maintenance activities can be implemented as a result of these inspections.

- **Effectiveness**—Physical surveillance is effective in determining the continued integrity of engineered systems and the need for repairs and/or replacement. Physical surveillance needs to be used with contaminant monitoring to assess the impact of integrity failure.
- **Implementability**—Physical surveillance is easily implemented. It requires experienced, but readily available personnel to make regular visits to the site for inspections.
- **Cost**—Low.

Long-Term Media Monitoring

Environmental media (groundwater, surface water, soil, etc.) can be monitored after the implementation of the remedial action to determine the effect the remedy has on the level of contamination. Long-term media monitoring can detect a potential failure of the action to meet the RAO. Monitoring can also be used to detect changes in expected conditions, either changing site conditions or the degree of expected remedy effectiveness, and to indicate whether additional actions should be implemented.

- **Effectiveness**—Long-term media monitoring is effective in evaluating the effectiveness of the remedial alternative. The effectiveness of the monitoring system depends on the design of the monitoring plan. Groundwater monitoring and water level elevations can be useful for determining the effectiveness of some source actions.
- **Implementability**—Monitoring equipment and personnel are readily available and the site is readily accessible. Groundwater monitoring has not been performed at the Sand Creek Site and baseline conditions are unknown.
- **Cost**—Moderate due to labor and analytical costs.

4.4.2.3 Summary of LUC Process Options

The LUC process options are considered applicable to an AOC such as the Sand Creek Site where historical disposal activities have occurred. Therefore, covenants and deed restrictions, administrative controls, physical barriers, physical surveillance, and long-term media monitoring are carried forward as representative process options for LUCs. The covenants and deed restriction will only be used if the U.S. Army releases the land. LUCs are generally not used as the sole remedy but are integrated and supplement implementation of an engineering remedy.

4.4.3 Containment

The containment GRA consists of technologies that limit the migration of contaminants and the associated potential for exposure, but they do not reduce contaminant mobility, toxicity, or volume. The technologies considered are soil, asphalt, or multilayer capping.

4.4.3.1 Capping

The capping technology is intended to minimize (1) infiltration of surface water/precipitation and subsequent leachate generation caused by percolation of water through the waste, (2) mobilization of contaminants through wind or water erosion, or (3) direct contact with surface or subsurface contamination by intruders or biota. The capping process options considered are soil covers, asphalt caps, and multilayer caps.

Geosynthetic Clay Liner

A soil cover with a geosynthetic clay liner (GCL) is an alternative to the traditional compacted clay cover. The GCL consists of two non-woven fabrics that sandwich a thin layer of bentonite. The GCL is laid over a prepared subgrade with a drainage layer and a layer of soil placed over the GCL. The soil layer over the GCL promotes the growth of vegetation that will limit erosion. The use of GCL eliminates the need for additional layers of soil, clay, and bentonite that may be needed to prevent infiltration. The purpose of the soil cover with GCL is to prevent access or exposure to the contamination and also controls infiltration of water through the contamination.

- **Effectiveness**—A soil cover with GCL can be very effective at preventing access to contaminants in surface and subsurface soil. The Sand Creek Site has steep slopes up to 60 degrees and is adjacent to Sand Creek that periodically overflows its banks. There is the potential for erosion of a soil cover along steep slopes and scouring where fast water comes into contact with the cover. Established vegetation on a soil cover and engineering controls can help prevent erosion and scouring from occurring.

- **Implementability**—Soil covers with GCL are very easy to implement. Standard earthmoving equipment can move local soil over the contaminated areas. The GCL comes in rolls that are easy to install. Portions of the Sand Creek Site may require some initial clearing. Soil cover maintenance to limit large vegetative growth that could disrupt the cover and to control erosion and scouring would be needed. Frequent maintenance (mowing) would be required.

- **Cost—**Moderate.

Asphalt Cap

Asphalt caps control infiltration of rainwater or run-on water through the installation of impermeable asphalt. This process option is particularly useful if the site is to be used as a parking lot or other light industrial use.

- **Effectiveness**—Asphalt caps can be effective at reducing infiltration if sufficient maintenance occurs. Asphalt can quickly develop cracks and holes that need to be filled, and maintenance will be needed to repair them as they occur. These caps are most effective if the area needs to be asphalted for another use that will promote its long-term maintenance.
- **Implementability**—Asphalt caps are easy to install. As with other caps to control infiltration, they need to be sloped to encourage runoff during rain events. Frequent maintenance is less necessary than with multiplayer caps as the asphalt caps do not require mowing. However, the asphalt cracks easily and must be controlled to maintain effectiveness.
- **Cost**—Moderate.

Multilayer Cap

A multilayer cap is an engineered cover that can consist of various layers of soil, clay, membranes and other materials. Multilayer caps are applicable for the controlled infiltration of rainwater or run-on water through the installation of impermeable layer materials and can prevent access or exposure to the contamination.

- **Effectiveness**—Multilayer caps can be effective at reducing infiltration if sufficient maintenance occurs. Long-term maintenance would be required for ensure cracks and holes do not develop. Maintenance will be needed to repair them as they occur.
- **Implementability**—A multilayer cap is more difficult to install compared to the soil or asphalt cap options due to the design requirements. As with other caps to control infiltration, they need to be sloped to encourage runoff during rain events. More maintenance is necessary with multiplayer cap than the asphalt cap as frequent mowing is required. The multilayer cap must be controlled to maintain effectiveness.
- **Cost**—High.

4.4.3.2 Summary of Containment Process Options

The soil cover with GCL alternative is a representative process option for the contaminants in surface and subsurface soil. It provides the least expensive option that meets the needs of a containment option; however, the capping option alone does not remove the contaminant source, which would has the potential to impact groundwater, and would be less protective of human health and the environment than other alternatives. Site-specific conditions such as steep slopes and the site's location adjacent to Sand Creek that is prone to periodic flooding may result in the occurrence of erosion and/or scouring of a soil cover; however, established vegetation and engineering controls as well as a well planned monitoring and maintenance program may mitigate impacts to the cover. The asphalt cover alternative is not consistent with the surrounding areas at the RVAAP and there are high costs associated with the implementation of a multilayer cap. Therefore, evaluation of these two capping alternatives is eliminated from further consideration. The soil cover with GCL alternative is carried forward as a representative process option for containment.

4.4.4 Removal

The removal GRA consists of technologies that remove contaminated media or waste material to either relocate it or prepare it for treatment and/or disposal. The removal technology considered is excavation with a process option of conventional excavation.

4.4.4.1 Solids Excavation

This excavation method uses a variety of conventional excavation equipment to remove debris, soil, and other buried waste. The equipment includes excavators, track loaders, bulldozers, and tool carriers of differing sizes with attachments or manipulators suitable for dealing with a varied waste profile. This equipment can be used individually or together as circumstances dictate. It is considered applicable to all source contamination at the Sand Creek Site. It can be used for both shallow and deep soil.

- **Effectiveness**—Conventional excavation equipment is applicable to the Sand Creek Site soils. The equipment has consistently proven reliable and effective for soil and other media in hazardous and nonhazardous applications for decades. The attachments and end effectors increase the versatility of the equipment, allowing their use with a wide range of wastes. Ancillary equipment for screening, sorting, and segregation can be effectively integrated with conventional excavation equipment.

  The hazards to operators, in addition to the normal excavation hazards, come from exposure to contaminated media. Personal protective equipment (PPE) can reduce or eliminate exposure from inhalation/ingestion or dermal contact. Misting or fixative agents can reduce fugitive dust emissions during excavation.

- **Implementability—**Conventional excavation is readily implemental, and the equipment, attachments, and operators are widely available. The equipment can be readily adapted to the material and conditions at the site.
- **Cost—**Moderate.

4.4.4.2 Summary of the Removal Process Option

Conventional excavation equipment is carried forward as the representative process option for soil removal because of its effective application for a wide range of wastes, its equipment availability and its widespread use in environmental restoration activities.

4.4.5 Disposal

The disposal GRA involves permanent disposition of the contaminated soil in a manner that protects human health and the environment. Both on-site and off-site disposal is evaluated. A selection of on-site facilities versus off-site disposal is made for developing alternatives.

4.4.5.1 Off-Site Disposal

Off-site disposal would involve the transportation of excavated soil to an approved and licensed disposal facility. Off-site disposal options include a RCRA disposal facility or an industrial landfill. The selection of the disposal facility depends on the waste characteristics and although all are evaluated here, none are selected to represent other off-site options.

RCRA Disposal Facility

This process option consists of any number of existing disposal facilities that use engineered features such as multilayer liners and caps, leachate detection and collection systems, run-on/-off controls, and intrusion barriers to isolate wastes from human and environmental receptors.

- **Effectiveness**—Disposal involves permanent disposition of the RCRA-generated contaminated soil in a manner that protects human health and the environment. Off-site disposal would include the transportation of excavated soils to an approved and licensed facility.
- **Implementability**—Implementation is moderate if the waste acceptance criteria can be met.
- **Cost**—Moderate.

Industrial Landfill

An existing industrial landfill can be used to dispose of that debris or refuse that is not a RCRA waste or has been decontaminated to acceptable levels. Such a facility is a Class II lined facility permitted to receive industrial, commercial, institutional, land-clearing, and construction/demolition waste. The facility does not accept RCRA hazardous waste or free liquids. This option would be used to dispose of waste that is considered hazardous to human health and the environment but is not RCRA hazardous waste.

- **Effectiveness**—Industrial landfills are effective in isolating low hazard wastes from the environment and human receptors because the waste acceptance criteria severely restrict the type and concentrations of waste that may be disposed.
- **Implementability**—Disposal of the excavated clean wastes or treated wastes would involve transportation and compliance with waste acceptance criteria.
- **Cost**—Moderate.

4.4.5.2 On-Site Disposal

On-site consolidation is considered as the technology process option for on-site disposal.

Consolidation

Consolidation involves placing treated waste and soil from the Sand Creek Site back into RVAAP areas. The waste is excavated, partially treated on the site if needed, and then placed elsewhere on the RVAAP. The contaminants in the treated waste would have to have been rendered immobile, making the treated waste better suited for placement. This option precludes the need to transport the treated waste to an off-site disposal facility or to a newly constructed on-site disposal facility. A single or multilayer cap would then be placed over the waste. If the waste is fully treated, no special disposal process option is needed.

- **Effectiveness**—Consolidation is effective in isolating the very low hazard wastes from human receptors and the environment. It can limit the area requiring long-term LUCs.
- **Implementability**—Consolidation is used at other hazardous waste sites around the country where off-site disposal options are unavailable or undesirable and where the continued on-site presence of treated waste is not problematic. Given the potential future land uses at the RVAAP, there may be regulatory and public reluctance to moving the waste around at the AOC.
- **Cost**—Low compared to off-site disposal.

4.4.5.3 Summary of Disposal Process Options

All off-site disposal process options are carried forward for additional consideration until waste streams and volumes are more clearly identified in the alternative development process. The on-site disposal option of consolidation is retained due to the low hazardous concentrations of antimony associated with the soils to be excavated and moved; however, there may be potential regulatory and public concerns about leaving waste on the RVAAP after having already removed it, the potential future land uses, and the widespread availability of off-site treatment and disposal facilities.

4.4.6 In Situ Treatment

In situ treatment technologies provide varying levels of treatment to soils without prior removal of the soils, and reduce the mobility or toxicity of the contaminants that may be mobilized by the percolation of precipitation through the unsaturated zone and groundwater. The process option considered for in situ treatment is chemical reduction/oxidation (redox).

4.4.6.1 Chemical Reduction/Oxidation

Chemical redox processes involve the addition of appropriate chemicals to raise or lower the oxidation state of the reactant. Oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Non halogenated SVOCs are resistant to oxidation, and metals may form toxic byproducts or become mobilized.

- **Effectiveness**—In situ chemical redox is effective on contaminants in a relatively homogeneous and porous medium. Long-term effectiveness is uncertain as a change in chemistry could mobilize or change the chemical behavior of the previously oxidized or reduced constituents. Chemical redox is most effective for VOCs (particularly trichloroethene) but is not that effective for non halogenated SVOCs that were detected in the soils at the Sand Creek Site. Additionally, chemical redox has the potential to mobilize inorganics into more toxic or concentrated states (i.e., arsenic, thallium, and hexavalent chromium).
- **Implementability**—This process option may be difficult to implement in situ because of concerns regarding delivery and sufficient exposure of the contaminants to the chemical agents. An additional concern is the release of excess reactants or byproducts to the environment, in particular Sand Creek located adjacent to the site. There have been limited applications of these processes, which are generally more readily implemented in the ex situ mode. The application of in situ chemical redox is highly dependent upon the delivery system and the subsurface conditions at the AOC consist primarily of dense clay that would make direct contact with the COCs difficult.
- **Cost—**Low to moderate

4.4.6.2 Summary of In Situ Treatment Process Options

The chemical redox process option will not be retained for remedial alternative development as this option is not that effective for phthalates that were detected at the site and is generally not effective for metals. In some instances, chemical redox can mobilize metals into more toxic or concentrated states. Additionally, there is concern regarding release of excess reactants or byproducts to nearby Sand Creek.

4.4.7 Ex Situ Treatment

Ex situ treatment technologies provide varying levels of waste treatment following removal of the waste. These technologies are applied to reduce the volume, mobility, or toxicity of the waste. The ex situ treatment technologies considered are chemical, thermal, and biological treatment. Ex situ treatment could be considered if excavated material requires treatment before disposal to meet waste acceptance criteria or if complete treatment could be achieved so remaining material is clean.

4.4.7.1 Chemical Reduction/Oxidation

The ex situ chemical redox process is the same as described in Section 4.4.6.1, with the exception that the soils are removed for treatment.

- **Effectiveness**—Ex situ application may be more effective at reducing contaminant concentrations, since the soils are removed and the amendments can be applied directly to the contaminated soils. However, as discussed in Section 4.4.6.1, this process is not that effective for phthalates that were detected in the soils at the Sand Creek Site. Additionally, chemical redox has the potential to mobilize metals into more toxic or concentrated states (i.e., arsenic, thallium, and hexavalent chromium).
- **Implementability**—This process option may be easier to implement ex situ than in situ, since direct contact between the removed soils and the chemical agents can be made. However, there is concern for a release of excess reactants or byproducts to the environment, in particular Sand Creek located adjacent to the site. Additionally, large amount of chemical waste products would be generated through this option that would require additional waste treatment and disposal.
- **Cost—**Low to moderate

4.4.7.2 Thermal Treatment

Thermal treatment destroys and/or removes organic and volatile metal contaminants. The process option considered is incineration.

Incineration

Incineration is an ex situ thermal destruction process in which organic compounds is destroyed by exposure to extremely high temperatures. It is considered applicable to the source problems at the Sand Creek Site. Many different systems are available: rotary dryer systems, indirect-fired systems, direct-fired systems, screw-type systems, and asphalt plant aggregate driers. Each system uses the same basic principle of operation, which is a furnace to remove and destroy organic compounds in the waste feed. One of the more common systems, a rotary kiln incinerator, feeds the waste material into a sloped rotating kiln. The slope and the rotating action conveys the heated waste to the low end of the kiln, exposing the waste to the heated gases (up to 1,800 degrees Fahrenheit) in the kiln and vaporizing and destroying the contaminants. The combustion gases are then drawn through an afterburner (2,200ºF) and scrubbing system before discharge to the atmosphere.

- **Effectiveness**—Incinerators have been effectively used for years on organic-contaminated media and are the best demonstrated available technology for many RCRA organics. It is applicable to most if not all of the organic- and explosives-contaminated wastes at the Sand Creek Site. The destruction capabilities of an incinerator allow the achievement of relatively low cleanup levels. Incineration is a robust technology that can handle a wide variety of organic compounds and concentrations because of its high temperatures. The disadvantages of incineration are that some organics generate toxic products of incomplete combustion, some materials are not incinerable, the capital and operating costs are high, and supplemental fuel is often required. If the ash contains heavy metals, the ash may have to be stabilized before disposal as a RCRA waste.
- **Implementability**—Incineration systems are available for both on- and off-site use. The off-gas stream may require additional treatment and may produce a residue that requires disposal. Thermal treatment systems are generally not well received by the public because of concerns with air emissions.
- **Cost**—High.

4.4.7.3 Biological Treatment

Biological treatment process options use biological processes to degrade or destroy contaminants. The ex situ processes evaluated was composting.

Composting

Composting is a controlled biological process by which organic contaminants (e.g., VOCs) are converted by microorganisms (under aerobic and anaerobic conditions) to innocuous, stabilized byproducts. Typically, thermophilic conditions (54–65 degrees Celsius) must be maintained to properly compost soil contaminated with hazardous organic contaminants. The increased temperatures result from heat produced by microorganisms during the degradation of the organic material in the waste. In most cases, this is achieved by the use of indigenous microorganisms. Soil is excavated and mixed with bulking agents and organic amendments, such as wood chips, and animal and vegetative wastes, to enhance the porosity of the mixture to be decomposed. Maximum degradation efficiency is achieved through maintaining oxygenation (e.g., daily windrow turning), irrigation as necessary, and closely monitoring moisture content and temperature. There are three process designs used in composting: aerated static pile composting (compost is formed into piles and aerated with blowers or vacuum pumps), mechanically agitated in-vessel composting (compost is placed in a reactor vessel where it is mixed and aerated), and windrow composting (compost is placed in long piles known as windrows and periodically mixed with mobile equipment). Windrow composting is usually considered to be the most cost-effective composting alternative. Meanwhile, it may also have the highest fugitive emissions. If VOC or SVOC contaminants are present in soil, off-gas control may be required.

- **Effectiveness**—The composting process may be applied to soil contaminated with biodegradable organic compounds. Pilot and full-scale projects have demonstrated that aerobic, thermophilic composting is able to reduce the concentration of VOCs, PAHs, and explosives but is not effective at reducing metals. Furthermore, the addition of amendments will increase the volume of the waste.
- Implementability—All materials and equipment used for composting is commercially available. Substantial space may be required for composting.
- **Cost**—Low.

4.4.7.4 Summary of Ex Situ Treatment Process Options

Ex situ chemical treatment using chemical redox is removed from further consideration, since it is not that effective for the COCs at the site and there are concerns regarding additional waste generated and impacts to the local environment. Incineration is effective for permanent destruction of the organic COCs detected in the soil; however, it is eliminated from consideration due to the high cost of treatment and potential concerns of emissions. Biological treatment by composting is less developed for the Sand Creek Site conditions and is removed from further consideration as well.

4.5 Process Options Retained for Evaluation of Remedial Alternatives

The process options that were retained from the representative GRAs for the development of remedial alternatives are presented in **Table 4-4**. The development of the screening alternatives are presented and evaluated in Section 5.0.

Table 4-2
Screening of Technologies and Process Options

Soil General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
No Action	None	Not applicable	No action.	Required for consideration by the NCP.
Land Use Controls	Access Controls	Covenants/deed restrictions	Restricts land use by codes	Potentially applicable.
		Administrative controls	Use of training procedures, etc. to limit access to contaminated areas	Potentially applicable.
		Physical mechanisms	Maintain/install security fences/signs; use security personnel to limit access to contaminated areas.	Potentially applicable.
	Monitoring	Physical Surveillance	Inspection of engineered remedial actions and conduct maintenance to ensure proper operation of engineered controls	Potentially applicable.
		Long-term monitoring	Long-term monitoring to evaluate effectiveness of remedial action	Potentially applicable.
Containment	Capping	Geosynthetic clay liner	A GCL and layer of clean soil is placed over contaminated areas to prevent exposure and erosion. Structural barriers needed around cap to prevent vehicular travel on cap.	Potentially applicable.
		Asphalt	Asphalt placed over areas of contamination. Structural barriers needed around cap to prevent vehicular travel on cap.	Potentially applicable.
		Multilayer, multimedia cap	Clay and synthetic membrane covered by soil over areas of contamination. Structural barriers needed around cap to prevent vehicular travel on cap.	Potentially applicable.
	Vertical barriers	Slurry wall	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Soil and COCs likely not migrating horizontally, technology not necessary.
		Sheet piling	Vibrating force to advance sheet piles into the ground.	Soil and COCs likely not migrating horizontally, technology not necessary.
Removal	Excavation	Solids excavation	Remove contaminated solids from area of concern.	Potentially applicable.

Table 4-2 (continued)
Screening of Technologies and Process Options

Soil General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
Disposal	Off-site disposal	RCRA disposal facility	RCRA hazardous waste disposed in an off-site RCRA Subtitle C facility.	Potentially applicable.
		Industrial landfill	Nonhazardous waste disposed in an off-site RCRA Subtitle D landfill	Potentially applicable
	On-site disposal	Consolidation	Consolidate waste and dispose at a designated location at the facility.	Potentially applicable
In Situ Treatment	Physical Treatment	SVE	Vacuum applied to extraction wells induces movement of gas-phase volatiles to collection for treatment.	Not applicable to inorganic contaminants found in soils at the Sand Creek Site.
	Chemical Treatment	Chemical reduction/oxidation	Apply chemical oxidants to destroy contaminants in the subsurface.	Potentially applicable
		Soil flushing	Inject cosolvent through contaminated area and collected liquid from the subsurface for further treatment.	Results are uncertain. Undesired byproducts are a potential result.
		Solidification/stabilization	Add binders to mechanically or chemically interact with the contaminants to limit their solubility or mobility.	More applicable for mobilizing inorganics.
	Biological Treatment	Enhanced bioremediation	Circulate water-based nutrients through the soil in place. Indigenous microbes degrade contaminants over time.	No treatment during winter months.
		Phytoremediation	Introduce plants to remove contaminants from impacted soils through natural biological processes.	Depth of contamination is deeper than root system. No treatment during winter months.
	Thermal Treatment	Radio frequency heating	Use electromagnetic energy from electrodes to heat soils and enhance SVE performance.	Not applicable for inorganic contaminants found in soils at the Sand Creek Site.
		Steam injection	Inject steam below the zone of contamination to release contaminants from soil and migrate upwards to be collected with an SVE system.	Not applicable for inorganic contaminants found in soils at the Sand Creek Site

Table 4-2 (continued)
Screening of Technologies and Process Options

Soil General Response Actions	Remedial Technology Types	Process Options	Description	Screening Comments
Ex Situ Treatment	Physical Treatment	Separation	Magnetic separation (or sieve after stabilizing step) of contaminants from soil. Requires further handling of separated solids.	Potential limited applicability. Not a final treatment step.
	Chemical Treatment	Chemical extraction	Uses acid to extract heavy metal contaminants, or cosolvents for other constituents, from soils. Extractant requires further treatment.	Potential limited applicability. Not a final treatment step. Undesired byproducts are a potential result.
		Chemical reduction/oxidation	Remove soils and directly apply chemical oxidants to destroy contaminants.	Potentially applicable
		Soil washing	Mix soils in reactor to detach contaminants from soil. Extractant requires further treatment.	Potential limited applicability. Not a final treatment step. Undesired byproducts are a potential result.
		Solidification/stabilization	Add binders to mechanically or chemically interact with the contaminants to limit their solubility or mobility.	More applicable for mobilizing inorganics.
	Biological Treatment	Composting	Combine contaminated soil with readily degradable carbon sources and bulking agents and nutrients. Indigenous microbes degrade contaminants over time.	Potential limited applicability.
	Thermal Treatment	Incineration	Chemical decomposition induced in organic materials by heat.	Potential limited applicability.
		Pyrolysis	Chemical decomposition induced in organic materials by heat in the absence of oxygen.	Not applicable to inorganic contaminants found in soils at the Sand Creek Site.

