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14. ABSTRACT

The purpose of this report is to present the findings and conclusions of the remedial investigation (RI) field activities conducted at the RVAAP-008-R-01 Load Line #1 MRS at the Ravenna Army Ammunition Plant under the Military Munitions Response Program. The reports presents a determination as to whether the Load Line #1 MRS warrants further response action pursuant to the Comprehensive, Environmental, Responsibility, Compensation and Liability Act and the National Oil and Hazardous Substances Pollution Contingency Plan. More specifically, the RI Report presents the nature and extent of munitions and explosives of concern (MEC) and munitions constituents (MC) at the MRS and subsequently provides an evaluation of the hazards and risks posed to human health and the environment by MEC and MC. The RI Report also presents additional data for the Feasibility Study (FS) to assist in determining if remediation alternatives, if any, are appropriate. This RI report was prepared in accordance with the Army's Final Munitions Response RI/FS guidance dated November 2009.

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Shaw Environmental & Infrastructure Inc. has completed the *Draft Remedial Investigation Report for RVAAP-008-R-01 Load Line #1 MRS* 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.

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Draft Remedial Investigation Report for RVAAP-008-R-01 Load Line #1 MRS Version 1.0

Ravenna Army Ammunition Plant
Ravenna, Ohio

Contract No. W912DR-09-D-0005
Delivery Order 0002

Prepared for:

US Army Corps of Engineers®

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ARNG—Army National Guard
BRACD—Base Realignment and Closure Division
OHARNG—Ohio Army National Guard
Ohio EPA—Ohio Environmental Protection Agency
RVAAP—Ravenna Army Ammunition Plant
USACE—U.S. Army Corps of Engineers

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Acronyms and Abbreviations

AEDB-R	Army Environmental Data Base Restoration Module
AOC	area of concern
AMEC	AMEC Earth and Environmental, Inc.
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
ASR	Archives Search Report
ASTM	American Society of Testing and Materials
BERA	baseline ecological risk assessment
bgs	below ground surface
BRAC	Base Realignment and Closure
BSV	background screening value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CRJMTC	Camp Ravenna Joint Military Training Center
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DERP	Defense Environmental Restoration Program
DoD	U.S. Department of Defense
DQO	data quality objective
e^2M	engineering-environmental Management, Inc.
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ESA	Endangered Species Act
ESV	ecological screening value
EU	exposure unit
FS	feasibility study
F&T	fate and transport
FWCUG	Facility-Wide Cleanup Goal
FWSAP	Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the RVAAP
HA	hazard assessment
HHRA	human health risk assessment
HQ	hazard quotient
HRR	Historical Records Review
IDW	investigation derived waste
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
ISM	incremental sampling method
LCS	laboratory control sample

Acronyms and Abbreviations (continued)

LOD	limit of detection
Pb	lead
MC	munitions constituents
MD	munitions debris
MDC	maximum detected concentration
MDL	method detection limit
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
MKM	MKM Engineers, Inc.
MMRP	Military Munitions Response Program
MPPEH	materiel potentially presenting an explosive hazard
MRL	method reporting limit
MRS	munitions response site
MRSPP	Munitions Response Site Prioritization Protocol
MS/MSD	matrix spike/matrix spike duplicate sample
NA	not applicable/not available
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
N&E	nature and extent
NGT	National Guard Trainee
NIST	NIST Chemistry WebBook
NOAEL	no observed adverse effect level
ODNR	Ohio Department of Natural Resources
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PBT	persistent, bioaccumulative, and toxic
QA	quality assurance
QC	quality control
RFA	Residential Farmer Adult
RFC	Residential Farmer Child
RI	remedial investigation
RME	reasonable maximum exposure
RPD	relative percent difference
RSL	regional screening level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
Shaw	Shaw Environmental & Infrastructure, Inc.
SI	site inspection
SLERA	screening-level ecological risk assessment
SMDP	scientific management decision point
SOP	standard operating procedure
SRC	site-related chemical

Acronyms and Abbreviations (continued)

TBC	to be considered
TNT	2,4,6-trinitrotoluene
TOC	total organic carbon
TRV	toxicity reference value
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
VQ	validation qualifier

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EXECUTIVE SUMMARY

This *Remedial Investigation (RI) Report* documents the finding and conclusions of the RI field activities for the Load Line #1 (RVAAP-008-R-01) Munitions Response Site (MRS) located at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. This RI Report is being prepared by Shaw Environmental & Infrastructure, Inc. (Shaw) under Delivery Order 0002 for Military Munitions Response Program (MMRP) environmental services at the RVAAP under the *Multiple Award Military Munitions Services Performance-Based Acquisition Contract* No. W912DR-09-D