Shaded cells indicate that the remedial technology type and/or process option was eliminated from further evaluation.
COC denotes chemical of concern.
NCP denotes National Oil and Hazardous Substances Pollution Contingency Plan.
RGO denotes remedial goal objective.
Sand Creek Site denotes RVAAP-34 Sand Creek Disposal Road Landfill.
SVE denotes soil vapor extraction.

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Table 4-3
Evaluation of Process Options

Soil General Response Actions	Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost
No Action	None	Not applicable	Does not achieve RAOs	Not acceptable to Ohio EPA.	None
Land Use Controls	Access controls	Covenants/deed restrictions	Effective as long as a property owners and local authorities enforce them. Does not reduce contamination	Easily implement but has legal and authority requirements.	Low cost to document land use restrictions.
		Administrative controls	Effective as long as LUCs are implemented. Does not reduce contamination.	Training and procedures are available and readily implemented.	Low cost to implement training and routine inspection and maintenance of LUCs.
		Physical mechanisms	Effective as long as physical mechanisms are maintained. Does not reduce contamination.	Readily implemented. Fences and signs are commercially available items.	Low cost to install fences and signs.
	Monitoring	Physical surveillance	Effective but needs to be used with contaminant monitoring to assess impact of integrity failure. Does not reduce contamination.	Readily implemented but required experienced personnel to make routine inspections.	Low cost to implement but depends on frequency of inspections.
		Long-term monitoring	Effectiveness depends on the design of the monitoring plan. Does not reduce contamination.	Readily implemented; however, there are no monitoring wells on site to monitor effectiveness.	Moderate cost due to labor and analytical requirements.
Containment	Capping	Geosynthetic clay liner	Effective. The soil cover is susceptible to cracking but has self healing properties. The GCL prevents infiltration to contamination. Requires maintenance and LTM.	Easily implemented. Restrictions on future land use in capped areas.	Medium cost, high maintenance.
		Asphalt	Effective but susceptible to weathering and cracking. Requires maintenance and LTM.	Easily implemented. Restrictions on future land use in capped areas. Capping with asphalt is not consistent with surrounding area.	Medium cost, high maintenance.
		Multilayer, multimedia cap	Effective. Least susceptible to cracking.	Moderate implementability. Restrictions on future land use in capped areas.	High cost, high maintenance.

Table 4-3 (continued)
Evaluation of Process Options

Soil General Response Actions	Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost
Removal	Excavation	Solids excavation	Effective for permanent removal of contaminants. Removed solids require treatment or disposal.	Easily implemented. Conventional excavation equipment is widely available.	Moderate cost. LUCs may be required depending on RGOs that soils are removed to (i.e., Military Training or Unrestricted Land Use).
Disposal	Off-site disposal	RCRA disposal facility	Effective at isolating hazardous wastes from the environment due to engineering design requirements.	Moderate implementability if the waste criteria can be met. Requires frequent waste sampling	Moderate cost, no maintenance.
		Industrial landfill	Effective at isolating low hazard wastes from the environment due to waste restrictions.	Easily implemented if waste criteria is below acceptable levels for landfill disposal.	Moderate cost, no maintenance.
	On-site disposal	Consolidation	Effective in isolating the very low hazard wastes from human receptors and the environment.	Easily implementable but may be regulatory/public concerns.	Low compared to off-site disposal
In Situ Treatment	Chemical Treatment	Chemical redox	Not applicable for reducing mobility of metals.	Moderate implementability but does not reduce metals in soils.	Moderate capital, no maintenance.
Ex Situ Treatment	Chemical Treatment	Chemical redox	Not applicable for reducing mobility of metals.	Moderate implementability but does not reduce metals in soils.	Moderate capital, no maintenance.
	Biological Treatment	Composting	Not applicable for reducing mobility of metals.	Readily implementable; however, off-gas may require additional treatment. Substantial space may be required.	Low capital, low maintenance.
	Thermal Treatment	Incineration	Not applicable for reducing mobility of metals.	Readily implementable; however, off-gas may require additional treatment. Public may have concerns about emissions.	High capital, no maintenance.

Table 4-3 (continued)
Evaluation of Process Options

Shaded cells indicate that the remedial technology type and/or process option was eliminated from further evaluation.
LTM denotes long-term monitoring.
LUC denotes Land Use Control.
RAO denotes remedial action objective.
RCRA denotes Resource Conservation and Recovery Act.
redox denotes reduction/oxidation.
RGO denotes remedial goal objective.
VOC denotes volatile organic compound.

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Table 4-4
Retained Process Options for Soils

General Response Action	Technology Type	Process Options
No Action[1]	None	None
Land Use Controls	Access controls	Covenant/deed restrictions
		Administrative controls
		Physical mechanisms
	Monitoring	Physical surveillance
		Long-term monitoring
Containment	Capping	Geosynthetic clay liner
Removal	Solids excavation	Conventional excavation
Disposal	Off-site disposal	RCRA disposal facility
		Industrial landfill
		Consolidation

[1] The NCP requires that "no action" be included among the general response actions evaluated (40 CFR 300.43[e][6]).
CFR denotes Code of Federal Regulations.
NCP denotes National Oil and Hazardous Substances Pollution Contingency Plan.
RCRA denotes Resource Conservation and Recovery Act.

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5.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section describes the remedial alternatives assembled for impacted surface and subsurface soils at the Sand Creek Site. The remedial alternatives were constructed by combining GRAs, technology types, and process options retained from the screening processes described in Section 4.0. Remedial alternatives should assure adequate protection of human health and the environment, achieve the RAO, meet ARARs, and permanently and significantly reduce the volume, toxicity, and/or mobility of COCs.

The results of the screening process identified a limited number of technologies that are potentially viable for the contaminants and conditions at the Sand Creek Site for the Military Training Land Use and Unrestricted Land Use scenarios. The remaining technologies include the following: no action, LUCs, containment, excavation, and off-site disposal. Other technologies that were eliminated in the last step were those that would require to be operated in combination or only in a selected area and the costs would then be prohibitive compared to the single stage processes.

The remedial alternatives presented herein address impacted surface and subsurface soils at the Sand Creek Site. A detailed analysis of each alternative is discussed in Section 6.0. The remedial alternatives encompass a range of potential remedial actions as listed below:

- Alternative 1—No Action
- Alternative 2—LUCs
- Alternative 3—Containment with LUCs
- Alternative 4—Excavation of Soils, Off-Site Disposal, and LUCs (Military Training Land Use)
- Alternative 5—Excavation of Soils and Off-Site Disposal (Unrestricted Land Use)

Alternative 1 is the No Action response required under CERCLA. Alternative 2 relies on LUCs. No source control or RAs are implemented under Alternative 2. Alternative 3 consists of consolidating soils at the site and placing a GCL cap over the areas of soil contamination. No reduction in soil volume would occur under Alternative 3; therefore, frequent maintenance and long-term monitoring (LTM) would be required. Alternatives 4 and 5 involve excavating impacted soils and disposal at an off-site facility. Both of these alternatives address organic and inorganic impacts; however, monitoring would be required for Alternative 4, since limited soil removal that is protective of the Military Training Land Use receptors only would occur.

Time periods for environmental monitoring were developed dependent on relevant ARARs and the specific technologies employed under each remedial alternative. For the no action alternative, the assumed time period is zero. For Alternatives 2, 3, and 4, environmental monitoring was assumed to be conducted for 30 years. Alternative 5 would include the removal of all contaminated soils to the Unrestricted Land Use RGOs; therefore, LTM would not be required.

The remedial alternatives for this FS do not address media other than surface and subsurface soil at the Sand Creek Site. As previously stated, the objective of this FS is to obtain an interim remedy for soil for AOC closure in a ROD. The alternatives presented here are for soil source control and do not include management of migration aspects for the COC. The following sections provide the detailed descriptions of the alternatives for soil based on the future land use of the AOC.

5.1 Alternative 1—No Action

Consideration of the No Action alternative is required under EPA guidance for RAs under CERCLA for baseline comparison with other alternatives. Under this alternative, contaminated soil would remain in place. No action would be taken to reduce the hazards present at the Sand Creek Site to potential human or ecological receptors. There would be no measured reduction in toxicity, mobility, or volume of the contaminated media. However, organics may naturally attenuate with time. It should be noted that besides the fencing installed around the RVAAP property, no physical access controls exist at the Sand Creek Site and the area is accessible to those who do have access to the RVAAP. In addition, maintenance of the facility’s perimeter fence is not a component of this alternative.

Although this FS does not address management of migration remedies for the AOC, it should be noted that the No Action alternative would not impact implementation of potential future remedial actions. The detailed analysis of the No Action alternative is discussed in Section 6.2.1.

5.2 Alternative 2—Land Use Controls

LUCs include access restrictions, administration controls, physical mechanisms, physical surveillance, and LTM that would reduce the potential for exposure to contaminated soil at the Sand Creek Site. Under this alternative, there would be no measured reduction in toxicity, mobility, or volume of the contaminated media. However, organics may naturally attenuate with time. Institutional restrictions would be applied to control access to contaminated areas by implementing administrative policies that specify access controls, installing Seibert stakes, maintenance, and by performing LTM activities at the AOC. Administrative policies would include restricting future property use within the contaminated area of the Sand Creek Site that would result in any unacceptable risks. If the LUCs alternative is selected as the preferred alternative for the site, details concerning access restrictions would be specified in the ROD.

Land-use restrictions would include the prohibition of any use of the property, vehicular traffic, and intrusive (digging) activities. These restrictions would be incorporated into the Property Management Plan and subsequent facility Master Plan. All restrictions would be incorporated into any real property documents should the property be transferred. Any restrictions or LUCs would need to be properly managed including compliance documentation through inspections and an annual report to the Ohio EPA.

A RD would be developed to address maintenance activities, monitoring requirements (such as groundwater monitoring and Five-Year Reviews), and LUCs. The RD would incorporate existing access restrictions. A more detailed discussion of the LUCs would be developed as part of the RD including notification requirements for changes in land use. Coordination with any planned OHARNG AOC improvement and environmental monitoring activities would be necessary to ensure consistency with the Sand Creek Site's designated land use and RAO. LTM would include the installation of groundwater monitoring wells around the perimeter of the AOC. Pursuant to CERCLA, a review would be conducted every 5 years, as COCs would remain on site above the cleanup goals for the Unrestricted Land Use. Five-Year Reviews permit evaluation of all remedy components including LUCs to assess the presence and behavior of remaining COCs. For cost estimating purposes, it is assumed that five wells will be installed with quarterly monitoring until the first Five-Year Review followed by semiannual monitoring for a minimum duration of 30 years. Continued surveillance would ensure any land use changes or disturbances of impacted areas are identified. The detailed analysis of the LUC alternative is discussed in Section 6.2.2.

5.3 Alternative 3—Containment with LUCs

Alternative 3 consists of installing a GCL with a soil cover cap to act as a physical barrier against direct exposure of receptors to contaminants in surface and subsurface soil and to prevent infiltration and erosion. This alternative would be protective of both the Military Training Land Use and the Unrestricted Land Use receptors. Under this alternative, surface soil at the southern portion of the AOC that present potential risks to the Unrestricted Land Use receptors would be removed and relocated at the northern portion of the AOC where the cap will be installed. Due to the steep slopes at the site and the site's location adjacent to Sand Creek, surface controls would be necessary to prevent erosion damage from heavy rains and scouring during times of periodic flooding along the creek, and control runoff or other disturbances to the cap. This alternative would also require frequent maintenance to ensure the integrity of the cap is maintaining its effectiveness and LUCs would be required to prevent access and invasive activities in the capped area. Alternative 3 will require coordination of remediation and monitoring activities with OHARNG and the U.S. Army. Such coordination will minimize health and safety risks to on-site personnel and potential disruptions during remediation activities. The amount of time to complete this remedial action is relatively short and includes O&M and LTM (30 years is the assumed duration for cost estimating purposes). Components of this remedial alternative include the following:

- RD Plan
- Excavation and consolidation
- Placement of cap
- Maintenance and LUCs
- Five-Year Reviews

RD Plan. A RD plan would be developed prior to the initiation of remedial actions. This plan would detail AOC preparation activities, the cap design, sequence of construction activities, decontamination, and segregation, transportation, and disposal of various waste streams. Engineering and administrative controls (e.g., erosion controls, health and safety controls) will be developed during the active construction period to ensure remedial workers and the environment are protected.

Excavation and Consolidation. Impacted surface soils at the southern portion of the AOC that present potential risks to the Unrestricted Land Use receptors due elevated antimony (units SCss-075 and SCss-076 as shown on Figure B-2 in **Appendix B**), will be excavated and relocated to the northern portion of the AOC that will receive the cap. Confirmatory sampling using ISM will be performed following excavation at the subject areas of the AOC to ensure that soils have been removed to the extent necessary to meet the remediation goals for the Unrestricted Land Use receptors. The total volume of soil to be excavated and relocated is approximately 600 cubic yards (yd^3). Impacted surface soils removal would be accomplished using standard construction equipment such as excavators, bulldozers, front-end loaders, and scrapers. Excavation would be guided using a limited quantity of analytical samples. Movement of impacted soils would be performed using dump trucks and conventional construction equipment. Erosion control materials such as silt fences and straw bales would be installed to minimize erosion. Impacted soils would be kept moist or covered with tarps to minimize dust generation. The removed soils would be spread over the ground surface area that will receive the cap using the aforementioned equipment. The safety of remediation workers, on-site employees, and the general public would be covered in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Placement of cap. Installation of the cap on impacted surface and subsurface soils would include subgrade preparation activities followed by placement of the GCL and cover materials. A 6-inch layer of sand would be placed over the GCL to allow for the drainage of precipitation that infiltrates the soil cover. A 12-inch layer of soil will be placed over the drainage layer to promote vegetative growth for the prevention of erosion. The total area that is proposed to be capped at the Sand Creek Site is 1.5 acres. The total volume of sand to be placed for the drainage layer is approximately 1,200 yd^3. The total volume of soil for the backfill material and topsoil is 4,200 yd^3. All soil and cover material that is brought on-site would be tested prior to placement to ensure compliance with acceptance criteria established in the RD plan. Installation of the GCL cover would be accomplished using standard construction equipment such as excavators, bulldozers, compactors, and front-end loaders.

Clearing of vegetation at the site as well as the movement of impacted soils may occur as part of the subgrade preparation activities; however, the soils will be kept moist to minimize dust generation. Erosion control materials such as silt fences and straw bales would be installed to minimize erosion. The safety of remediation workers, on-site employees, and the general public would be covered in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Maintenance and LUCs. Soil cover maintenance will be required to limit large vegetative growth that could disrupt the cover and to control erosion on the steep slopes at the site and scouring that may occur due to periodic flooding of Sand Creek. Maintenance to control vegetation would include mowing. The LUCs discussed in Section 5.2 would be required to be implemented to restrict land use that would disturb the GCL cover and potentially expose personnel to contaminants in soils. The LUCs would include access restrictions, training, inspections, and LTM. The LUCs would be utilized to assure and reinforce protectiveness to human health.

Five-Year Reviews. Five-Year Reviews and environmental monitoring would be conducted to assess potential off-site contaminant migration. Pursuant to CERCLA, a review would be conducted every 5 years, since COCs would remain on site.

The detailed analysis of the capping alternative is discussed in Section 6.2.3.

5.4 Alternative 4—Excavation of Soils, Off-Site Disposal, and LUCs (Military Training Land Use)

Alternative 4 consists of excavating surface and subsurface soil to meet the remediation goals for the Military Training Land Use. The excavated soils would be disposed off site at a licensed disposal facility. Achieving the Military Training Land Use applies only to chemical contamination in surface and subsurface soils at the AOC. The soils media will not be unrestricted until MEC issues at the AOC are addressed under the MMRP. Alternative 4 will require coordination of remediation and monitoring activities with OHARNG and the U.S. Army. Such coordination will minimize health and safety risks to on-site personnel and potential disruptions during remediation activities. The amount of time to complete this remedial action is relatively short and includes an O&M period (30 years is the assumed duration for cost estimating purposes). Components of this remedial alternative include the following:

- RD Plan
- Excavation
- Handling of waste material
- Off-site disposal
- Confirmatory sampling
- Restoration
- Maintenance and LUCs
- Five-Year Reviews

<u>RD Plan</u>. A RD plan would be developed prior to the initiation of remedial actions. This plan would detail AOC preparation activities, the extent of the excavation, implementation, sequence of construction activities, decontamination, and segregation, transportation, and disposal of various waste streams. Engineering and administrative controls (e.g., erosion controls, health and safety controls) will be developed during the active construction period to ensure remedial workers and the environment are protected.

<u>Excavation.</u> Impacted surface and subsurface soils above the National Guard Trainee remediation goals would be excavated and transported to a staging area for loading trucks. Prior to the excavation activities, additional characterization for metals and SVOCs, the COCs at the AOC, will be conducted to further delineate the extent of contamination. The extent of impacted surface and subsurface soils at the Sand Creek Site above the remediation goals for the National Guard Trainee is depicted in Figure B-1 in **Appendix B**. Total disposal volume (i.e., ex situ) for this scenario is estimated to be 4,700 yd^3. Impacted surface and subsurface soils removal would be accomplished using standard construction equipment such as excavators, bulldozers, front-end loaders, and scrapers. Excavation would be guided using a limited quantity of analytical samples. Oversize debris would be crushed or otherwise processed to meet disposal facility requirements. Movement of impacted soils would be performed using dump trucks and conventional construction equipment. Erosion control

materials such as silt fences and straw bales would be installed to minimize erosion. Impacted soils would be kept moist or covered with tarps to minimize dust generation. The safety of remediation workers, on-site employees, and the general public would be covered in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Handling of Waste Material. Impacted soils would be hauled to a licensed and permitted disposal facility by truck. Trucks would be lined with polyethylene sheeting and covered with specially designed tarps or hard covers to prevent release of impacted soils. All trucks would be inspected prior to use and surveyed for contamination prior to leaving the AOC. Appropriate bills-of-lading (in accordance with the U.S. Department of Transportation regulations for shipment of impacted materials on public roads) would accompany waste shipments. Only regulated and licensed transporters and vehicles would be used. All trucks will travel pre-designated routes and an emergency response plan will be developed in the event of a vehicle accident.

Transportation activities would be performed in accordance with a AOC-specific Transportation and Emergency Response Plan (TERP) developed in the RD plan. The TERP would evaluate the types and number of vehicles to be used; the safest transportation routes including considerations to minimize use of high traffic roads, public facilities, or secondary roads not designed for trucks; and emergency response procedures for responding to a vehicle accident

Off-site Disposal. Impacted soils would be disposed of at an existing facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the types of wastes, location, transportation options, and cost. Waste streams with different constituents and/or characteristics may be generated. Disposal cost savings may be possible by utilizing specific disposal facilities for different waste streams.

Confirmatory Sampling. Confirmatory sampling would be conducted after excavation of each hotspot area. This sampling would confirm that the remediation goals for the National Guard Trainee, that are protective of all the Military Training Land Use receptors, have been achieved. Additionally, confirmation sampling using ISM would be conducted for soil at the bottom of each hot spot location. The analyses will include the RVAAP "full suite" of analyses that were also conducted for the Phase I RI. These analyses will include TAL metals, VOCs, SVOCs, pesticides, PCBs, explosives, propellants, perchlorate, total cyanide, and hexavalent chromium at a minimum.

If confirmation sampling shows concentrations that exceed remediation goals, either additional LUCs will be implemented or further soil removal will be required. Areas successfully remediated would be available for Military Training Land Use only.

<u>Restoration.</u> Excavated areas that meet the cleanup goals for the National Guard Trainee will be backfilled with clean soil (un-impacted soil excavated from the AOC and off-site fill) and re-vegetated. Fill would be tested prior to placement to ensure compliance with acceptance criteria established in the RD plan.

<u>Maintenance and LUCs</u>. Maintenance would continue to be required for the Sand Creek Site because soils would remain on site above the Unrestricted Land Use RGOs. The LUCs discussed in Section 5.2 would be implemented to prevent unauthorized personnel from entering the area. The LUCs would include access restrictions, training, inspections, and LTM. The LUCs would be utilized to assure and reinforce protectiveness to human health.

<u>Five-Year Reviews.</u> Five-Year Reviews and environmental monitoring would be conducted to assess potential off-site contaminant migration. Pursuant to CERCLA, a review would be conducted every 5 years, since COCs would remain on site above the Unrestricted Land Use RGOs.

The detailed analysis of the excavation, off-site disposal, with LUCs alternative that will achieve Military Training Land Use is discussed in Section 6.2.4.

5.5 Alternative 5—Excavation of Soils and Off-Site Disposal (Unrestricted Land Use)

Alternative 5 consists of excavating surface and subsurface soil to meet the remediation goals for the Unrestricted Land Use receptors. The excavated soils would be disposed off site at a licensed disposal facility. Achieving Unrestricted Land Use applies only to chemical contamination in surface and subsurface soils at the AOC. The soils media will not be unrestricted until MEC issues at the AOC are addressed under the MMRP. Alternative 5 will require coordination of remediation and monitoring activities with OHARNG and the U.S. Army. Such coordination will minimize health and safety risks to on-site personnel and potential disruptions during remediation activities. The amount of time to complete this remedial action is relatively short and includes an O&M period (30 years is the assumed duration for cost estimating purposes). Components of this remedial alternative include the following:

- RD Plan
- Excavation

- Handling of waste material
- Off-site disposal
- Confirmatory sampling
- Restoration

RD Plan. A RD plan would be developed prior to the initiation of remedial actions. This plan would detail AOC preparation activities, the extent of the excavation, implementation, sequence of construction activities, decontamination, and segregation, transportation, and disposal of various waste streams. Engineering and administrative controls (e.g., erosion controls, health and safety controls) will be developed during the active construction period to ensure remedial workers and the environment are protected. Evaluation of groundwater at the RVAAP is conducted on a facility-wide basis and confirmation of groundwater beneath the AOC as meeting the Unrestricted Land Use criteria will be conducted under the facility-wide groundwater monitoring program.

Excavation. Impacted surface and subsurface soils above the Unrestricted Land Use receptors remediation goals would be excavated and transported to a staging area for loading trucks. The extent of impacted surface and subsurface soils at the Sand Creek Site above the Unrestricted Land Use receptors RGOs is depicted in Figure B-2 in **Appendix B**; however, additional characterization for metals and SVOCs, the COCs at the AOC, will be conducted to further delineate the actual extent of contamination prior to excavation. Total disposal volume (i.e., ex situ) for this scenario is estimated to be approximately 6,290 yd^3. Impacted surface and subsurface soils removal would be accomplished using standard construction equipment such as excavators, bulldozers, front-end loaders, and scrapers. Excavation would be guided using a limited quantity of analytical samples. Oversize debris would be crushed or otherwise processed to meet disposal facility requirements. Movement of impacted soils would be performed using dump trucks and conventional construction equipment. Erosion control materials such as silt fences and straw bales would be installed to minimize erosion. Impacted soils would be kept moist or covered with tarps to minimize dust generation. The safety of remediation workers, on-site employees, and the general public would be covered in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Handling of Waste Material. Impacted soils would be hauled to a licensed and permitted disposal facility by truck. Trucks would be lined with polyethylene sheeting and covered with specially designed tarps or hard covers to prevent release of impacted soils. All trucks would be inspected prior to use and surveyed for contamination prior to leaving the AOC. Appropriate bills-of-lading [in accordance with U.S. Department of Transportation regulations for shipment of impacted materials on public roads] would accompany waste shipments. Only regulated and licensed transporters and vehicles would be used. All trucks will travel pre-designated routes and an emergency response plan will be developed in the event of a vehicle accident.

Transportation activities would be performed in accordance with a AOC-specific TERP developed in the RD plan. The TERP would evaluate the types and number of vehicles to be used; the safest transportation routes including considerations to minimize use of high traffic roads, public facilities, or secondary roads not designed for trucks; and emergency response procedures for responding to a vehicle accident

Off-site Disposal. Impacted soils would be disposed of at an existing facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the types of wastes, location, transportation options, and cost. Waste streams with different constituents and/or characteristics may be generated. Disposal cost savings may be possible by utilizing specific disposal facilities for different waste streams.

Confirmatory Sampling. Confirmatory sampling would be conducted after excavation of each hotspot area. This sampling would confirm the cleanup goals for the Unrestricted Land Use receptors have been achieved. Additionally, confirmation sampling using ISM would be conducted for soil at the bottom of each hot spot location. The analyses will include the RVAAP "full suite" of analyses that were also conducted for the Phase I RI. These analyses will include at a minimum TAL metals, VOCs, SVOCs, pesticides, PCBs, explosives, propellants, perchlorate, total cyanide, and hexavalent chromium.

If confirmation sampling shows concentrations that exceed cleanup goals, either additional LUCs will be implemented or further soil removal will be required. Areas successfully remediated would be available for Unrestricted Land Use with no restrictions.

Restoration. Excavated areas that meet the cleanup goals for the Resident (Adult and Child) receptors will be backfilled with clean soil (un-impacted soil excavated from the AOC and off-site fill) and re-vegetated. Fill would be tested prior to placement to ensure compliance with acceptance criteria established in the RD plan.

The detailed analysis of the excavation and off-site disposal alternative that will achieve Unrestricted Land Use is discussed in Section 6.2.5.

6.0 DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives evaluates remedial alternatives selected for final consideration. The detailed analysis begins with an individual analysis in which each alternative is individually evaluated according to the evaluation criteria identified in the NCP (40 CFR 300.430). Following the individual analysis, the alternatives are compared in relation to the two threshold criteria and then the alternatives are assessed regarding the five balancing criteria, highlighting the key advantages, and trade-offs that are considered as part of the evaluation process.

6.1 Overview of the Evaluation Criteria

CERCLA, Section 121, as amended, specifies regulatory requirements for remedial actions. These requirements include the protection of human health and the environment, compliance with ARARs, a preference for permanent solutions that incorporate treatment as a principle element to the maximum extent practicable, and cost-effectiveness. To assess whether alternatives meet the requirements, EPA has identified nine criteria in the NCP (40 CFR 300.430) that must be evaluated for each alternative considered for selection (Section 300.430[e][9][iii]). The nine criteria consist of the following:

- CERCLA threshold criteria:
  - Overall protection of human health and the environment
  - Compliance with ARARs
- CERCLA balancing criteria:
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility or volume through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
  - State acceptance
  - Community acceptance

The two CERCLA modifying criteria (State and community acceptance) will be evaluated after State and public comments on the Proposed Plan are received. The purpose of this analysis is to provide sufficient information to compare the alternatives, select an appropriate and complete final remedy for AOC closure, and demonstrate its compliance with the CERCLA remedy selection requirements in a ROD.

Provided in the following sections are summaries of the factors that comprise the nine criteria and an overview of the approach taken by this FS to address the criteria.

6.1.1 Overall Protection of Human Health and the Environment

The NCP requires that the selected remedy adequately protect human health and the environment over the long term. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. This evaluation criterion describes the manner in which AOC risks posed through the identified pathways are eliminated, reduced, or controlled through treatment, engineering or institutional controls. This evaluation criterion also considers whether the alternative poses any unacceptable short-term or cross-media impacts.

6.1.2 Compliance with ARARs

This criterion is used to determine whether an alternative will meet federal and state ARARs. It identifies the requirements that are applicable or relevant and appropriate to an alternative and describes how the alternative meets action-specific, chemical-specific, and location-specific ARARs. If an ARAR is not met, the basis for justifying a waiver will be discussed. The principal ARARs for remediation of soils at the Sand Creek Site are discussed in Section 3.0 and are summarized in **Appendix A**.

6.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the risk remaining at the AOC after the RAO is met. Specific evaluation of this criterion focuses on assessing the magnitude of the residual risk, and the adequacy and reliability of controls used to manage remaining waste and treatment residuals over the long term.

6.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the statutory preference for selecting remedial actions that employ treatment to permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. Specifically, the factors on which this analysis focuses include the following:

- The treatment processes and what they will treat;
- The amount of hazardous materials treated or destroyed and how the principal threat is addressed;

- The degree of expected reduction in toxicity, mobility or volume;
- The degree to which treatment will be irreversible; and
- The type and quantity of residuals that will remain following treatment.

6.1.5 Short-Term Effectiveness

This criterion addresses the effects of a remedial alternative during the construction and implementation phase, including the protection of the community and workers, potential environmental impacts and mitigative measures, and the time frame to achieve cleanup goals.

6.1.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Specifically, evaluation of this criterion considers the following:

- The ability to construct and operate components of the alternatives and potential technical difficulties and unknowns;
- The ease of undertaking additional remedial action;
- The ability to monitor the performance and effectiveness of the remedy and the ability to evaluate the risks of exposure should the monitoring be insufficient to detect a failure of the remedy;
- Administrative feasibility (i.e., activities that are necessary to coordinate with other offices and agencies for permits, rights-of-way, etc.); and
- The availability of services, capacities, materials, equipment, and specialists.

6.1.7 Cost

Cost estimating procedures are contained in the EPA costing guidance (EPA, 2000). The purpose of the cost evaluation is to compare how an alternative's cost impacts the overall "cost-effectiveness" of the alternative over time. These "study estimate" costs are expected to provide an accuracy of +50 percent to -30 percent and were prepared for the AOC using data available from the Phase I RI (Shaw, 2013).

The estimates are divided into capital cost and O&M cost. The estimates are escalated using industry standard escalation rates (average 7 percent a year) and according to an assumed schedule for the various activities based on similar project experience. Additionally, present worth and cost sensitivity analyses are components of the cost estimating procedures that evaluate the input assumptions for the estimates and the ability to cover the costs over its planned life. Further details regarding these individual components of the cost estimates are as follows:

- **Capital Costs**—Capital costs consist of direct (construction) and indirect (no construction and overhead) costs associated with installation and implementation of remedial alternatives. Direct costs include expenditures for the equipment, labor, and materials necessary to install remedial actions. Indirect costs include expenditures for engineering, financial, administration, and other services that are not part of actual installation activities.
- **Annual O&M Costs**—Annual O&M costs are post construction costs necessary to ensure the continued effectiveness of a remedy.
- **Present Worth Analysis**—A present worth analysis is used to evaluate expenditures that occur over different time periods. This analysis provides a single figure representing the amount of money that, if invested in the base year at a given interest rate, would be sufficient to cover costs associated with the remedial action over its planned life.
- **Cost Sensitivity Analysis**—A sensitivity analysis assesses the effect that variations in specific assumptions associated with the design, implementation, operation, discount rate, and effective life of an alternative may have on the estimated cost of the alternative.

6.1.8 State Acceptance and Community Acceptance

The final two criteria, State acceptance and community acceptance, are not included in this FS in accordance with EPA guidance because these two criteria are typically evaluated by EPA following a public comment period on a Proposed Plan for the selected remedy and are considered by EPA in arriving at a ROD.

6.2 Individual Analysis of Alternatives

The following sections evaluate the remedial alternatives detailed in Section 5.0, using the seven criteria discussed in the preceding section. The alternatives include No Action, LUCs, Excavation, Off-Site Disposal and LUCs (Military Training Land Use), and Excavation with Off-Site Disposal (Unrestricted Land Use).

6.2.1 Alternative 1—No Action

The No Action alternative does not include any further action. No remedial actions would be undertaken to reduce, contain, or remove contaminated soil. Off-site migration of contaminants would not be mitigated under the No Action alternative. It should be noted that besides the fencing installed around the RVAAP property, no physical access controls exist at the Sand Creek Site, with the exception of Siebert stakes and signs warning unauthorized personnel to stay out, and the area is accessible to those who do have access to the RVAAP. In addition, maintenance of the facility's perimeter fence is not a component of this alternative.

6.2.1.1 Overall Protection of Human Health and the Environment

The No Action alternative will not actively treat the COC-impacted soil or isolate human or environmental receptors from potential exposure to the COC. This remedy will not reduce the short-term risk to humans or terrestrial organisms through ingestion, inhalation or contact with exposed COC-impacted soil. This remedy does not involve the natural attenuation of the COC within an acceptable timeframe; therefore, does not provide long-term protection of human health and the environment. The lack of institutional controls and permanent AOC fencing increase the potential risk of exposure to the COC. The Resident (Adult and Child) receptors will not be protected from potential exposure for Unrestricted Land Use.

This alternative does not reduce the migration of the COC from impacted soil to potential environmental receptors. However, as described in Section 3.0, impacts to environmental receptors are not included in the evaluation of alternatives.

6.2.1.2 Compliance with ARARs

The principal ARARs for remediation of soils at the Sand Creek Site are presented in Section 3.0 and summarized in **Appendix A**. These federally enforceable standards would be protective of the Resident (Adult and Child) receptors that could be exposed to COCs under the Unrestricted Land Use scenario.

The No Action alternative would not comply with chemical-specific ARARs. The concentrations in soil would remain above the RGOs, and although natural attenuation may occur for the COC, the soil would not be confirmed to have been restored to the unrestricted land use standards. Since no remedial activities would be conducted, action-specific, and location-specific ARARs would not apply.

6.2.1.3 Long-Term Effectiveness and Permanence

The No Action alternative does not involve active treatment and will not yield treatment residuals or require long-term management. However, in the absence of an active remedy or significant natural attenuation processes, contaminated soils will remain in place at the Sand Creek Site and will continue to pose a long-term risk to human health and the environment. In addition, this alternative will not reduce the toxicity, mobility, or volume of contamination.

Monitoring data will not be available to assess whether AOC conditions are adequately protective of human health and the environment. The lack of institutional controls and permanent AOC fencing increase the potential risk of exposure to the COC.

6.2.1.4 Reduction of Toxicity, Mobility, or Volume

This alternative will not involve active treatment, containment, removal, or disposal. Because no treatment would be implemented, there would be no reduction in toxicity, mobility, or volume. Due to the recalcitrant nature of the COCs, they will not naturally attenuate to levels protective of human health and the environment, within an acceptable timeframe. Therefore this alternative will not result in the significant reduction in the mass or volume of the COCs. In the absence of active treatment and degradation processes, the contaminants will continue to be toxic to humans and terrestrial organisms. Under this alternative, the migration of COCs through surface water runoff, dust, and leaching to groundwater, will pose a potential risk to environmental receptors.

6.2.1.5 Short-Term Effectiveness

Because this remedy does not involve active remediation or construction, there would not be a risk of exposure for AOC workers or the surrounding community to the COC. The workers at the AOC will use appropriate PPE to prevent contact with impacted media. The environment will not face additional adverse impact due to construction activities such as erosion, sedimentation, or vegetative damage.

In the absence of any active treatment or containment, the No Action alternative will not reduce the risk to humans or terrestrial organisms through ingestion, inhalation or contact with COC-impacted soils. However, the lack of permanent residents on the RVAAP, and the low population density on its adjacent properties and existence of the facility perimeter fencing, will mitigate the risk of exposure to COCs in the short term.

6.2.1.6 Implementability

This section is divided into three categories: technical feasibility, administrative feasibility, and availability of services and materials.

Technical Feasibility

The No Action alternative does not involve active remediation; therefore, technical feasibility is not a consideration. This alternative will not interfere with any planned remedial actions in the future.

Administrative Feasibility

No administrative or regulatory attention from the State agencies involved is required to implement this alternative with the exception that the Ohio EPA would have to accept this remedy as the final remedy.

Feasibility of Obtaining Services and Materials

No services, equipment, or materials are necessary to implement this alternative.

6.2.1.7 Cost

The No Action alternative will not have capital or O&M costs.

6.2.1.8 Community Acceptance

This alternative has not yet been formally presented to the public for comment. There is a 30-day public comment period after submittal of the Proposed Plan. Responses to the public's comments will be prepared prior to the selection of the remedial action.

6.2.2 Alternative 2—Land Use Controls

The LUCs alternative consists of instituting access controls and monitoring process options. Under this alternative alone, no remedial actions would be undertaken to reduce, contain, or remove contaminated soil. Off-site migration of the contaminant would not be mitigated under the LUCs alternative. It should be noted that besides the fencing installed around the RVAAP property, no physical access controls exist at the Sand Creek Site, with the exception of Siebert stakes and signs warning unauthorized personnel to stay out, and the area is accessible to those who do have access to the RVAAP. In addition, maintenance of the facility's perimeter fence is not a component of this alternative.

6.2.2.1 Overall Protection of Human Health and the Environment

The LUCs alternative will not actively treat the COC-impacted soil; however, it may isolate human or environmental receptors from potential exposure to the COC with LUCs (i.e., no invasive activities). This remedy will reduce the short-term risk to humans or terrestrial organisms through ingestion, inhalation, or contact with exposed COC-impacted soil. This remedy does not involve the natural attenuation of the COC within an acceptable timeframe; therefore, does not provide long-term protection of human health and the environment.

This alternative does not reduce the migration of the COC from impacted soil to potential environmental receptors. However, as described in Section 3.0, impacts to environmental receptors are not included in the evaluation of alternatives.

6.2.2.2 Compliance with ARARs

The principal ARARs for remediation of soils at the Sand Creek Site are presented in Section 3.0 and summarized in **Appendix A**. These federally enforceable standards would be protective of the potential Resident (Adult and Child) receptors that could be exposed to COCs under the Unrestricted Land Use scenario.

The LUCs alternative would not comply with chemical-specific ARARs. The concentrations in soil would remain above the RGOs, and although natural attenuation may occur for the organic fractions of the COCs, the soil would not be confirmed to have been restored to the Unrestricted Land Use standards. Since no remedial activities would be conducted, action-specific, and location-specific ARARs would not apply.

6.2.2.3 Long-Term Effectiveness and Permanence

The LUCs alternative does not involve active treatment and will not yield treatment residuals or require long-term management. However, in the absence of an active remedy or significant natural attenuation processes, contaminated soils will remain in place at the Sand Creek Site and will continue to pose a long-term risk to human health and the environment. In addition, this alternative will not reduce the toxicity, mobility or volume of contamination. Monitoring data will not be available to assess whether AOC conditions are adequately protective of human health and the environment.

6.2.2.4 Reduction of Toxicity, Mobility, or Volume

This alternative will not involve active treatment, containment, removal, or disposal. Because no treatment would be implemented, there would be no reduction in toxicity, mobility, or volume. Due to the recalcitrant nature of the COCs, they will not naturally attenuate to levels protective of human health and the environment, within an acceptable timeframe. Therefore this alternative will not result in the significant reduction in the mass or volume of the COCs. In the absence of active treatment and degradation processes, the contaminants will continue to be toxic to humans and terrestrial organisms. Under this alternative, the migration of the COCs through surface water runoff, dust, and leaching to groundwater, will pose a potential risk to environmental receptors.

6.2.2.5 Short-Term Effectiveness

There are currently Seibert stakes and warning signs regarding access restrictions to unauthorized personnel around the perimeter of the AOC that are expected to reduce the risk of exposure in the short-term for facility personnel. The implementation of LUCs would not introduce additional short-term risks to the community and the environment will not face additional adverse impact due to construction activities such as erosion, sedimentation, or vegetative damage. The alternative’s remedial measures would require zero years to complete and would include an O&M period (30 years assumed for cost estimating purposes).

6.2.2.6 Implementability

This section is divided into three categories: technical feasibility, administrative feasibility, and availability of services and materials.

Technical Feasibility

The LUCs alternative does not involve active remediation; therefore, technical feasibility is not a consideration. This alternative will not interfere with any planned remedial actions in the future.

Administrative Feasibility

Preparing an RD plan for O&M activities and implementing LUCs is technically implementable. Implementing proposed LUCs would supplement and support restrictions already existing at the AOC. Consultation with State and local agencies, and approval of this remedy by the Ohio EPA as the final remedy will be required.

Feasibility of Obtaining Services and Materials

Numerous vendors and contractors are available to complete the necessary LUCs and O&M activities involved in this remedy.

6.2.2.7 Cost

The total capital cost of this alternative is estimated at $214,389 while the total annual O&M costs are estimated at $1,742,085 (nondiscounted). The total present worth of capital and annual O&M costs is approximately $1,663,787 calculated over 30 years at a discount rate of 7 percent. Details of the cost calculations are presented in **Appendix C**.

6.2.2.8 Community Acceptance

This alternative has not yet been formally presented to the public for comment. There is a 30-day public comment period after submittal of the proposed plan. Responses to the public’s comments will be prepared prior to the selection of the remedial action.

6.2.3 Alternative 3—Containment with LUCs

Alternative 3 includes the excavation at hot spot surface soil areas at the southern portion of the AOC that present potential risk to the Unrestricted Land Use receptors, relocating the impacted soils to the northern portion of the AOC, and covering the areas of contaminated soil with a GCL liner and soil cover to prevent erosion and direct contact by human and environmental receptors. The total area to be covered with the GCL at the AOC is 1.5 acres. Other technologies required would include long-term maintenance and LUCs.

6.2.3.1 Overall Protection of Human Health and the Environment

The remedial action proposed for this alternative will eliminate the potential for exposure of human and environmental receptors to COCs and the long-term protectiveness of this alternative is considered to be high. Installation of a GCL would limit the future activities of the Sand Creek Site for Military Training Land Use, since the cap is protective of human and environmental receptors and cannot be disturbed. This alternative is protective of the Military Training Land Use and the Unrestricted Land Use receptors and achieves the RAO for the Sand Creek Site.

6.2.3.2 Compliance with ARARs

The principal ARARs for the elimination of exposure to COCs at the Sand Creek Site are presented in Section 3.0 and summarized in **Appendix A**. These enforceable standards would be protective of representative receptors under both the Military Training Land Use and Unrestricted Land Use scenarios that could be exposed to COCs at the Sand Creek Site.

This alternative would comply with chemical-specific ARARs for the Military Training Land Use and the Unrestricted Land Use receptors at the Sand Creek Site assuming that no intrusive activities are conducted. Exposure to soils with measured concentrations of COCs greater than the RGOs would be removed for the most stringent National Guard receptor, the National Guard Trainee and the Resident (Adult and Child) receptors.

The activities that would be conducted under this alternative would comply with all location-specific ARARs. No activities would take place in sensitive environments such as wetlands, and no impacts to archeological resources or threatened and endangered species are anticipated.

The activities that would be conducted under this alternative would comply with all action-specific ARARs. Implementation of the proposed remedy would occur in compliance with all transportation and disposal requirements. Dust mitigation and runoff control would be important during disturbance of impacted soil. All runoff requirements would be met to protect Sand Creek.

6.2.3.3 Long-Term Effectiveness and Permanence

Alternative 3 is protective in the long term for the Military Training Land Use and Unrestricted Land Use receptors; however, no reduction in soil volume will occur. This alternative includes long-term maintenance and LUCs to ensure the integrity and the effectiveness of the remedy to eliminate or reduce exposures to receptors. With appropriate documentation and procedures, LUCs can be successfully implemented and would be effective in protecting human health and the environment.

Reviews will be conducted at least once every 5 years, pursuant to CERCLA requirements. CERCLA Five-Year Reviews permit the evaluation of remedy components, including effectiveness of LUCs.

6.2.3.4 Reduction of Toxicity, Mobility, or Volume

This alternative will not destroy or remove the contaminated material; however, installation of a GCL will eliminate infiltration and the ability of contaminants in the surface and subsurface soil to mobilize. This alternative will not yield any toxic residuals as no on-site treatment of the soils will occur and the remedy includes off-site disposal. Additional process residuals that will require handling may include wash water from equipment decontamination, accumulated storm water, and disposable PPE. In order to ensure that contaminants in the soil were not mobilized during the remediation activities, it is expected that groundwater at the Sand Creek Site will monitored under the facility-wide groundwater monitoring program.

6.2.3.5 Short-Term Effectiveness

This alternative is protective of the surrounding community during remedy implementation primarily because all activities would occur on site with minimal disturbance of contaminated material. Truck traffic for equipment and materials, including the delivery of approximately 5,400 yd^3 of borrow material for backfill, the drainage layer, and the final soil cap cover, will occur. During excavation activities and installation of the GCL at the Sand Creek Site, control of surface runoff would be important to avoid releases of contamination to adjacent Sand Creek.

Some short-term risks to human health or the environment would exist during implementation of this alternative. The soil excavation activity has the potential to present transportation or construction accidents to the work site environment. Additionally, this alternative would involve potential short-term risks to workers associated with the operation of heavy equipment and potential exposure to contaminated soil during installation of the cap. Air quality could be affected by the release of particulates during the disturbance of soil for the cap subgrade. Air monitors would be used to measure dust emissions during construction activities. Engineering controls would be implemented to ensure emissions do not exceed levels that could pose a risk to human health. Implementation of a good health and safety program along with a migration control plan should minimize any risk associated with this alternative. Remediation workers would conform to the site health and safety program and would be equipped with the necessary PPE. A site-specific health and safety plan would be prepared prior to implementing this alternative.

Clearing and grubbing at the Sand Creek Site will be required to provide an effective subgrade for the cap. However, since these areas have been cleared in the past, it is unlikely that there are any sensitive species that would be impacted. If any sensitive areas were found, the appropriate regulation would be followed. The implementation of proper engineering controls would minimize the risk of environmental impacts.

The duration of the field work for this alternative is less than 1 month to complete. LTM and O&M activities will be required for a minimum of 30 years following the implementation of this remedy.

6.2.3.6 Implementability

This section is divided into three categories: technical feasibility, administrative feasibility, and availability of services and materials.

Technical Feasibility

Alternative 3 is technically implementable. Standard earthmoving equipment can move local soil over the contaminated areas; however, because of the potential presence of MEC and MD at the site from historic activities, UXO technicians would need to be utilized in the construction operations, which would prolong the excavation. The GCL comes in rolls that are easy to install. Portions of the Sand Creek Site may require some initial clearing prior to implementation of the remedy. Construction and operation of the components of Alternative 3 would be straightforward with resources readily available to complete the remedial activity. Borrow sites for backfill and soil cover have not been selected, but are anticipated to be locally available.

The required maintenance activities will be easily implementable. Soil cover maintenance to limit large vegetative growth that could disrupt the cover and to control erosion and scouring would be needed. Frequent maintenance (mowing) would be required.

The LUCs also are implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs, access controls, or cover material. The Sand Creek Site currently has access restrictions implemented at the AOC.

Careful planning would be needed between remedial action planners and the OHARNG to minimize disruptions and/or impacts to OHARNG operations during implementation. Access routes for heavy equipment to remediation areas would be selected to minimize the disruption. Additional steps would be taken to minimize hazards posed to facility personnel. This type of planning will increase the implementation difficulty of Alternative 3, but also will reduce the risks to facility personnel.

Administrative Feasibility

Preparing an RD plan for the proposed remedy, O&M activities, and LUCs is technically implementable. Consultation with State and local agencies, and approval of this remedy by the Ohio EPA as the final remedy will be required.

Feasibility of Obtaining Services and Materials

Numerous vendors and contractors are available to complete the tasks involved in this remedy. The necessary labor and equipment required to install the GCL are available. Clean fill is available in the volume required to bring the soil cover for the cap to final grade. "Clean" fill consists of on- or off-site soil that has passed the chemical and physical requirements in accordance with the RVAAP facility-wide plans. All soil sources must be approved by the Ohio EPA prior to transport to the RVAAP and on-site use. Necessary services, equipment, and materials required for the implementation of the cap installation activities and as part of the LTM and O&M program are also readily available.

6.2.3.7 Cost

The cost analysis is presented in **Appendix C**. Present worth costs use 30 years as a costing period, although the remedy may require monitoring, maintenance, and enforcement beyond this 30-year period. The total present worth cost for this alternative is estimated at $2,629,722. This estimated cost is comprised of a capital cost of $671,624 and a nondiscounted O&M cost of $1,448,334.

6.2.3.8 Community Acceptance

This alternative has not yet been formally presented to the public for comment. This is a proposed final remedy for the Sand Creek Site and it is subject to public review and comment. There is a 30-day public comment period after submittal of the Proposed Plan. Responses to the public's comments will be prepared prior to the selection of the remedial action.

6.2.4 Alternative 4—Excavation of Soils, Off-Site Disposal, and LUCs (Military Training Land Use)

Alternative 4 includes excavation and off-site disposal to remove impacted soils exceeding the remediation goals for the National Guard Trainee. An estimated 4,700 yd^3 (ex situ) of impacted soils would be excavated and shipped off site to a permitted disposal facility. Other technologies required would include LUCs, short-term containment, and waste handling via trucks.

6.2.4.1 Overall Protection of Human Health and the Environment

The remedial action proposed for this alternative will remove COCs to below the remediation goals for the National Guard Trainee, the most representative receptor for the

Military Training Land Use, and the long-term protectiveness of this alternative is considered to be high. Residual contamination after the completion of the remedial actions would not limit the intended future activities of the Sand Creek Site for the Military Training Land Use and would not require exposure limitations for the intended receptors. This alternative is not protective of human health under the Unrestricted Land Use scenario for the Sand Creek Site.

6.2.4.2 Compliance with ARARs

The principal ARARs for remediation of soils at the Sand Creek Site are presented in Section 3.0 and summarized in **Appendix A**. These enforceable standards would be protective of representative receptors under both the Military Training Land Use and Unrestricted Land Use scenarios that could be exposed to COCs at the Sand Creek Site.

This alternative would comply with chemical-specific ARARs for the Military Training Land Use. Soils with measured concentrations of COCs greater than the RGOs would be removed for the most stringent National Guard receptor, the National Guard Trainee. Effectiveness of the remedy would be confirmed through confirmatory samples analyzed at a certified analytical laboratory. This alternative would not comply with the chemical-specific ARARs for Unrestricted Land Use, since residual soils above the cleanup goals would remain.

The activities that would be conducted under this alternative would comply with all location-specific ARARs. No activities would take place in sensitive environments such as wetlands, and no impacts to archeological resources or threatened and endangered species are anticipated.

The activities that would be conducted under this alternative would comply with all action-specific ARARs. Soil remediation would occur in compliance with all transportation and disposal requirements. Runoff control would be important during soil excavation. All runoff requirements would be met to protect Sand Creek.

6.2.4.3 Long-Term Effectiveness and Permanence

Alternative 4 is protective in the long term for the Military Training Land Use. Contaminants will remain on site above the remediation goals for the Unrestricted Land Use. This alternative includes LUCs to eliminate or reduce exposures to receptors. With appropriate documentation and procedures, LUCs can be successfully implemented and would be effective in protecting human health and the environment.

Reviews will be conducted at least once every 5 years, pursuant to CERCLA requirements. CERCLA Five-Year Reviews permit the evaluation of remedy components, including effectiveness of LUCs.

6.2.4.4 Reduction of Toxicity, Mobility, or Volume

Although this alternative will not destroy the contaminated material, it will significantly reduce the total mass of the COC in soils that may create an exposure hazard at the Sand Creek Site through excavation and off-site disposal. This alternative will not yield any toxic residuals as no on-site treatment of the soils will occur and the remedy includes off-site disposal. Additional process residuals that will require handling may include wash water from equipment decontamination, accumulated storm water, and disposable PPE. In order to ensure that contaminants in the soil were not mobilized during the remediation activities, it is expected that groundwater at the Sand Creek Site will monitored under the facility-wide groundwater monitoring program.

6.2.4.5 Short-Term Effectiveness

Short-term risk of potential exposure to the community will be minimized by inspecting vehicles before and after use, decontaminating when needed, covering the transported waste, observing safety protocols, following predesignated routes, and limiting the distance the waste is transported. Truck traffic for equipment and materials, including approximately 4,700 yd^3 of contaminated soil taken off the site for disposal and on-site delivery of borrow material for backfilling, will occur. If a contaminated soil spill occurred during an accident, the spill would be easy to contain and would not likely impact the surrounding communities. During excavation of soils at the Sand Creek Site, control of surface runoff would be important to avoid releases of contamination to adjacent Sand Creek.

Some short-term risks to human health or the environment would exist during implementation of this alternative. The soil excavation activity has the potential to present transportation or construction accidents to the work site environmental. Additionally, this alternative would involve potential short-term risks to workers associated with the operation of heavy equipment and potential exposure to contaminated soil during sampling activities. Air quality could be affected by the release of particulates during soil excavation. Air monitors would be used to measure dust emissions during construction activities. Engineering controls would be implemented to ensure emissions do not exceed levels that could pose a risk to human health. Implementation of a good health and safety program along with a migration control plan should minimize any risk associated with this alternative. Remediation workers would conform to the site health and safety program and would be equipped with the necessary PPE. A site-specific health and safety plan would be prepared prior to implementing this alternative.

Minor clearing and grubbing at the Sand Creek Site will be required to effectively excavate the soil. However, since these areas have been cleared in the past, it is unlikely that there are any sensitive species that would be impacted. If any sensitive areas were found, the appropriate regulation would be followed. The implementation of proper engineering controls would minimize the risk of environmental impacts.

The duration of the field work for this alternative is less than 1 month to complete, followed by 30 years of LTM and O&M. Upon the completion of the excavation activities, the Sand Creek Site would be released for Military Training Land Use.

6.2.4.6 Implementability

This section is divided into three categories: technical feasibility, administrative feasibility, and availability of services and materials.

Technical Feasibility

Alternative 4 is technically implementable. Excavation is a common remedy used for contaminated soils and can be completed with little difficulty; however, because of the potential presence of MEC and MD at the site from historic activities, UXO technicians would need to be utilized in the construction operations, which would prolong the excavation. Excavation of impacted soils, construction of temporary roads, and waste handling are conventional activities in construction projects of this kind. Multiple disposal facilities are available that can accept generated waste. Construction and operation of the components of Alternative 4 would be straightforward with resources readily available to complete the remedial activity. Borrow sites for backfill and soil cover have not been selected, but are anticipated to be locally available.

The LUCs also are implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs, access controls, or cover material. The Sand Creek Site currently has access restrictions implemented at the AOC.

Careful planning would be needed between remedial action planners and the OHARNG to minimize disruptions and/or impacts to OHARNG operations during implementation. Access routes for heavy equipment to remediation areas would be selected to minimize the disruption. Additional steps would be taken to minimize hazards posed to facility personnel. This type of planning will increase the implementation difficulty of Alternative 4, but also will reduce the risks to facility personnel.

Administrative Feasibility

The acceptability of Alternative 4 would be affected by administrative requirements for transport and disposal and the requirements for Military Training Land Use at the Sand Creek Site. The engineering departments from the local communities would be consulted to evaluate the impact of the truck traffic on the roads surrounding the RVAAP.

Feasibility of Obtaining Services and Materials

Numerous vendors and contractors are available to complete the tasks involved in this remedy. The necessary labor and equipment required to delineate the excavation areas, perform the excavation activities are available. Clean fill is available in the volume required to replace the excavated material and restore the original surface grade. "Clean" backfill consists of on- or off-site soil that has passed the chemical and physical requirements in accordance with the RVAAP facility-wide plans. All backfill soil sources must be approved by the Ohio EPA prior to transport to the RVAAP and on-site use. Necessary services, equipment, and materials required for sampling during remediation activities and as part of the LTM program are also readily available.

6.2.4.7 Cost

The cost analysis is presented in **Appendix C**. Present worth costs use 30 years as a costing period, although the remedy may require monitoring, maintenance, and enforcement beyond this 30-year period. The total present worth cost for this alternative is estimated at $2,809,775. This estimated cost is comprised of a capital cost of $2,202,319 and a nondiscounted O&M cost of $1,742,085.

6.2.4.8 Community Acceptance

This alternative has not yet been formally presented to the public for comment. This is a proposed final remedy for the Sand Creek Site and it is subject to public review and comment. There is a 30-day public comment period after submittal of the Proposed Plan. Responses to the public's comments will be prepared prior to the selection of the remedial action.

6.2.5 Alternative 5—Excavation of Soils and Off-Site Disposal (Unrestricted Land Use)

Alternative 5 includes excavation and off-site disposal to remove impacted soils exceeding the remediation goals for the Unrestricted Land Use. An estimated 7,000 yd^3 (ex situ) of impacted soils would be excavated and shipped off site to a permitted disposal facility. Other technologies required would include short-term containment and waste handling via trucks.

6.2.5.1 Overall Protection of Human Health and the Environment

The remedial action proposed for this alternative will remove COCs to below the remediation goals for the Unrestricted Land Use, and the long-term protectiveness of this alternative is considered to be high. Under this alternative, no residual contamination would remain after the completion of the remedial actions; thereby, allowing for Unrestricted Land Use of the site. Therefore, this alternative is protective of human health for the Resident (Adult and Child) receptors and achieves the RAO for Unrestricted Land Use for the Sand Creek Site.

6.2.5.2 Compliance with ARARs

The principal ARARs for remediation of soils at the Sand Creek Site are presented in Section 3.0 and summarized in **Appendix A**. These enforceable standards would be protective of representative receptors under both the Military Training Land Use and Unrestricted Land Use scenarios that could be exposed to COCs at the Sand Creek Site.

This alternative would comply with chemical-specific ARARs for the Unrestricted Land Use at the Sand Creek Site. Soils with measured concentrations of COCs greater than the RGOs would be removed for the Resident (Adult and Child) receptors. Additionally, this alternative would meet the substantive use of the Sand Creek Site by the OHARNG for the Military Training Land Use. Effectiveness of the remedy would be confirmed through confirmatory samples analyzed at a certified analytical laboratory.

The activities that would be conducted under this alternative would comply with all location-specific ARARs. No activities would take place in sensitive environments such as wetlands, and no impacts to archeological resources or threatened and endangered species are anticipated.

The activities that would be conducted under this alternative would comply with all action-specific ARARs. Soil remediation would occur in compliance with all transportation and disposal requirements. Runoff control would be important during soil excavation. All runoff requirements would be met to protect Sand Creek.

6.2.5.3 Long-Term Effectiveness and Permanence

Alternative 5 would effectively reduce the long-term contamination for soils at the Sand Creek Site. All soils above the Unrestricted Land Use cleanup goals would be excavated and transported off site for disposal, thereby mitigating risks to human health and the environment. Confirmatory sampling would be conducted after excavation activities to confirm the cleanup goals for the Resident (Adult and Child) receptors have been achieved. Under this alternative, no LUCs, CERCLA Five-Year Reviews. or O&M sampling will be required.

6.2.5.4 Reduction of Toxicity, Mobility, or Volume

Although this alternative will not destroy the contaminated material, it will significantly reduce the total mass of the COC in soils that may create an exposure hazard at the Sand Creek Site through excavation and off-site disposal. This alternative will not yield any toxic residuals as no on-site treatment of the soils will occur and the remedy includes off-site disposal. Additional process residuals that will require handling may include wash water from equipment decontamination, accumulated storm water, and disposable PPE. In order to ensure that contaminants in the soil were not mobilized during the remediation activities, it is expected that groundwater at the Sand Creek Site will monitored under the facility-wide groundwater monitoring program.

6.2.5.5 Short-Term Effectiveness

Short-term risk of potential exposure to the community will be minimized by inspecting vehicles before and after use, decontaminating when needed, covering the transported waste, observing safety protocols, following predesignated routes, and limiting the distance the waste is transported. Truck traffic for equipment and materials, including approximately 7,000 yd^3 of contaminated soil taken off the site for disposal and on-site delivery of borrow material for backfilling, will occur. If a contaminated soil spill occurred during an accident, the spill would be easy to contain and would not likely impact the surrounding communities. During excavation of soils at the Sand Creek Site, control of surface runoff would be important to avoid releases of contamination to adjacent Sand Creek.

Some short-term risks to human health or the environment would exist during implementation of this alternative. The soil excavation activity has the potential to present transportation or construction accidents to the work site environment. Additionally, this alternative would involve potential short-term risks to workers associated with the operation of heavy equipment and potential exposure to contaminated soil during sampling activities. Air quality could be affected by the release of particulates during soil excavation. Air monitors would be used to measure dust emissions during construction activities. Engineering controls would be implemented to ensure emissions do not exceed levels that could pose a risk to human health. Implementation of a good health and safety program along with a migration control plan should minimize any risk associated with this alternative. Remediation workers would conform to the site health and safety program and would be equipped with the necessary PPE. A site-specific health and safety plan would be prepared prior to implementing this alternative.

Minor clearing and grubbing at the Sand Creek Site will be required to effectively excavate the soil. However, since these areas have been cleared in the past, it is unlikely that there are any sensitive species that would be impacted. If any sensitive areas were found, the appropriate regulation would be followed. The implementation of proper engineering controls would minimize the risk of environmental impacts.

The duration of the field work for this alternative is approximately 1 month to complete. The relatively short duration of remedial activities further reduces overall exposure risks to workers and the community from operations.

6.2.5.6 Implementability

This section is divided into three categories: technical feasibility, administrative feasibility, and availability of services and materials.

Technical Feasibility

Alternative 5 is technically implementable. Excavation is a common remedy used for contaminated soils and can be completed with little difficulty; however, because of the potential presence of MEC and MD at the site from historic activities, UXO technicians would need to be utilized in the construction operations, which would prolong the excavation. Excavation of impacted soils, construction of temporary roads, and waste handling are conventional activities in construction projects of this kind. Multiple disposal facilities are available that can accept generated waste. Construction and operation of the components of Alternative 5 would be straightforward with resources readily available to complete the remedial activity. Borrow sites for backfill and soil cover have not been selected, but are anticipated to be locally available.

The LUCs also are implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs, access controls, or cover material. The Sand Creek Site currently has access restrictions implemented at the AOC.

Careful planning would be needed between remedial action planners and the OHARNG to minimize disruptions and/or impacts to OHARNG operations during implementation. Access routes for heavy equipment to remediation areas would be selected to minimize the disruption. Additional steps would be taken to minimize hazards posed to facility personnel. This type of planning will increase the implementation difficulty of Alternative 5, but also will reduce the risks to facility personnel.

Administrative Feasibility

The acceptability of Alternative 5 would be affected by administrative requirements for transport and disposal and the requirements for Unrestricted Land Use at the Sand Creek Site. The engineering departments from the local communities would be consulted to evaluate the impact of the truck traffic on the roads surrounding the RVAAP.

Feasibility of Obtaining Services and Materials

Numerous vendors and contractors are available to complete the tasks involved in this remedy. The necessary labor and equipment required to delineate the excavation areas, perform the excavation activities are available. Clean fill is available in the volume required to replace the excavated material and restore the original surface grade. “Clean” backfill consists of on- or off-site soil that has passed the chemical and physical requirements in accordance with the RVAAP facility-wide plans. All backfill soil sources must be approved by the Ohio EPA prior to transport to the RVAAP and on-site use. Necessary services, equipment, and materials required for sampling during remediation activities and as part of the LTM program are also readily available.

6.2.5.7 Cost

The cost analysis is presented in **Appendix C**. Present worth costs use 30 years as a costing period, although the remedy may require monitoring, maintenance, and enforcement beyond this 30-year period. The total present worth cost for this alternative is estimated at $4,029,911. This estimated cost is comprised entirely of the capital cost, since not O&M activities will be required after implementation of the remedy.

6.2.5.8 Community Acceptance

This alternative has not yet been formally presented to the public for comment. This is a proposed final remedy for the Sand Creek Site and it is subject to public review and comment. There is a 30-day public comment period after submittal of the Proposed Plan. Responses to the public's comments will be prepared prior to the selection of the remedial action.

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7.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, the AOC-wide remedial alternatives described and analyzed in detail in previous sections are evaluated in relation to one another for seven of the nine evaluation criteria, defined in Section 6.1, in accordance with the NCP (40 CFR 300[e][9][ii]). State and community acceptance, the other two NCP criteria, are typically assessed in decision documents prepared by EPA based on public comment received after the FS is completed. The comparison of alternatives and evaluation criteria are summarized in **Table 7-1** at the end of this section.

7.1 Overall Protection of Human Health and the Environment

Alternative 1 will not reduce the short- or long-term risks for human or environmental receptors from potential exposure to the COCs in soils at the Sand Creek Site. Alternative 2 will reduce the short-term risks for human or environmental receptors from potential exposure to the COCs; however, there is no measured reduction in toxicity, mobility, or volume of the contaminated media under Alternative 2 and the long-term risk of migration and potential exposure is not reduced by the implementation of LUCs alone. Installation of a cap over the contaminated soils under Alternative 3 will be protective of long-term risk for human and environmental receptors by eliminating the potential mobility of COCs. The LUCs to be implemented as part of Alternative 3 will add to ensure the integrity and effectiveness of the remedy. Alternative 4 and Alternative 5 provide long-term protection of human health by removing the source of contamination from potential human exposure through ingestion, inhalation, or contact. These two alternatives also eliminate the mobility of COCs from the impacted soils; therefore, protecting environmental receptors from potential exposure to COC-impacted media. Implementing Alternative 5 will reduce the toxicity, mobility, and volume of the COCs and protect the Unrestricted Land Use receptors in the long term.

Alternative 2 and Alternative 3 result in restricted access for Military Training Land Use and Unrestricted Land Use receptors. Alternative 4 allows of the Sand Creek Site to be used for the Military Training Land Use but is restricted for Unrestricted Land Use. Alternative 5 allows for use of the Sand Creek Site for both the Military Training Land Use and Unrestricted Land Use scenarios. The LUCs that would be required for Alternatives 2 through 4 would be implemented through the RVAAP in concurrence with the Ohio EPA. These LUCs would provide protection of human health through LTM, the maintenance of AOC-perimeter fencing and warning signs, and institutional controls placed on the use of on-site soils. Short-term exposure risks will be mitigated through the use of best management practices, Occupational Safety and Health Administration training, and the use of appropriate PPE.

7.2 Compliance with ARARs

The ARARs are presented in **Appendix A**. Each alternative, except Alternative 1, could be designed and implemented to meet respective ARARs.

7.3 Long-Term Effectiveness and Permanence

Alternative 1 is rated low in terms of long-term effectiveness in preventing exposures or the spread of contamination. Alternative 1 does not involve any remedial actions or LUCs for potential future exposure. Alternative 2 utilizes LUCs and is considered moderately effective and permanent, since such controls can potentially fail. Alternative 2 is nonetheless considered more effective and permanent than Alternative 1 and is rated medium. The long-term effectiveness and permanence of Alternatives 3, 4, and 5 are considered high. Alternative 3 is considered highly permanent and effective, since this remedy eliminates potential exposure of human and environmental receptors to contaminated soils by consolidation, placement of a cap, and application of LUCs. Alternatives 4 and 5 are highly permanent and effective, since these alternatives involve the removal of AOC contamination and achievement of remediation goals for the Military Training Land Use and the Unrestricted Land Use scenarios, respectively. Alternative 5 provides the greatest long-term effectiveness and permanence, since it allows for Unrestricted Land Use at the Sand Creek Site.

7.4 Reduction of Toxicity, Mobility, or Volume

None of the remedial alternatives include treatment as a principal element; therefore, the ability of any of the alternatives to reduce contaminant toxicity, mobility, or volume is low.

7.5 Short-Term Effectiveness

No additional short-term risks to the community are associated with Alternatives 1 and 2, since no remediation activities are conducted for these alternatives. Correspondingly no transportation risks, potential for worker exposure, or short-term risks to the community beyond baseline conditions are associated with these alternatives. Therefore, Alternatives 1 and 2 are rated high. The short-term effectiveness of Alternatives 3, 4, and 5 is affected by potential accidents from the use of heavy equipment and transportation vehicles required to implement the remedies. The potential exposures to impacted soils during the remedy implementations also present short-term risks to on-site workers. Although mitigation measures would be implemented to reduce or eliminate these risks/exposures, this alternative is assigned a medium rating for Alternatives 3, 4, and 5.

7.6 Implementability

All alternatives are considered implementable on a technical and availability-of-services basis. Alternative 1 is a No Action alternative and is rated high. Alternative 2 involves implementing LUCs at the Sand Creek Site. Since the RVAAP currently has facility-wide LUCs in effect, implementing and maintaining additional AOC-specific LUCs should not be difficult. Consequently, Alternative 2 is also rated highly. Installation of a GCL cover at the site under Alternative 3 and soil removal and disposal under Alternatives 4 and 5 should also be readily implementable but not as easily as Alternatives 1 and 2. Therefore, Alternatives 3, 4, and 5 are assigned a medium rating.

7.7 Cost

The cost analysis for the alternatives is presented in **Appendix C**. Alternative 1 does not have capital or O&M costs. The capital costs for Alternative 2 has the lowest capital costs. The capital costs for Alternative 3 are the next highest and are lower than the capital costs for Alternatives 4 and 5, since there are no off-site disposal costs or transportation fees. Although, the proposed remedies under Alternatives 4 and 5 are similar (i.e., excavation and off-site disposal), the capital costs for Alternative 5 are higher than compared to Alternative 4, since Alternative 5 requires the excavation of 4,800 yd^3 of soils than for Alternative 4 in order to meet the remediation goals for Unrestricted Land Use. The additional cost associated with the Alternative 5 will eventually be mitigated, since the lifespan of this alternative is only a few months compared to the LUCs, O&M activities, and Five-Year Reviews that will be to be required to be implemented for Alternative 4 in perpetuity.

7.8 State Acceptance

State acceptance considers comments received from agencies of the State of Ohio on the remedial alternatives being considered. For the process supporting remedy of the Sand Creek Site, the Ohio EPA is the lead regulatory agency and this FS has been prepared in consultation with the Ohio EPA. The Ohio EPA has provided input during the ongoing investigation and report development process to ensure the remedy ultimately selected for the Sand Creek Site, meets the needs of the State of Ohio and fulfills the requirements of the *Director's Final Findings and Orders (DFFO) for RVAAP* (Ohio EPA, 2004). Comments will be solicited from the Ohio EPA on the FS and on the Proposed Plan. The U.S. Army will obtain Ohio EPA concurrence prior to the final selection of the remedy for Sand Creek Site.

7.9 Community Acceptance

Community acceptance considers comments provided by the community on the remedial alternatives being considered. CERCLA 42 USC 9617(a) emphasizes early, constant, and responsive community relations. The U.S. Army has prepared a Community Relations Plan

(USACE, 2003b) for this project to ensure the public has convenient access to information regarding project progress. The community relations program interacts with the public through news releases, public meetings, public workshops, and Restoration Advisory Board meetings with local officials, interest groups, and the general public. The public also is provided the opportunity to comment on draft documents submitted to the Administrative Record that support remedy of Sand Creek Site, including the previously completed Phase I RI Report (Shaw, 2013) and this FS.

7.10 Recommended Alternative

Based on the evaluation of alternatives, Alternative 4 is chosen as the remedy for the Sand Creek Site because it will protect human health and the environment, complies with ARARs, and is the most cost effective alternative with regards to the actual anticipated future land use. Although the proposed remedy does not allow for the AOC to be used for Unrestricted Land Use, the recommended alternative is protective of the Military Training Land Use receptors. LUCs will include LTM and O&M to evaluate the effectiveness of the remedy and to ensure that in situ contamination is not migrating from the AOC.

The institutional controls required by this remedy will include LTM of groundwater. If COC concentrations are shown through monitoring, a HHRA could be conducted to determine if the groundwater poses any unacceptable risks. Additionally, there is currently no use of shallow groundwater in the area and the future use of shallow groundwater at the site as a potable source is highly unlikely because potable water at the RVAAP locations near the Sand Creek Site is from a municipal water source provided by the Village of Windham. There is currently no existing data for groundwater, however, the COCs identified in surface and subsurface soil are highly immobile and the subsurface conditions consists primarily of dense clay that will likely limit the ability of the COCs to substantially migrate and impact groundwater beneath the AOC.

Table 7-1
Comparative Analysis of Remedial Action Alternatives for the Sand Creek Site

	Remedial Alternatives				
	1	**2**	**3**	**4**	**5**
Evaluation Criteria	**No Action**	**LUCs**	**Containment with LUCs**	**Excavation, Off-Site Disposal, and LUCs (Military Training Land Use)**	**Excavation and Off-Site Disposal (Unrestricted Land Use)**
Protective of Human Health and Environment	No	Yes	Yes	Yes	Yes
Complies with ARARs	No	Yes	Yes	Yes	Yes
Effective and Permanent	No	No	Yes	Yes	Yes
Reduces Toxicity, Mobility, or Volume	None (no treatment)				
Short-Term Effectiveness	Unacceptable	Acceptable	Acceptable	Acceptable	Acceptable
Implementable	Yes	Yes	Yes	Yes	Yes
Costs					
Capital	$0	$215,127	$671,833	$2,203,734	$4,029,911
Nondiscounted O&M	$0	$1,742,294	$1,471,273	$1,743,671	$0
Total Present Worth	$0	$1,661,109	$2,629,922	$2,809,095	$4,029,911

ARAR denotes applicable or relevant and appropriate requirement.
LUC denotes Land Use Control.
O&M denotes operation and maintenance.

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Appendix A
Applicable or Relevant Appropriate Requirements Tables

Table A-1
Cleanup Goals for the National Guard Trainee

COC Targeted for Remediation	Unit	Deep Surface Soil (0 to 4 feet bgs)			Subsurface Soil (4 to 7 feet bgs)		
		Non-Cancer Risk HI = 1	Cancer Risk Risk = 10^{-5}	Background	Non-Cancer Risk HI = 1	Cancer Risk Risk = 10^{-5}	Background
Inorganics							
Arsenic	mg/kg	1,140	27.8	15.4	1,140	27.8	15.4
Lead	mg/kg			19.1	400*	--	19.1
Semivolatile Organic Compounds							
Benzo(a)pyrene	mg/kg	--	4.77	NA			NA
Benzo(b)fluoranthene	mg/kg	--	47.7	NA			NA

Cleanup goals taken from the Final Facility Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (SAIC, 2010)
Shaded cells indicate that the COC is not targeted for remediation at that depth interval
**non-cancer risk cleanup goal at HI = 1.0 for lead taken from the Regional Screening Levels Tables (EPA, 2012)*
-- denotes no cleanup goal could be quantified based on lack of approved toxicity value
bgs denotes below ground surface
COC denotes chemical of concern
HI denotes hazard index
mg/kg denotes milligrams per kilogram
NA denotes a background value has not been calculated.

Table A-2
Cleanup Goals for the Resident (Adult and Child) Receptors

COC Targeted for Remediation	Unit	Surface Soil (0 to 1 foot bgs)			Subsurface Soil (1 to 13 feet bgs)		
		Non-Cancer Risk HI = 1	Cancer Risk Risk = 10^{-5}	Background	Non-Cancer Risk HI = 1	Cancer Risk Risk = 10^{-5}	Background
Inorganics							
Antimony	mg/kg	28.2	--	0.96			0.96
Arsenic	mg/kg	82.1	4.25	15.4	82.1	4.25	19.8
Lead	mg/kg			26.1	400*	--	19.1
Silver	mg/kg	386	--	0			0
Mercury	mg/kg	22.7	--	0.036	22.7	--	0.044
Semivolatile Organic Compounds							
Benzo(a)anthracene	mg/kg	--	2.21	NA			NA
Benzo(a)pyrene	mg/kg	--	0.221	NA	--	0.221	NA
Benzo(b)fluoranthene	mg/kg	--	2.21	NA	--	2.21	NA
Dibenzo(a,h)anthracene	mg/kg	--	0.221	NA			NA

Cleanup goals taken from the Final Facility Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (SAIC, 2010) unless otherwise denoted.
Shaded cells indicate that the COC is not targeted for remediation at that depth interval
**non-cancer risk cleanup goal at HI = 1.0 for lead taken from the Regional Screening Levels Tables (EPA, 2012)*
-- denotes no cleanup goal could be quantified based on lack of approved toxicity value
bgs denotes below ground surface
COC denotes chemical of concern
HI denotes hazard index
mg/kg denotes milligrams per kilogram
NA denotes a background value has not been calculated.

Table A-3
Potential Action-Specific ARARs and TBC Guidance

Action	Requirements	Prerequisite	Citation(s)
General Construction Standards—Site Preparation and Excavation			
Activities resulting in the emission of particulate matter, dusts, fumes, gas, mists, smoke, etc. from a hazardous waste facility	No owner/operator of a hazardous waste facility shall cause or allow the emission of any particulate matter, dusts, gas, fumes, mists, smoke, vapor, or odorous substances that interferes with the enjoyment of life or property by persons living or working in the vicinity of the facility. Any such action is considered a public nuisance.	Applicable to soil excavation at ODA1	ORC 3734.02(I) OAC 3745-15-07(A)
Activities Causing Fugitive Dust Emissions	Persons engaged in construction activities shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions include, but are not limited to, the following: • the use of water or chemicals for control of dust during construction operations or clearing of land; and • the application of asphalt, oil, water, or suitable chemicals on dirt roads, materials stockpiles, and other surfaces, which can create airborne dusts. No person shall cause, or allow, fugitive dust to be emitted in such a manner that visible emissions are produced beyond the property line.	Applicable to fugitive emissions from demolition of existing structures, construction operations, grading of roads, or the clearing of land. Applicable to pre-construction clearing activities and excavation activities.	OAC 3745-17-08(B)
Construction Activities Causing Storm Water Runoff (e.g., clearing, grading, and excavation)	Construction activities disturbing more than 1 acre must develop and implement a storm water pollution prevention plan incorporating best management practices (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the requirements of the Ohio EPA General Permit for Construction Activities (Permit ORC 000002). An NOI shall be submitted 21 days prior to initiation of the construction activity.	Applicable to stormwater discharges from land disturbances from a construction activity involving more than 1 acre. NOI must be submitted pursuant to DERR-OO-RR-034, which indicates that no permit exemption equivalent to CERCLA Section 121(e) is available for non-NPL sites.	40 CFR 122.26 OAC 3745-38-06

Action	Requirements	Prerequisite	Citation(s)
Removal of Contaminated Soils			
Removal or Remediation of Hazardous-contaminated Soils	The GDCS may apply to any property except for certain circumstances specified in OAC 3745-30008(B)(1). Property-specific risk-based standards must be determined in place of or in addition to the GDCS if: (l) the exposure pathways or exposure factors for the intended land use are not included in the development of the GDCS for residential, commercial, or industrial scenarios; (2) the chemicals of concern at the property are not included in the GDCS; (3) radioactive materials are identified on the property; (4) PCBs subject to TSCA are identified on the property; or (5) important ecological resources are identified on the property.	The GDCS are not applicable to soil at ODA1 because the action is not under the VAP. The GDCS are not re1evant and appropriate because the exposure scenarios for the intended land use are not considered in the development of the GDCS and certain chemicals of concern are not included in OAC 3745-30008(B)(3). Property-specific risk-based clean-up standards will be developed in accordance with CERCLA methodology.	OAC 3745-300-08(B)(1) OAC 3745-300-09(B)(2)
	No person shall engage in filling, grading, excavating, drilling, or mining on land where a hazardous waste or solid waste facility was operated without prior authorization from the director of the Ohio EPA.	Not applicable to HTRW excavation activities at ODA1. MEC activities are covered under the Administrative Orders and are therefore exempt from OAC 3745-27-13. See OAC 3745-27.13(C).	ORC 3734.02(H) OAC 3745-27-13(C)
Waste Generation, Characterization, Segregation, and Storage-Excavated Soils and Buried Wastes, Sludge, Surface Features, Debris, and Secondary Wastes			
Generation and Characterization of Solid Waste (all primary and secondary wastes)	The generator must determine if the material is a solid waste, as defined in 40 CFR 261.2 and 40 CFR 261.4(a). if the material is a solid waste, the generator must determine if the solid waste is a hazardous waste by:	Applicable to generation of a solid waste as defined in 40 CFR 261.2 and that is not excluded under 40 CFR 261.4(a).	40 CFR 262.11(a)(b)(c) OAC 3745-52-11(A)(B)(C)(D)

Action	Requirements	Prerequisite	Citation(s)
	• determining if the waste is listed under 40 CFR Part 261; or • determining if the waste exhibits characteristics by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used; and • determining if the waste is excluded under 40 CFR Parts 261, 262, 266, 268, and 273	Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Process history indicates that soils were contaminated with metals and explosives from OB/OD operations. Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Applicable to generation of decontamination wastewater.	40 CFR 262.11(a)(b)(c) OAC 3745-52-11(A)(B)(C)(D) 40 CFR 262.II(a)(b)(c) OAC 3745-52-11(A)(B)(C)(D)
	The generator must determine if the waste is restricted from land disposal under 40 CFR 268 et seq. by testing in accordance with prescribed methods or use of generator knowledge of waste.	Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Applicable to generation of decontamination wastewater.	40 CFR 268.7 OAC 3745-270-07
	The generator must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40, Subpart D.	Applicable to the generation and characterization of hazardous-contaminated soil and hazardous debris resulting from excavation. Applicable to generation of decontamination wastewater.	40 CFR 268.9(a) OAC 3745-270-07 OAC 3745-270-09
	The generator must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the waste.	Applicable to the generation and characterization of RCRA characteristic hazardous waste (except D00I non-wastewaters treated by combustion, recovery of organics, or polymerization. See 268.42, Table I) and to hazardous-contaminated soils for their subsequent storage, treatment, or disposal.	40 CFR 268.9(a) OAC 3745-270-09

Action	Requirements	Prerequisite	Citation(s)
Accumulation of Hazardous Debris from Excavation and Screening. It is Assumed that any Debris Resulting from Excavation and Screening will be Accumulated for < 90 Days	A generator may accumulate for up to 90 days or conduct treatment of hazardous wastes in containers without an Ohio EPA permit. Generators that accumulate for 90 days or conduct on-site treatment of hazardous waste in containers must comply with the personnel training, preparedness and prevention requirements, and contingency plan requirements of 40 CFR 265.16; 40 CFR 265, Subpart C; and 40 CFR 265, Subpart D, respectively.	Applicable to 90-day accumulation of debris from excavation and screening if such debris contains listed wastes or exhibits a characteristic.	40 CFR 262.34(a)(4) OAC 3745-52-34(A)(4)
	Containers must be marked with the date upon which period of accumulation began and with the words "Hazardous Waste."	Applicable to 90-day accumulation of debris from excavation and screening if such debris contains listed wastes or exhibits a characteristic.	40 CFR 262.34 (a)(2)(3) OAC 3745-52-34 (A)(2)(3)
	Containers holding hazardous wastes must be kept closed except to add or remove wastes and must not be managed in a manner that would cause them to leak.	Applicable to 90-day accumulation of debris from excavation and screening if such debris contains listed wastes or exhibits a characteristic.	40 CFR 264.171 40 CFR 264.172 40 CFR 264.173 40 CFR 264.176 40 CFR 264.17 OAC 3745-52-34(A)(1)
	Containers of hazardous waste must be maintained in good condition and comparable with the waste stored therein. Containers holding ignitable or reactive wastes must be separated from potential ignition sources and located 50 ft from the property boundary.		

Action	Requirements	Prerequisite	Citation(s)
Storage of Hazardous-contaminated Soil in a Waste Pile	Submission of Parts A and B of the RCRA Permit Application is required for owners/operators of any Hazardous Waste Management Unit. Specific submission requirements are provided at 40 CFR 270.13 and 270.14.	Applicable to storage of soils from excavation if the soils are hazardous per the toxicity characteristic. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121(e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders).	40 CFR 270.13 40 CFR 270.14 40 CFR 270.18 OAC 3745-50-44 OAC 3745-50-44(C)(4)
	Owners/operators of hazardous waste management facilities must comply with the General Facility Standards of 40 CFR 264, Subpart B concerning waste analysis, site security, inspection/maintenance, personnel training, special precautions for management of ignitable or reactive wastes, and locations standards.	Applicable to storage of soils from excavation if the soils are hazardous per the toxicity characteristic. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121(e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders).	40 CFR 264.13 to 40 CFR 264.18 OAC 3745-54-13 to OAC 3745-54-18
	Owners/operators of hazardous waste management facilities must comply with the Preparedness Standards of 40 CFR 264, Subpart C concerning alarms, communication systems, notification of local authorities, testing and maintenance of spill control and emergency response equipment, and aisle space.	Applicable to storage of soils from excavation if the soils are hazardous per the toxicity characteristic. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121 (e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders).	40 CFR 264.31 to 40 CFR 264.38 OAC 3745-54-31 to OAC 3745-54-37

Action	Requirements	Prerequisite	Citation(s)
	Owners/operators of hazardous waste management facilities must comply with the Preparedness Standards of 40 CFR 264, Subpart D concerning development of a written contingency plan that designates the emergency coordinator, describes emergency and evacuation procedures, and identifies the emergency equipment to be maintained. Copies of the plan must be submitted to local authorities that would respond in the event of an emergency.	Applicable to storage of soils from excavation if the soils contain listed wastes K044 through K047 or exhibit the TC. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121(e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders).	40 CFR 264.50 to 40 CFR 264.56 OAC 3745-54-52 to OAC 3745-54-56
	Owners/operators of hazardous waste management facilities must comply with the Recordkeeping Standards of 40 CFR 264, Subpart E concerning maintenance of the operating record, manifest files, contingency plan, and closure plan.	Applicable to storage of soils from excavation if the soils are hazardous per the toxicity characteristic. Not ARAR if the soils do not contain a hazardous waste. There is no state equivalent to the permit exemption provided by CERCLA Section 121(e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders).	40 CFR 264.70 to 40 CFR 264.77 OAC 3745-54- 73 to OAC 3745-54-77

Action	Requirements	Prerequisite	Citation(s)
	Owners/Operators of waste piles must implement a groundwater monitoring program in accordance with 40 CFR 264, Subpart F unless the unit is an engineered structure that does not receive liquid wastes or wastes containing free liquids and is designed to exclude precipitation and run-on/runoff. The unit must also have inner and outer layers of containment. Waste piles that are inside or under a structure that prevents wind dispersal and protects the pile from contact with precipitation or run-on are exempt from groundwater monitoring. Owners/Operators of waste piles must implement a groundwater monitoring program in accordance	Applicable to storage of soils from excavation if the soils are hazardous per the toxicity characteristic. Provisions for groundwater monitoring are not considered relevant and appropriate to the operation of the waste piles if the soils do not contain hazardous wastes due to the limited nature of the action. There is no state equivalent to the permit exemption provided by CERCLA Section 121(e). It is the DERR's policy to require responsible parties to acquire and comply with all permits required by the action (unless permit exception is provided for by the orders).	40 CFR 264.90 to 40 CFR 264.100 OAC 3745-54-90 to OAC 3745-54-99 OAC 3745-55-01
	Upon closure of a hazardous waste management unit the owner/operator must comply with the general closure performance standard.	Closure must be conducted in a manner that minimizes the need for further maintenance and controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground, to surface waters, or to the atmosphere. Applicable to waste piles used to store soils that contain hazardous wastes. Relevant and appropriate to waste piles that manage soils not containing hazardous wastes.	40 CFR 264.111 OAC 3745-55-11

Action	Requirements	Prerequisite	Citation(s)
Storage of Hazardous-contaminated soil in a Waste Pile	Waste piles must have a liner that is designed, constructed, and installed to prevent any migration of wastes out of the pile into the adjacent subsurface soils or groundwater.	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils.	40 CFR 264.251 OAC 3745-56-51
	Waste piles must have a liner constructed of materials that have appropriate chemical properties and sufficient strength to prevent failures due to pressure gradients, contact with the waste, climatic conditions, and the stress of daily operation.	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils.	40 CFR 264.251 OAC 3745-56-51
	Waste piles must be placed upon a base or foundation capable of supporting the liner and preventing failure of the liner due to settlement, compression, or uplift. Liners must be installed to cover all surrounding earth likely to contact the waste or leachate.	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils.	40 CFR 264.251 OAC 3745-56-51
	Waste piles must be designed, constructed, and installed with a top liner (such as a geomembrane) that prevents migration of hazardous constituents into the liner and a bottom composite liner with a lower component constructed of at least 3 ft of compacted soil with a hydraulic conductivity of <10-7 cm/sec.	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils.	40 CFR 264.251 OAC 3745-56-51

Action	Requirements	Prerequisite	Citation(s)
	Waste piles must be designed, constructed, and installed with a leachate collection and removal system between the liners that has a bottom slope of 1 % and is constructed of granular drainage material with a thickness of > 12 in. and a hydraulic conductivity > 10-2 cm/sec. The leachate-collection system shall be chemically compatible with the wastes and leachate. The leachate-collection system shall be designed to minimize clogging. The leachate-collection system shall be constructed with sumps and liquid removal systems that ensure that the leachate depth over the liner does not exceed 12 in.	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils.	40 CFR 264.251 OAC 3745-56-51
	Waste piles must be designed, constructed, and operated with a run-on control system with a capacity to control the water volume from a 24-hr, 25-year storm event.	Applicable to storage of hazardous-contaminated soils in waste piles, if the wastes contain free liquid or generate leachate and are not protected from wind disposal and surface water run-on. Potentially relevant and appropriate if excavated soils are determined to not contain listed wastes or exhibit the TC soils.	40 CFR 264.251 OAC 3745-56-51
	Waste piles that are inside or under a structure that provides protection from precipitation, run-on, and wind dispersal, and that holds wastes that do not contain free liquids or generate leachate, are not required to meet the liner and leachate collection system requirements or the groundwater monitoring provisions of 40 CFR 264, Subpart F.	Applicable to waste piles that are engineered to be protected from precipitation, run-on, and wind dispersal where the wastes do not contain any free liquids and that store soils from excavation or construction and development of injection/monitoring wells.	40 CFR 264.250 40 CFR 264.90(b)(5)

Action	Requirements	Prerequisite	Citation(s)
	During construction, liners and cover system components must be inspected for uniformity, damage, or imperfections. During operation, a waste pile must be inspected weekly and after storms to detect signs of deterioration or improper operation of the run-on/run-off control systems, wind dispersal control systems, and leachate collection system. The volume of liquids collected from the leak detection system must be recorded weekly.	Applicable to waste piles used to store soils that contain hazardous wastes. Relevant and appropriate to waste piles that manage soils not containing hazardous wastes.	40 CFR 264.254 OAC 3745-56-54
Placement of Hazardous-contaminated Soil in a Waste Pile	A prohibited waste may be land-disposed only if it meets the treatment standards of 40 CFR 268, Subpart D.	Applicable to land disposal of hazardous wastes and hazardous debris by placement in a waste pile constituting land disposal by 40 CFR 268.2.	40 CFR 268.7 OAC 3745-270-40
	Hazardous-contaminated soils must be treated according to the alternative treatment standards of 40 CFR 268.49(c) or according to the UTSs specified in 40 CFR 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Applicable to placement of soils that contain listed wastes or exhibit the TC in a waste pile.	40 CFR 268.49 (b) OAC 3745-270-49
	Unless the wastes will be placed in a CAMU for storage and/or treatment only, CAMU-eligible wastes that have been determined to contain principal hazardous constituents must be treated to the following standards: • for non-metals, 90% reduction in total principal hazardous constituent; and • for metals, 90% reduction in principal hazardous constituent concentration as measured in the leachate by TCLP analysis.	Applicable to hazardous-contaminated soils replaced within the excavation with the excavation designated as a CAMU for purposes other than storage or treatment. Note that Ohio EPA has proposed to adopt these conforming changes to the CAMU rules but that the rule changes are not finalized.	40 CFR 264.552(e)(4)

Action	Requirements	Prerequisite	Citation(s)
	Groundwater monitoring that is sufficient to continue to detect and characterize the nature, direction, and movement of existing releases of hazardous constituents in groundwater must be conducted during operation. In addition, the groundwater monitoring must be able to detect and subsequently characterize releases of hazardous constituents to groundwater that may occur from areas of the CAMU in which wastes will remain in place after closure of the CAMU.	Not applicable to replacement of excavated soils because such soils will be returned to the excavation only if RGOs are met.	40 CFR 264.552(e)(5) 40 CFR 264.552(g)
	The owner/operator must conduct daily inspections of the aboveground portions of the tank system, monitoring and leak detection system data, and the secondary containment.	Potentially relevant and appropriate to wastewater that is determined to contain listed wastes or exhibits the TC and that is returned to the ground. Wastewater from RI activities has not exhibited the TC. It is expected that wastewater would be determined to not contain listed wastes. Therefore, these requirements are likely not applicable or relevant and appropriate.	40 CFR 264.195 OAC 3745.55.95
	Temporary tanks used to store hazardous remediation wastes may be designated as temporary units. The temporary unit must be located within the contiguous property under the control of the owner/operator where the waste was generated. For temporary units, the Ohio EPA Administrator may replace the design, operating, and closure standards of 40 CFR 264 with alternative requirements that are protective of human health and the environment. Temporary units are authorized to operate for up to 1 year.	Potentially applicable to storage of hazardous wastewaters prior to application to the soils returned to CFR 264.553(d) the excavation. Allows temporary storage without berms to meet all technical standards for permitted units. Designation of the tank as a temporary unit is achieved by permit or within the provision of the orders.	40 CFR 264.553(a) 40 CFR 264.553(d) OAC 3745.57-73

Action	Requirements	Prerequisite	Citation(s)
	The requirements for hazardous waste tank systems of 40 CFR 264, Subpart J do not apply to tanks that store or treat hazardous wastewaters that are part of a wastewater treatment facility subject to Section 402 or 307(b) of the CWA.	Applicable to tank systems that store or treat hazardous wastewaters prior to discharge to a POTW or surface water under Sections 307 or 402 of the CWA.	40 CFR 264.1(g)(c)
Off-site Disposal of Waste-Excavated Soils, Debris, and Secondary Wastes			
Disposal of RCRA-Hazardous Waste in a Land- based Unit (i.e., lead, other debris, and soils exhibiting the TC or that contain listed waste)	RCRA-restricted waste may be land-disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Applicable to land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste. Applicable to disposal of exhumed hazardous wastes (i.e., soils and water from excavation and injection/monitoring well installation that exhibit a hazardous waste characteristic).	40 CFR 268.40(a)
	Hazardous debris may be land-disposed if it meets the requirements in the table "Alternative Treatment Standards for Hazardous Debris" at 40 CFR 268.45 before land disposal or the debris is treated to the waste-specific treatment standard provided in 40 CFR 268.40 for the waste contaminating the debris.	Applicable to land disposal, as defined in 40 CFR 268.2, of restricted RCRA-hazardous Debris.	40 CFR 268.45(a)
	Hazardous-contaminated soils must be treated according to the alternative treatment standards of 40 CFR 268.49 (c) or according to the UTSs specified in 40 CFR 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Applicable to land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils.	40 CFR 268.49(b) OAC 3745-270-49
Off-site Shipment of Hazardous Wastes, Debris, or Hazardous-contaminated Soils	A generator who transports or offers hazardous wastes for off-site transport must prepare a Uniform Hazardous Waste Manifest.	Applicable to the offsite shipment of soils or wastewater that contain listed wastes or that exhibit the TC.	40 CFR 262.20 OAC 3745-52-20
	Before transporting or offering a hazardous waste for transport, the generator must package the waste, label the package, and placard the carrier in accordance with DOT requirements.	Applicable to the off-site shipment of soils or wastewater that contain listed wastes or that exhibit the TC.	40 CFR 262.30 to 40 CFR 262.33 OAC 3745-52-30 to OAC 3745-52-33

Action	Requirements	Prerequisite	Citation(s)
	Prior to sale, lease, or transfer of the property from DOD control, a notation to the deed must be recorded that indicates that the property has been used as a disposal facility and that its use is restricted in accordance with the approved closure/post-closure plan.	Applicable to transfer of a solid waste disposal facility. CFR 264.119	40OAC 3745-55-19
Hazardous Waste, On-Site Capping of Soils, Landfill Disposal			
On-site Hazardous Waste Land Disposal Facilities.	Establishes the substantive hazardous waste land disposal permit requirements necessary for Ohio EPA to determine adequate protection of the groundwater. Includes information such as groundwater monitoring data, information on interconnected aquifers, plume(s) of contamination, plans and reports on groundwater monitoring program.	Pertains to any facility/site which will have hazardous waste disposed of on-site or has existing areas of hazardous waste contamination on-site that will be capped in-place. This, along with other paragraphs of this rule, establishes the minimum information required during the remedial design stage.	OAC 3745-50-44 (8)
Construction of On-site Sanitary Landfills	Specifies the minimum technical information required of a solid waste permit to install included are a hydrogeologic investigation report, leachate production and migration information, surface water discharge information, design calculations, plan drawings.	Pertains to any new solid waste disposal facility created on-site and expansions of existing solid waste landfills. Also pertains to existing areas of contamination that are capped per solid waste rules. This rule establishes the minimum information required during the remedial design stage.	OAC 3745-27-06 (b,c)
	Specifies the minimum requirements for the soil/clay layers, granular drainage layer, geosynthetics, leachate management system, gas monitoring system, etc. Also establishes construction requirements for facilities to be located in geologically unfavorable areas.	Pertains to any new solid waste disposal facility created on-site and any expansions to existing solid waste landfills. Portions also pertain to areas of contamination that are capped per solid waste rules. May serve as siting criteria	OAC 3745-27-08 (c,d-h)

Action	Requirements	Prerequisite	Citation(s)
Sanitary Landfill- GW Monitoring and Correction	Groundwater monitoring program must be established for all sanitary landfill facilities. The system must consist of a sufficient number of wells that are located so that samples indicate both upgradient (i.e., background) and downgradient water samples. The system must be designed per the minimum requirements specified in this rule. The sampling and analysis procedures used must comply with this rule. Specifies procedures for assessment and correction of contamination.	Pertains to any new solid waste facility and any expansions of existing solid waste landfills on-site. Also may pertain to existing areas of contamination that are capped in-place per the solid waste rules.	OAC 3745-27-10 (b,c,d,e,f)
Final Closure of Sanitary Landfill Facilities	Requires closure of a landfill in a manner which minimized the need for post-closure maintenance and minimizes post-closure formation and release of leachate and explosive gases to air, soil, groundwater, or surface water. Specifies acceptable cap design; soil barrier layer, granular drainage layer, soil and vegetative layer. Provides for use of comparable materials to those specified with approval of director.	Pertain to any new solid waste landfills created on-site, any expansions of existing solid waste landfills on-site, and any existing areas of contamination that are capped in-place per the solid waste rules	OAC 3745-27-11 (b,g)

ARAR denotes Applicable or Relevant and Appropriate Requirements.
CAMU denotes Corrective Action Management Units.
CERCLA denotes Comprehensive Environmental Response, Compensation, and Liability Act.
CFR denotes Code of Federal Regulations.
CWA denotes Clean Water Act.
DERR denotes Division of Emergency and Remedial Response.
DOD denotes U.S. Department of Defense.
DOT denotes U.S. Department of Transportation.
EPA denotes U.S. Environmental Protection Agency.
GDCS denotes General Direct Contact Soil Standards.
HTRW denotes Hazardous, Toxic, and Radiological Waste.
MEC denotes munitions and explosives of concern.
NOI denotes Notice of Intent.
NPL denotes National Priorities List.
OAC denotes Ohio Administrative Code.
OB/OD denotes open burn/open detonation.
ODA1 denotes Open Demolition Area #1 area of concern.
Ohio EPA denotes Ohio Environmental Protection Agency.
ORC denotes Ohio Revised Code.
PCB denotes polychlorinated biphenyls.
POTW denotes publicly owned treatment works.
RCRA denotes Resource Conservation and Recovery Act.
RGO denotes Remedial Goal Options.
RI denotes remedial investigation.
TBC denotes to be considered.
TC denotes toxicity characteristic.
TCLP denotes toxicity characteristic leaching procedure.
TSCA denotes Toxic Substances Cleanup Act.

Table A-4
Potential Location-Specific ARARs and TBC Guidance

Action	Requirements	Prerequisite	Citation(s)
Wetlands			
Waters of the State, as Defined in ORC 6111.01	Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.	Not Applicable: No active remediation will occur in wetlands; no wetlands occur at the site	40 CFR 230.10(a)
	No discharge of dredged or fill material shall be permitted if it: (1) Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard; (2) Violates any applicable toxic effluent standard or prohibition under section 307 of the Act.	Not Applicable: No active remediation will occur in wetlands; no wetlands occur at the site.	40 CFR 230.10(b)
	Pollution of waters of the state is prohibited. Duty to comply.	Not Applicable: No active remediation will occur in wetlands; no wetlands occur at the site. No discharge to surface water.	ORC 6111.04 and ORC 6111.07
T&E Species			
Threatened and Endangered Species	Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented.	Not Applicable: There are currently no federally listed species or critical habitat on the facility. There are a few species currently under federal observation for listing, but none listed. State-listed species have been confirmed to be present on RVAAP/Camp Ravenna property through biological and confirmed sightings (AMEC, 2008). The site has not been previously surveyed for rare species. There are no known documented sightings of rare or threatened and endangered species at the site.	Endangered Species Act of 1973 (16 U.S.C, §§ 1531-1543)

Action	Requirements	Prerequisite	Citation(s)
	Protects almost all species of native migratory birds in the U.S. from unregulated "take," which can include poisoning at hazardous waste sites.	Not Applicable: There are currently no federally listed species or critical habitat on the facility. There are a few species currently under federal observation for listing, but none listed. State-listed species have been confirmed to be present on RVAAP/Camp Ravenna property through biological and confirmed sightings (AMEC, 2008). The site has not been previously surveyed for rare species. There are no known documented sightings of rare or threatened and endangered species at the site.	Migratory Bird Treaty Act of 1972 (16 U.S.C. §§ 703–712)
	Accords protection to species of wildlife within the state which may be found to be in jeopardy. Prohibits the taking, possession, transportation or sale of endangered species.	Relevant and Appropriate: Several state-listed species have been observed at RVAAP. There are no known documented sightings of rare or threatened and endangered species at the site.	Endangered Species Conservation Act RSA 212-A
	Prohibits removal or destruction of endangered animal species.	Relevant and Appropriate: There are no known documented sightings of rare or threatened and endangered species at the site.	ORC 1531.25 and OAC 1501-31-23
	Accords protection to plant species in the State which are threatened by the loss, drastic modification or severe curtailment of their habitants.	Relevant and Appropriate: Several state-listed species have been observed at RVAAP. There are no known documented sightings of rare or threatened and endangered species at the site.	Native Plant Protection RSA 217-A
	Prohibits removal or destruction of endangered plant species.	Relevant and Appropriate: No endangered plant species have been documented at ODA1.	ORC 1518.02 and OAC 1501-18-1

Table A-4 (continued)
Potential Location-Specific ARARs and TBC Guidance

ARAR denotes Applicable or Relevant and Appropriate Requirements.
CFR denotes Code of Federal Regulations.
TBC denotes to be considered.
OAC denotes Ohio Administrative Code.
ODA1 denotes Open Demolition Area #1 area of concern.
ORC denotes Ohio Revised Code.
RSA denotes Revised Statutes Annotated.
RVAAP denotes Ravenna Army Ammunition Plant.
U.S.C. denotes United States Code.

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Appendix B
Soil Removal Volume Calculations

Table B-1
Estimated Volume of Impacted Soils for the National Guard Trainee

Sampling Unit Location	Area (acres)	Area (ft^2)	Depth (ft)	In Situ		In Situ Constructability[a]		Ex Situ[a,b]	
				Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
SCss-058	0.037	1,612	4	6,447	239	8,059	298	9,670	358
SCss-059	0.028	1,220	4	4,879	181	6,098	226	7,318	271
SCss-060	0.024	1,045	4	4,182	155	5,227	194	6,273	232
SCss-061	0.030	1,307	4	5,227	194	6,534	242	7,841	290
SCss-062	0.046	2,004	1	2,004	74	2,505	93	3,006	111
SCss-063	0.114	4,966	4	19,863	736	24,829	920	29,795	1,104
SCss-065	0.250	10,890	1	10,890	403	13,613	504	16,335	605
SCss-073	0.250	10,890	1	10,890	403	13,613	504	16,335	605
SCss-074	0.385	16,771	1	16,771	621	20,963	776	25,156	932
SCsb-037*	0.007	305	7	2,134	79	2,668	99	3,202	119
			Total:	**83,287**	**3,085**	**104,108**	**3,856**	**124,930**	**4,627**

*Excavation volume around soil boring SCsb-037 assumes a 20-foot radius at a maximum depth of 7 feet bgs.

[a] Includes 25% constructability factor

[b] includes 20% swell factor

ft denotes feet

ft^2 denotes square feet

ft^3 denotes cubic feet

yd^3 denotes cubic yards

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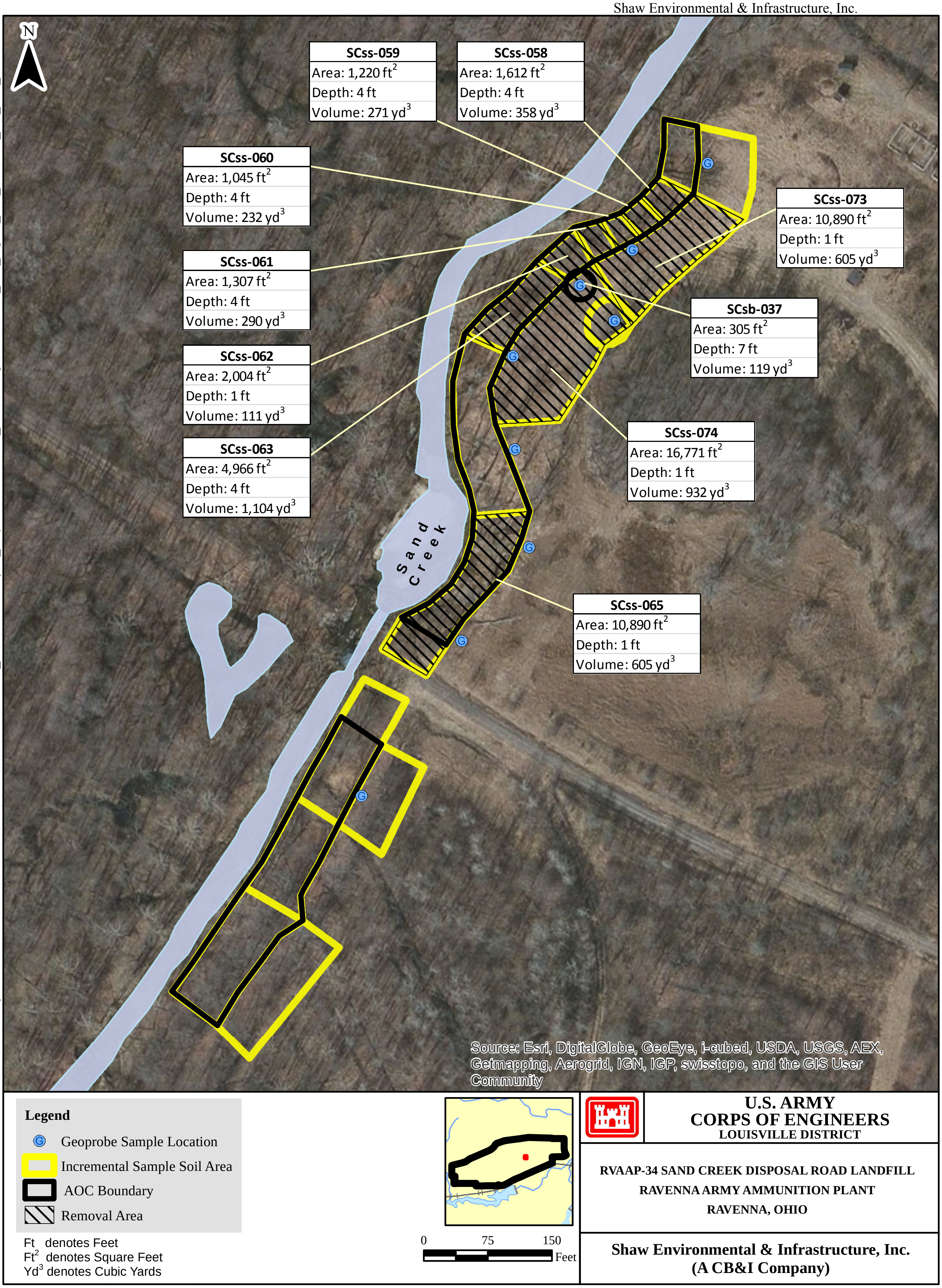

Figure B-1 Volume Estimate for Soil Removal - National Guard Trainee

Table B-2
Estimated Volume of Impacted Soil for the Resident Receptors

Sampling Unit Location	Area (acres)	Area (ft^2)	Depth (ft)	In Situ Volume (ft^3)	In Situ Volume (yd^3)	In Situ Constructability[a] Volume (ft^3)	In Situ Constructability[a] Volume (yd^3)	Ex Situ[a,b] Volume (ft^3)	Ex Situ[a,b] Volume (yd^3)
SCss-058	0.037	1,612	5	8,059	298	10,073	373	12,088	448
SCss-059	0.028	1,220	5	6,098	226	7,623	282	9,148	339
SCss-060	0.024	1,045	5	5,227	194	6,534	242	7,841	290
SCss-061	0.030	1,307	5	6,534	242	8,168	303	9,801	363
SCss-062	0.046	2,004	1	2,004	74	2,505	93	3,006	111
SCss-063	0.114	4,966	5	24,829	920	31,037	1,150	37,244	1,379
SCss-065	0.250	10,890	1	10,890	403	13,613	504	16,335	605
SCss-073*	0.250	10,890	6.5	70,785	2,622	88,481	3,277	106,178	3,933
SCss-074	0.385	16,771	1	16,771	621	20,963	776	25,156	932
SCsb-037**	0.007	305	9	2,744	102	3,430	127	4,116	152
SCss-075	0.147	6,403	1	6,403	237	8,004	296	9,605	356
SCss-076	0.218	9,496	1	9,496	352	11,870	440	14,244	528
			Total:	**169,840**	**6,290**	**212,301**	**7,863**	**254,761**	**9,436**

*Average depth of excavation in samping unit SCss-073 is assumed to be 6.5 feet bgs or half the maximum depth of contamination at soil boring SCsb-036 (13 feet bgs).

*Excavation volume around soil boring SCsb-037 assumes a 20-foot radius at a maximum depth of 9 feet bgs.

[a] Includes 25% constructability factor

[b] includes 20% swell factor

ft denotes feet

ft^2 denotes square feet

ft^3 denotes cubic feet

yd^3 denotes cubic yards

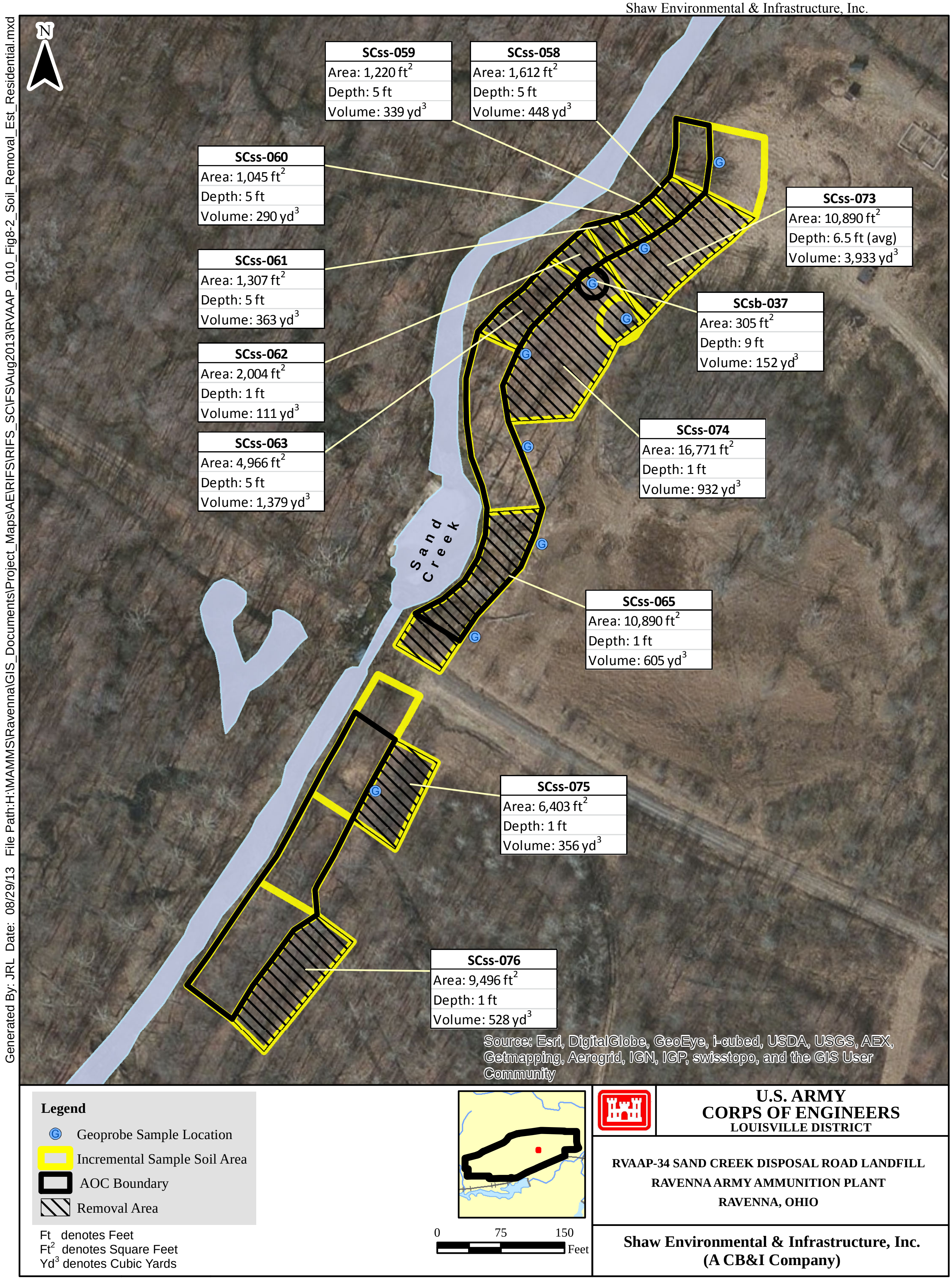

Figure B-2 Volume Estimate for Soil Removal - Resident Receptors

Appendix C
Feasibility Study Cost Summary Tables

1

BASIS OF ESTIMATE FOR RVAAP-34 SAND CREEK DISPOSAL ROAD LANDFILL REMEDIATION ALTERNATIVES

The information included here provides the basis for the estimates discussed in the *Feasibility Study for RVAAP-34 Sand Creek Disposal Road Landfill*. The accuracy of the estimate is +50 percent/–30 percent in accordance with guidance from the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Labor Rates:

Labor rates used in the estimate are national averages and are not area specific. The labor rates include direct cost, fringes, employer liability, and workmen's comprehension. Some rates as indicated below are fully burdened including indirect and profit. The following are the rates used in the estimate:

Laborer (L)	$19.00 per hour
Equipment Operator (OP)	$33.00 per hour
Truck Driver (TD)	$25.00 per hour
CAD Operator	$53.00 per hour (Fully Burden Rate)
Word Processor (WP)	$42.00 per hour (Fully Burden Rate)
Junior Engineer (Jr. Eng)	$65.00 per hour (Fully Burden Rate)
Senior Engineer (Sr. Eng)	$80.00 per hour (Fully Burden Rate)
Quality Control Specialist (QC)	$77.00 per hour (Fully Burden Rate)
Risk Assessor (Risk)	$125.00 per hour (Fully Burden Rate)
Field Superintendent - GC (Super)	$69.00 per hour (Fully Burden Rate)
Technician (Tech)	$35.00 per hour (Fully Burden Rate
Scientist (Sci)	$74.00 per hour (Fully Burden Rate)
Health & Safety Officer (H/S)	$74.00 per hour (Fully Burden Rate)
UXO Technician III (UXO)	$90.00 per hour (Fully Burden Rate)

Material, Equipment, and Production:

The material, equipment, and production rates were generated using national averages obtained from nationally recognized cost references such as R.S. Means and Richardson.

The estimators used their experience to modify national average production rates for remedial action work. Most national cost references are based on the construction of facilities and not the remediation of existing facilities. Cost adjustments are required to reflect the actual estimated cost of the work.

O&M Costs:

O&M costs do not include capital cost for the installation of equipment, wells, or the modification of existing facilities. O&M costs will be assumed to go for 30 years from the beginning of the project unless otherwise specified in the alternative discussion part of the document.

Project Management Costs:

A factor of 8 percent and 15 percent were used to calculate for project management costs and contingency costs, respectively.

Present Worth:

Present Worth is calculated based on the schedule in the alternative discussion section of the document. A 7 percent discount factor per year was used to calculate present worth.

Analytical Requirements:

Separate analytical requirements were identified based on the need for additional characterization, confirmatory sampling, or groundwater monitoring. These suites are identified as follows:

Suite 1: Additional characterization in soil (metals and semivolatile organic compounds [SVOCs])

Suite 2: Confirmatory soil sampling following excavation activities (volatile organic compounds [VOCs], SVOCs, metals, explosives, propellants, polychlorinated biphenyls [PCBs], pesticides, total cyanide, perchlorate, total organic compounds [TOC], pH).

Suite 3: Groundwater monitoring (VOCs, SVOCs, dissolved, metals, explosives, propellants, PCBs, pesticides, total cyanide, perchlorate, pH)

Suite 4: Waste characterization for soils (VOCs, SVOCs, metals, Toxicity Characteristic Leaching Procedure, and hazardous characteristics [i.e., ignitability, corrosivity, reactivity, and toxicity])

Alternative 2 - Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Task		Capital Cost	O&M Costs
Capital Costs			
Planning/Regulatory Documents		$84,800	
Engineering Support		$21,100	
Well Installation		$40,560	
Reports		$27,840	
Subtotal:		**$174,300**	
Contigency	15%	$26,145	
Project Management	8%	$13,944	
Total Capital Costs:		**$214,389**	
O&M/LTM Costs			
O&M/LTM - Year 1			$95,935
O&M/LTM - Years 2-30			$1,199,994
5 Year Reviews			$120,400
Subtotal:			**$1,416,329**
Contigency	15%		$212,449
Project Management	8%		$113,306
Total Annual O&M Costs:			**$1,742,085**
Years of Operation			30
Discount Rate			7%
O&M Present Worth (30 years at 7%)			**$1,449,398**
Total Present Worth Cost (30 Yrs at 7%)			**$1,663,787**

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Alternative 2 - Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**
Job No: 133616
Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item No.	DESCRIPTION	QTY	UNIT	LABOR UNIT MH	LABOR TOTAL MH	LABOR CRAFT	LABOR $/MH	LABOR $ VALUE	MATERIAL $/UNIT	MATERIAL $ VALUE	EQUIPMENT $/UNIT	EQUIPMENT $ VALUE	SUBCONTRACT $/UNIT	SUBCONTRACT $ VALUE	TOTAL ($)
	Planning/Regulatory Documents														
1	Legal fees, administrative controls, and documentation	1	LS										32,000	32,000	$32,000
2	Remedial Design Plan	1	ea	240	240	sr. eng	80	19,200	800	800					$20,000
3	Remedial Design Report	1	ea	240	240	sr. eng	80	19,200	800	800					$20,000
4	LTM/O&M Plan	1	ea	160	160	sr. eng	80	12,800							$12,800
	Total:														**$84,800**
	Engineering Support														
1	Develop design report, drawings, specs & procurement pkgs.	1	ls	150	150	sr. eng	80	12,000	1,000	1,000			1,600	1,600	$14,600
2	RFP & S / C procurement doc.support	1	ea	40	40	sr. eng	80	3,200	100	100					$3,300
3	Bid and award S / C support	1	ea	40	40	sr. eng	80	3,200							$3,200
	Total:														**$21,100**
	Well Installation														
1	Mobilization/demobilization	1	ls	48	48		70	3,360	2,500	2,500			5,000	5,000	$10,860
2	Engineer Technician	2	hr	40	80	jr. eng	65	5,200							$5,200
3	Site H&S Officer	1	hr	40	40	sci	74	2,960							$2,960
4	Rental Truck	5	day								56	280			$280
5	Temporary facilities	1	week										250	250	$250
6	Equipment	1	week								500	500			$500
7	Well installation	5	ea										2,300	11,500	$11,500
8	Waste disposal profile	1	ls										2,500	2,500	$2,500
9	Waste documentation report	1	lot	40	40	jr. eng	65	2,600	400	400					$3,000
10	Waste disposal and transportation	3	drum										400.00	1,200	$1,200
11	Sample supplies	6	ea						50	300					$300
12	Sample shipping	3	ea										55	165	$165
13	Lodging	15	day						77	1,155					$1,155
14	Meals	15	day						46	690					$690
	Total:														**$40,560**
	Reports														
1	Data validation & data management	1	ea	80	80	sci	63	5,040							$5,040
2	Prepare sample report	1	ea	80	80	sci	63	5,040							$5,040
3	Quality Control Specialist	1	hr	80	80	qc	77	6,160							$6,160
4	Environmental Engineer	1	hr	120	120	jr. eng	65	7,800							$7,800
5	CADD Operator	1	hr	40	40	co	53	2,120							$2,120
6	Word Processor	1	hr	40	40	wp	42	1,680							$1,680
	Total:														**$27,840**

Alternative 2 - Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**
Job No: 133616
Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	O&M/LTM														
	Year 1														
1	Establish initial database, licenses, coordinate well,	1	ls	300	300	sr. eng	80	24,000	2,250	2,250			5,000	5,000	$31,250
2	characterization, develop work plans, etc														
3	Mobilization/demobilization	1	ls	32	32		80	2,560	400	400					$2,960
4	Sample supplies	28	ea						50	1,400					$1,400
5	Sample shipping	15	ea										55	825	$825
6	Sample analysis (Suite 3)	28	ea	4	112	tech	35	3,920					1650	46,200	$50,120
7	Waste disposal and transportation	4	drum										400.00	1,600	$1,600
8	Perform annual inspection	2	ea	8	16	sr. eng	80	1,280							$1,280
9	Lodging	10	day						77	770					$770
10	Meals	10	day						46	460					$460
11	Annual report	1	ea	64	64	sr. eng	80	5,120	150	150					$5,270
	Total:														**$95,935**
	Years 2-30														
1	Mobilization/demobilization	1	ls	1856	1856		80	148,480	400	400					$148,880
2	Sample supplies	406	ea						50	20,300					$20,300
3	Sample shipping	200	ea										55	11,000	$11,000
4	Sample analysis (Suite 3)	406	ea	4	1624	tech	35	56,840					1650	669,900	$726,740
5	Waste disposal and transportation	58	drum										400.00	23,200	$23,200
6	Perform annual inspection	2	ea	464	928	sr. eng	80	74,240							$74,240
7	Lodging	348	day						77	26,796					$26,796
8	Meals	348	day						46	16,008					$16,008
9	Annual report	29	ea	64	1856	sr. eng	80	148,480	150	4,350					$152,830
	Total:														**$1,199,994**
	5 Year Reviews (Years 5, 10, 15, 25, 30)														
1	Environmental Engineer	1	ea	600	600	sr. eng.	65	39,000							$39,000
2	Sr. Engineer	1	ea	600	600	eng	80	48,000							$48,000
3	Risk Assessor	1	ea	200	200	risk	125	25,000							$25,000
4	Word Processor	1	ea	200	200	wp	42	8,400							$8,400
	Total:														**$120,400**
	Capital Subtotal							$111,560		$7,745		$780		$54,215	**$174,300**
	Project Management @ 8%														$13,944
	Contigency @ 15%														$26,145
	Total Capital Costs:														**$214,389**
	Annual O&M Subtotal														**$1,295,929**
	Project Management @ 8%														$103,674
	Contigency @ 15%														$194,389
	Total Annual O&M Costs:														**$1,593,993**

Alternative 2 - Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**
Job No: 133616
Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item No.	DESCRIPTION	QTY	UNIT	LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		TOTAL ($)
				UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	
	O&M Subtotal (5-Year Reviews only)														**$120,400**
	Project Management @ 8%														$9,632
	Contigency @ 15%														$18,060
	Total O&M Costs (5-Year Reviews only)														**$148,092**
	Present Worth of O&M (30 yrs, non-discounted)														**$1,449,398**
	Present Worth of O&M (30 yrs at 7%)														**$619,211**
														Total Present Worth (30 yrs at 7%)	**$ 1,663,787**

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Alternative 3 - Containment with Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Task		Capital Cost	O&M Costs
Capital Costs			
Planning		$107,200	
Engineering Support		$41,100	
Site Preparation		$42,942	
Clear and Grade Site		$71,717	
GCL Liner with Soil Cover		$153,812	
Site Restoration		$66,203	
Well Installation		$35,222	
Reports		$27,840	
Subtotal:		**$546,035**	
Contigency	15%	$81,905	
Project Management	8%	$43,683	
Total Capital Costs:		**$671,624**	
O&M/LTM Costs			
O&M/LTM - Year 1			$79,117
O&M/LTM - Years 2-30			$977,990
5 Year Reviews			$120,400
Subtotal:			**$1,177,507**
Contigency	15%		$176,626
Project Management	8%		$94,201
Total Annual O&M Costs:			**$1,448,334**
Years of Operation			30
Discount Rate			7%
O&M Present Worth (30 years at 7%)			**$1,958,098**
Total Present Worth Cost (30 Yrs at 7%)			**$2,629,722**

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Alternative 3 - Containment and Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Planning														
1	Legal fees, administrative controls, and documentation	2	ea	200	400	sr. eng	80	32,000							$32,000
2	Remedial Design Plan	4	ea	120	480	sr. eng	80	38,400	800	3,200					$41,600
3	Remedial Design Report	2	ea	120	240	sr. eng	80	19,200	800	1,600					$20,800
4	LTM/O&M Plan	2	ea	80	160	sr. eng	80	12,800							$12,800
	Total:														**$107,200**
	Engineering Support														
1	Develop design report, drawings, specs & procurement pkgs.	1	ls	300	300	sr. eng	80	24,000	1,000	1,000			1,600	1,600	$26,600
2	RFP & S/C procurement doc.support	1	ea	100	100	sr. eng	80	8,000	100	100					$8,100
3	Bid and award S/C support	1	ea	80	80	sr. eng	80	6,400							$6,400
	Total:														**$41,100**
	Site Preparation														
1	Mobilization/demobilization	1	ls	160	160		70	11,200	2,500	2,500	3,000	3,000	3,200	3,200	$19,900.00
2	Porta-John rental	1	mo										320	320	$320.00
3	Silt fence at construction area	1200	lf	0.02	40	l	19	774	0.36	432	0.00				$1,206.40
4	Hay bales	400	ea	0.02	20	l	19	387	0.40	160	0.05	20			$567.20
5	Survey crew	1	day										1,500	1,500	$1,500.00
6	Personal protective equipment	50	mday								30	1,500			$1,500.00
7	Construction equip. staging area	1	ea	120	120	op	29	3,480	2,000	2,000	1,500	1,500			$6,980.00
8	Construct decontamination pad	1	ea	30	30	op	33	1,000	6,000	6,000	2,000	2,000			$8,999.90
9	Lodging	16	day						77	1,232					$1,232
10	Meals	16	day						46	736					$736
	Total:														**$42,942**
	Clear and Grade Site														
1	330 Excavator	5	day	10	50	op	33	1,650			300	1,500			$3,150.00
2	FOGM excavator	50	hr								50	2,500			$2,500.00
3	D-6 dozer	5	day	10	50	op	33	1,650			300	1,500			$3,150.00
4	FOGM dozer	50	hr								50	2,500			$2,500.00
5	3 cy loader	5	day	10	50	op	33	1,650			300	1,500			$3,150.00
6	FOGM loader	50	hr								50	2,500			$2,500.00
7	Water truck	5	day	2	10	td	25	250			150	750			$1,000.00
8	FOGM water truck	10	hr								30	300			$300.00
9	30 ton off-road dump truck	5	day	10	50	td	25	1,250			350	1,750			$3,000.00
10	FOGM dump truck	50	hr								35	1,750			$1,750.00
11	Aerosol Monitor	5	day								10	50			$50.00
12	Health & Safety officer	5	day	10	50	h/s	74	3,700							$3,700.00
13	Field Supervisor	5	day	10	50	super	69	3,429							$3,429.00
14	Laborer	5	day	20	100	l	19	1,900			2825	14,125			$16,025.00
15	UXO Tech III	5	day	10	50	uxo	90	4,500			2825	14,125			$18,625.00
16	Lodging	56	day						77	4,312					$4,312
17	Meals	56	day						46	2,576					$2,576
	Total:														**$71,717**

Alternative 3 - Containment and Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Excavate and Stockpile														
1	Additional characterization (Suite 1)	6	ea	4	24	tech	35	840	10	60			480	2,880	$3,780
2	330 Excavator	3	day	10	30	op	33	990			300	900			$1,890.00
3	FOGM excavator	30	hr								50	1,500			$1,500.00
4	D-6 dozer	3	day	10	30	op	33	990			300	900			$1,890.00
5	FOGM dozer	30	hr								50	1,500			$1,500.00
6	3 cy loader	3	day	10	30	op	33	990			300	900			$1,890.00
7	FOGM loader	30	hr								50	1,500			$1,500.00
8	Water truck	3	day	2	6	td	25	150			150	450			$600.00
9	FOGM water truck	30	hr								30	900			$900.00
10	30 ton off-road dump truck	3	day	10	30	td	25	750			350	1,050			$1,800.00
11	FOGM dump truck	30	hr								35	1,050			$1,050.00
12	Aerosol Monitor	3	day								10	30			$30.00
13	Health & Safety officer	3	day	10	30	h/s	74	2,220							$2,220.00
14	Field Supervisor	3	day	10	30	super	69	2,057							$2,057.40
15	Laborer	3	day	20	60	l	30	1,800			2825	8,475			$10,275.00
16	UXO Tech III	3	day	10	30	uxo	90	2,700			2825	8,475			$11,175.00
17	Lodging	34	day						77	2,618					$2,618
18	Meals	34	day						46	1,564					$1,564
	Total:														**$48,239**
	Confirmatory Sample Collection														
1	Collect ISM confirmation samples (Suite 2)	4	ea	4	16	tech	35	560					1,650	6,600	$7,160
2	ISM sample processing	4	ea										30	120	$120.00
3	Sample Supplies	4	ea						10	40					$40.00
4	Sample Shipping	1	ea										150	150	$150.00
	Total:														**$7,470**
	GCL Liner with Soil Cover														
1	D-6 dozer	5	day								320	1,600			$1,600.00
2	FOGM dozer	50	hr								12.00	600			$600.00
3	330 excavator	5	day								287.00	1,435			$1,435.00
4	FOGM excavator	50	hr								12	600			$600.00
5	Water truck	5	day								232.00	1,160			$1,160.00
6	FOGM water truck	50	hr								20	1,000			$1,000.00
7	Off road 35 ton dump truck	5	day								399.00	1,995			$1,995.00
8	FOGM dump truck	50	hr								20.00	1,000			$1,000.00
9	VIB soil compactor/84"/Smooth	5	day								110	550			$550.00
10	FOGM soil compactor/84"/smooth	50	hr								10	500			$500.00
11	Supply and install GCL	65,000	sf						0.75	48,750					$48,750.00
12	Health & Safety officer	5	day	10	50	h/s	74	3,700							$3,700.00
13	Field Supervisor	5	day	10	50	super	69	3,429							$3,429.00
14	Laborer	5	day	20	100	l	30	3,000			2825	14,125			$17,125.00
15	12-inch soil cover (delivered)	2,700	cy						16	43,200					$43,200.00

Alternative 3 - Containment and Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
16	6-inch sand drainage layer	1,200	cy						10	12,000					$12,000.00
17	Backfill testing (Suite 2)	2	ea	4	8	tech	35	280					1650	3,300	$3,580.00
18	Compaction Testing	1	ls										4700	4,700	$4,700.00
19	Lodging	56	day						77	4,312					$4,312
20	Meals	56	day						46	2,576					$2,576
	Total:														**$153,812**
	Site Restoration														
1	6-inches topsoil (delivered)	1,500	cy						20	30,000					$30,000.00
2	Skid steer	5	day	10	50	op	33	1,650			250	1,250			$2,900.00
3	FOGM skid steer	50	hr								25	1,250			$1,250.00
4	Compaction, 6" lifts, 4 passes	1,200	cy	0.009	11	op	33	360			0.47	564			$923.96
5	Post Excavation Survey	10	hr										112.5	1,125	$1,125.00
6	Backfil testing (Suite 2)	1	ea	4	4	tech	35	140					1650	1,650	$1,790.00
7	Seeding	1.5	acre										1000	1,500	$1,500.00
8	Health & Safety officer	5	day	10	50	h/s	74	3,700							$3,700.00
9	Field Supervisor	5	day	10	50	super	69	3,429							$3,429.00
10	Laborer	5	day	20	100	l	30	3,000			2825	14,125			$17,125.00
11	Lodging	20	day						77	1,540					$1,540
12	Meals	20	day						46	920					$920
	Total:														**$66,203**
	Well Installation														
1	Mobilization/demobilization	1	ls	48	48		70	3,360	2,500	2,500			5,000	5,000	$10,860
2	Engineer Technician	2	hr	40	80	jr. eng	65	5,200							$5,200
3	Site H&S Officer	1	hr	40	40	sci	74	2,960							$2,960
4	Rental Truck	5	day								56	280			$280
5	Temporary facilities	1	week										250	250	$250
6	Equipment	1	week								500	500			$500
7	Well installation	3	ea										2,300	6,900	$6,900
8	Waste disposal profile	1	ls										2,500	2,500	$2,500
9	Waste documentation report	1	lot	40	40	jr. eng	65	2,600	400	400					$3,000
10	Waste disposal and transportation	3	drum										400.00	1,200	$1,200
12	Sample shipping	3	ea										55	165	$165
13	Lodging	9	day						77	693					$693
14	Meals	9	day						46	414					$414
	Total:														**$35,222**

Alternative 3 - Containment and Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Reports														
1	Data validation & data management	1	ea	80	80	sci	63	5,040							$5,040
2	Prepare sample report	1	ea	80	80	sci	63	5,040							$5,040
3	Quality Control Specialist	1	hr	80	80	qc	77	6,160							$6,160
4	Environmental Engineer	1	hr	120	120	jr. eng	65	7,800							$7,800
5	CADD Operator	1	hr	40	40	co	53	2,120							$2,120
6	Word Processor	1	hr	40	40	wp	42	1,680							$1,680
	Total:														**$27,840**
	O&M/LTM														
	Year 1														
1	Establish initial database, licenses, coordinate well,	1	ls	300	300	sr. eng	80	24,000	2,250	2,250			5,000	5,000	$31,250
2	characterization, develop work plans, etc														
3	Mobilization/demobilization	1	ls	32	32		80	2,560	400	400					$2,960
5	Sample shipping	3	ea										55	165	$165
6	Sample analysis (Suite 3)	20	ea	4	80	tech	35	2,800					1650	33,000	$35,800
7	Waste disposal and transportation	4	drum										400	1,600	$1,600
8	Perform annual inspection	2	ea	8	16	sr. eng	80	1,280							$1,280
9	Lodging	4	day						77	308					$308
10	Meals	4	day						46	184					$184
11	Annual report	1	ea	64	64	sr. eng	80	5,120	150	150					$5,270
	Total:														**$79,117**
	Years 2-30														
1	Mobilization/demobilization	1	ls	1856	1856		80	148,480	400	400					$148,880
2	Sample supplies	290	ea						50	14,500					$14,500
3	Sample shipping	174	ea										55	9,570	$9,570
4	Sample analysis (Suite 3)	290	ea	4	1160	tech	35	40,600					1650	478,500	$519,100
6	Waste disposal and transportation	58	drum										400.00	23,200	$23,200
7	Perform annual inspection	2	ea	464	928	sr. eng	80	74,240							$74,240
8	Lodging	290	day						77	22,330					$22,330
9	Meals	290	day						46	13,340					$13,340
10	Annual report	29	ea	64	1856	sr. eng	80	148,480	150	4,350					$152,830
	Total:														**$977,990**
	5 Year Reviews (Years 5, 10, 15, 25, 30)														
1	Environmental Engineer	1	ea	600	600	sr. eng.	65	39,000							$39,000
2	Sr. Engineer	1	ea	600	600	eng	80	48,000							$48,000
3	Risk Assessor	1	ea	200	200	risk	125	25,000							$25,000
4	Word Processor	1	ea	200	200	wp	42	8,400							$8,400
	Total:														**$120,400**

Alternative 3 - Containment and Land Use Controls
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item No.	DESCRIPTION	QTY	UNIT	LABOR UNIT MH	LABOR TOTAL MH	LABOR CRAFT	LABOR $/MH	LABOR $ VALUE	MATERIAL $/UNIT	MATERIAL $ VALUE	EQUIPMENT $/UNIT	EQUIPMENT $ VALUE	SUBCONTRACT $/UNIT	SUBCONTRACT $ VALUE	TOTAL ($)
	Capital Subtotal							$256,316		$36,767		$17,969		$20,290	**$601,745**
	Project Management @ 8%														$48,140
	Contigency @ 15%														$90,262
	Total Capital Costs:														**$740,146**
	Annual O&M Subtotal														**$1,057,107**
	Project Management @ 8%														$84,569
	Contigency @ 15%														$158,566
	Total Annual O&M Costs:														**$1,300,242**
	O&M Subtotal (5-Year Reviews only)														**$120,400**
	Project Management @ 8%														$9,632
	Contigency @ 15%														$18,060
	Total O&M Costs (5-Year Reviews only)														**$148,092**
	Present Worth of O&M (30 yrs, non-discounted)														**$1,217,952**
	Present Worth of O&M (30 yrs at 7%)														**$515,250**
														Total Present Worth (30 yrs at 7%)	**$ 1,958,098**

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Alternative 4 - Excavation, Off-Site Disposal and LUCs for Military Training Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Task		Capital Cost	O&M Costs
Capital Costs			
Planning		$107,200	
Engineering Support		$41,100	
Site Preparation		$40,452	
Excavate Contaminated Soils		$154,474	
Confirmatory Sample Collection		$27,900	
Backfill and Site Restoration		$118,308	
Waste Transportation and Disposal		$1,232,670	
Well Installation		$40,560	
Reports		$27,840	
Subtotal:		**$1,790,503**	
Contigency	15%	$268,576	
Project Management	8%	$143,240	
Total Capital Costs:		**$2,202,319**	
O&M/LTM Costs			
O&M/LTM - Year 1			$95,935
O&M/LTM - Years 2-30			$1,199,994
5 Year Reviews			$120,400
Subtotal:			**$1,416,329**
Contigency			$212,449
Project Management	15%		$113,306
Total Annual O&M Costs:	8%		**$1,742,085**
Years of Operation			30
Discount Rate			7%
O&M Present Worth (30 years at 7%)			**$607,456**
Total Present Worth Cost (30 Yrs at 7%)			**$2,809,775**

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Alternative 4 - Excavation, Off-Site Disposal, and LUCs for Military Training Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Planning														
1	Legal fees, administrative controls, and documentation	2	ea	200	400	sr. eng	80	32,000							$32,000
2	Remedial Design Plan	4	ea	120	480	sr. eng	80	38,400	800	3,200					$41,600
3	Remedial Design Report	2	ea	120	240	sr. eng	80	19,200	800	1,600					$20,800
4	LTM/O&M Plan	2	ea	80	160	sr. eng	80	12,800							$12,800
	Total:														**$107,200**
	Engineering Support														
1	Develop design report, drawings, specs & procurement pkgs.	1	ls	300	300	sr. eng	80	24,000	1,000	1,000			1,600	1,600	$26,600
2	RFP & S/C procurement doc.support	1	ea	100	100	sr. eng	80	8,000	100	100					$8,100
3	Bid and award S/C support	1	ea	80	80	sr. eng	80	6,400							$6,400
	Total:														**$41,100**
	Site Preparation														
1	Mobilization/demobilization	1	ls	160	160		70	11,200	2,500	2,500	3,000	3,000	3,200	3,200	$19,900.00
2	Porta-John rental	1	mo										320	320	$320.00
3	Silt fence at construction area	1200	lf	0.02	40	l	19	774	0.36	432	0.00				$1,206.40
4	Hay bales	400	ea	0.02	20	l	19	387	0.40	160	0.05	20			$567.20
5	Survey crew	1	day										1,500	1,500	$1,500.00
6	Personal protective equipment	50	mday								30	1,500			$1,500.00
7	Construction equip. staging area	1	ea	30	30	op	33	990	2,000	2,000	1,500	1,500			$4,490.00
8	Construct decontamination pad	1	ea	30	30	op	33	1,000	6,000	6,000	2,000	2,000			$8,999.90
9	Lodging	16	day						77	1,232					$1,232
10	Meals	16	day						46	736					$736
	Total:														**$40,452**
	Excavate Contaminated Soils														
1	Additional characterization (Suite 1)	12	ea	4	48	tech	35	1,680	10	120			480	5,760	$7,560
2	330 Excavator	10	day	10	100	op	33	3,300			300	3,000			$6,300.00
3	FOGM excavator	100	hr								50	5,000			$5,000.00
4	D-6 dozer	10	day	10	100	op	33	3,300			300	3,000			$6,300.00
5	FOGM dozer	100	hr								50	5,000			$5,000.00
6	3 cy loader	10	day	10	100	op	33	3,300			300	3,000			$6,300.00
7	FOGM loader	100	hr								50	5,000			$5,000.00
8	Water truck	10	day	2	20	td	34	680			150	1,500			$2,180.00
9	FOGM water truck	100	hr								30	3,000			$3,000.00
10	30 ton off-road dump truck	10	day	10	100	td	34	3,400			350	3,500			$6,900.00
11	FOGM dump truck	100	hr								35	3,500			$3,500.00
12	Aerosol Monitor	10	day								10	100			$100.00
13	Health & Safety officer	10	day	10	100	h/s	74	7,400							$7,400.00
14	Field Supervisor	10	day	10	100	super	69	6,858							$6,858.00
15	Laborer	10	day	20	200	lab	19	3,800			2825	28,250			$32,050.00
16	UXO Tech III	10	day	10	100	uxo	90	9,000			2825	28,250			$37,250.00
17	Lodging	112	day						77	8,624					$8,624
18	Meals	112	day						46	5,152					$5,152
	Total:														**$154,474**

Alternative 4 - Excavation, Off-Site Disposal, and LUCs for Military Training Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Confirmatory Sample Collection														
1	Collect ISM confirmation samples (Suite 2)	15	ea	4	60	tech	35	2,100					1,650	24,750	$26,850
2	ISM sample processing	15	ea										30	450	$450.00
3	Sample Supplies	15	ea						10	150					$150.00
4	Sample Shipping	3	ea										150	450	$450.00
	Total:														**$27,900**
	Backfill and Site Restoration														
1	Backfill material (delivered)	3,750	cy						16	60,000					$60,000.00
2	6-inches topsoil (delivered)	950	cy						20	19,000					$19,000.00
3	Skid steer	5	day	10	50	op	33	1,650			250	1,250			$2,900.00
4	FOGM skid steer	50	hr								25	1,250			$1,250.00
5	Compaction, 6" lifts, 4 passes	4,700	cy	0.009	42	op	33	1,410			0.47	2,209			$3,618.86
6	Post excavation survey	10	hr										112.5	1,125	$1,125.00
7	Backfill testing (Suite 2)	2	ea										1650	3,300	$3,300.00
8	Seeding	1.5	acre										1000	1,500	$1,500.00
9	Health & Safety officer	5	day	10	50	h/s	74	3,700							$3,700.00
10	Field Supervisor	5	day	10	50	super	69	3,429							$3,429.00
11	Laborer	5	day	20	100	l	19	1,900			2825	14,125			$16,025.00
12	Lodging	20	day						77	1,540					$1,540
13	Meals	20	day						46	920					$920
	Total:														**$118,308**
	Waste Transportation and Disposal														
1	Waste characterization (Suite 4)	2	ea	2	4	tech	35		10	20			1,200	2,400	$2,420.00
2	Sample Shipping	3	ea										150	450	$450.00
3	Waste documentation / reports	1	ea	40	40	tech	35	1,400	400	400					$1,800.00
4	Non-hazardous waste transportation/disposal	50	tons										60	3000	$3,000.00
5	Hazardous waste transportation/disposal	7,000	tons										175	1225000	$1,225,000.00
	Total:														**$1,232,670**
	Well Installation														
1	Mobilization/demobilization	1	ls	48	48		70	3,360	2,500	2,500			5,000	5,000	$10,860
2	Engineer Technician	2	hr	40	80	jr. eng	65	5,200							$5,200
3	Site H&S Officer	1	hr	40	40	sci	74	2,960							$2,960
4	Rental Truck	5	day								56	280			$280
5	Temporary facilities	1	week										250	250	$250
6	Equipment	1	week								500	500			$500
7	Well installation	5	ea										2,300	11,500	$11,500
8	Waste disposal profile	1	ls										2,500	2,500	$2,500
9	Waste documentation report	1	lot	40	40	jr. eng	65	2,600	400	400					$3,000
10	Waste disposal and transportation	3	drum										400.00	1,200	$1,200
11	Sample shipping	3	ea										55	165	$165
12	Lodging	15	day						77	1,155					$1,155
13	Meals	15	day						46	690					$690
	Total:														**$40,560**

Alternative 4 - Excavation, Off-Site Disposal, and LUCs for Military Training Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Reports														
1	Data validation & data management	1	ea	80	80	sci	63	5,040							$5,040
2	Prepare sample report	1	ea	80	80	sci	63	5,040							$5,040
3	Quality Control Specialist	1	hr	80	80	qc	77	6,160							$6,160
4	Jr Engineer	1	hr	120	120	jr. eng	65	7,800							$7,800
5	CADD Operator	1	hr	40	40	co	53	2,120							$2,120
6	Word Processor	1	hr	40	40	wp	42	1,680							$1,680
	Total:														**$27,840**
	O&M/LTM														
	Year 1														
1	Establish initial database, licenses, coordinate well,	1	ls	300	300	sr. eng	80	24,000	2,250	2,250			5,000	5,000	$31,250
2	characterization, develop work plans, etc														
3	Mobilization/demobilization	1	ls	32	32		80	2,560	400	400					$2,960
4	Sample supplies	28	ea						50	1,400					$1,400
5	Sample shipping	15	ea										55	825	$825
6	Sample analysis (Suite 3)	28	ea	4	112	tech	35	3,920					1650	46,200	$50,120
7	Waste disposal and transportation	4	drum										400	1,600	$1,600
8	Perform annual inspection	2	ea	8	16	sr. eng	80	1,280							$1,280
9	Lodging	10	day						77	770					$770
10	Meals	10	day						46	460					$460
11	Annual report	1	ea	64	64	sr. eng	80	5,120	150	150					$5,270
	Total:														**$95,935**
	Years 2-30														
1	Mobilization/demobilization	1	ls	1856	1856		80	148,480	400	400					$148,880
2	Sample supplies	406	ea						50	20,300					$20,300
3	Sample shipping	200	ea										55	11,000	$11,000
4	Sample analysis (Suite 3)	406	ea	4	1624	tech	35	56,840					1650	669,900	$726,740
5	Waste disposal and transportation	58	drum										400.00	23,200	$23,200
6	Perform annual inspection	2	ea	464	928	sr. eng	80	74,240							$74,240
7	Lodging	348	day						77	26,796					$26,796
8	Meals	348	day						46	16,008					$16,008
9	Annual report	29	ea	64	1856	sr. eng	80	148,480	150	4,350					$152,830
	Total:														**$1,199,994**

Alternative 4 - Excavation, Off-Site Disposal, and LUCs for Military Training Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: September 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	5 Year Reviews (Years 5, 10, 15, 25, 30)														
1	Jr. Engineer	1	ea	600	600	sr. eng.	65	39,000							$39,000
2	Sr. Engineer	1	ea	600	600	eng	80	48,000							$48,000
3	Risk Assessor	1	ea	200	200	risk	125	25,000							$25,000
4	Word Processor	1	ea	200	200	wp	42	8,400							$8,400
	Total:														**$120,400**
	Capital Subtotal							$255,418		$119,931		$119,734		$1,295,420	**$1,790,503**
	Project Management @ 8%														$143,240
	Contigency @ 15%														$268,576
	Total Capital Costs:														**$2,202,319**
	Annual O&M Subtotal														**$1,295,929**
	Project Management @ 8%														$103,674
	Contigency @ 15%														$194,389
	Total Annual O&M Costs:														**$1,593,993**
	O&M Subtotal (5-Year Reviews only)														**$120,400**
	Project Management @ 8%														$9,632
	Contigency @ 15%														$18,060
	Total O&M Costs (5-Year Reviews only)														**$148,092**
	Present Worth of O&M (30 yrs, non-discounted)														**$1,433,990**
	Present Worth of O&M (30 yrs at 7%)														**$607,456**
														Total Present Worth (30 yrs at 7%)	**$ 2,809,775**

Alternative 5 - Excavation and Off-Site Disposal for Resident Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Task		Capital Cost	O&M Costs
Capital Costs			
Planning		$107,200	
Engineering Support		$41,100	
Site Preparation		$40,452	
Excavate Contaminated Soils		$304,528	
Confirmatory Sample Collection		$27,900	
Backfill and Site Restoration		$232,091	
Waste Transportation and Disposal		$2,495,240	
Reports		$27,840	
Subtotal:		**$3,276,351**	
Contigency	15%	$491,453	
Project Management	8%	$262,108	
Total Capital Costs:		**$4,029,911**	
O&M/LTM Costs			
O&M/LTM - Year 1			$0
O&M/LTM - Years 2-30			$0
5 Year Reviews			$0
Subtotal:			**$0**
Contigency			$0
Project Management	15%		$0
Total Annual O&M Costs:	8%		**$0**
Years of Operation			30
Discount Rate			7%
O&M Present Worth (30 years at 7%)			**$0**
Total Present Worth Cost (30 Yrs at 7%)			**$4,029,911**

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Alternative 5 - Excavation and Off-Site Disposal for Resident Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: August 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Planning														
1	Legal fees, administrative controls, and documentation	2	ea	200	400	sr. eng	80	32,000							$32,000
2	Remedial Design Plan	4	ea	120	480	sr. eng	80	38,400	800	3,200					$41,600
3	Remedial Design Report	2	ea	120	240	sr. eng	80	19,200	800	1,600					$20,800
4	LTM/O&M Plan	2	ea	80	160	sr. eng	80	12,800							$12,800
	Total:														**$107,200**
	Engineering Support														
1	Develop design report, drawings, specs & procurement pkgs.	1	ls	300	300	sr. eng	80	24,000	1,000	1,000			1,600	1,600	$26,600
2	RFP & S/C procurement doc.support	1	ea	100	100	sr. eng	80	8,000	100	100					$8,100
3	Bid and award S/C support	1	ea	80	80	sr. eng	80	6,400							$6,400
	Total:														**$41,100**
	Site Preparation														
1	Mobilization/demobilization	1	ls	160	160		70	11,200	2,500	2,500	3,000	3,000	3,200	3,200	$19,900.00
2	Porta-John rental	1	mo										320	320	$320.00
3	Silt fence at construction area	1200	lf	0.02	40	l	19	774	0.36	432	0.00				$1,206.40
4	Hay bales	400	ea	0.02	20	l	19	387	0.40	160	0.05	20			$567.20
5	Survey crew	1	day										1,500	1,500	$1,500.00
6	Personal protective equipment	50	mday								30	1,500			$1,500.00
7	Construction equip. staging area	1	ea	30	30	op	33	990	2,000	2,000	1,500	1,500			$4,490.00
8	Construct decontamination pad	1	ea	30	30	op	33	1,000	6,000	6,000	2,000	2,000			$8,999.90
9	Lodging	16	day						77	1,232					$1,232
10	Meals	16	day						46	736					$736
	Total:														**$40,452**
	Excavate Contaminated Soils														
1	Additional characterization (Suite 1)	10	ea	4	40	tech	35	1,400	10	100			480	4,800	$6,300
2	330 Excavator	20	day	10	200	op	33	6,600			300	6,000			$12,600.00
3	FOGM excavator	200	hr								50	10,000			$10,000.00
4	D-6 dozer	20	day	10	200	op	33	6,600			300	6,000			$12,600.00
5	FOGM dozer	200	hr								50	10,000			$10,000.00
6	3 cy loader	20	day	10	200	op	33	6,600			300	6,000			$12,600.00
7	FOGM loader	200	hr								50	10,000			$10,000.00
8	Water truck	20	day	2	40	op	34	1,360			150	3,000			$4,360.00
9	FOGM water truck	200	hr								30	6,000			$6,000.00
10	30 ton off-road dump truck	20	day	10	200	op	34	6,800			350	7,000			$13,800.00
11	FOGM dump truck	200	hr								35	7,000			$7,000.00
12	Aerosol Monitor	20	day								10	200			$200.00
13	Health & Safety officer	20	day	10	200	h/s	74	14,800							$14,800.00
14	Field Supervisor	20	day	10	200	super	69	13,716							$13,716.00
15	Laborer	20	day	20	400	l	30	12,000			2825	56,500			$68,500.00
16	UXO Tech III	20	day	10	200	uxo	90	18,000			2825	56,500			$74,500.00
17	Lodging	224	day						77	17,248					$17,248
18	Meals	224	day						46	10,304					$10,304
	Total:														**$304,528**

Alternative 5 - Excavation and Off-Site Disposal for Resident Land Use Receptors
RVAAP-34 Sand Creek Disposal Road Landfill

Company Name: Shaw Environmental & Infrastructure **Date: August 2013**

Job No: 133616

Project Location: Sand Creek Disposal Road Landfill, Ravenna Army Ammunition Plant, Ravenna, OH

Item				LABOR					MATERIAL		EQUIPMENT		SUBCONTRACT		
No.	DESCRIPTION	QTY	UNIT	UNIT MH	TOTAL MH	CRAFT	$/MH	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	$/UNIT	$ VALUE	TOTAL ($)
	Confirmatory Sample Collection														
1	Collect ISM confirmation samples (Suite 2)	15	ea	4	60	tech	35	2,100					1,650	24,750	$26,850
2	ISM sample processing	15	ea										30	450	$450.00
3	Sample Supplies	15	ea						10	150					$150.00
4	Sample Shipping	3	ea										150	450	$450.00
	Total:														**$27,900**
	Backfill and Site Restoration														
1	Backfill material (delivered)	8,200	cy						16	131,200					$131,200.00
2	6-inches topsoil (delivered)	1,250	cy						20	25,000					$25,000.00
3	Skid steer	10	day	10	100	oper	33	3,300			250	2,500			$5,800.00
4	FOGM skid steer	100	hr								25	2,500			$2,500.00
5	Compaction, 6" lifts, 4 passes	10,050	cy	0.009	90	op	33	3,015			0.47	4,724			$7,738.20
6	Post excavation survey	10	hr										112.5	1,125	$1,125.00
7	Backfill testing (Suite 2)	2	ea										1650	3,300	$3,300.00
8	Seeding	2	acre										1000	2,000	$2,000.00
9	Health & Safety officer	10	day	10	100	h/s	74	7,400							$7,400.00
10	Field Supervisor	10	day	10	100	super	69	6,858							$6,858.00
11	Laborer	10	day	20	200	lab	30	6,000			2825	28,250			$34,250.00
12	Lodging	40	day						77	3,080					$3,080
13	Meals	40	day						46	1,840					$1,840
	Total:														**$232,091**
	Waste Transportation and Disposal														
1	Waste characterization (Suite 4)	4	ea	2	8	tech	35		10	40			1,200	4,800	$4,840.00
2	Sample Shipping	4	ea										150	600	$600.00
3	Waste documentation / reports	1	ea	40	40	tech	35	1,400	400	400					$1,800.00
4	Non-hazardous waste transportation/disposal	50	tons										60	3000	$3,000.00
5	Hazardous waste transportation/disposal	14,200	tons										175	2485000	$2,485,000.00
	Total:														**$2,495,240**
	Reports														
1	Data validation & data management	1	ea	80	80	sci	63	5,040							$5,040
2	Prepare sample report	1	ea	80	80	sci	63	5,040							$5,040
3	Quality Control Specialist	1	hr	80	80	qc	77	6,160							$6,160
4	Environmental Engineer	1	hr	120	120	jr. eng	65	7,800							$7,800
5	CADD Operator	1	hr	40	40	co	53	2,120							$2,120
6	Word Processor	1	hr	40	40	wp	42	1,680							$1,680
	Total:														**$27,840**
	Capital Subtotal							$300,940		$208,322		$230,194		$2,536,895	**$3,276,351**
	Project Management @ 8%														$262,108
	Contigency @ 15%														$491,453
	Total Capital Costs:														**$4,029,911**
														Total Present Worth: $	**4,029,911**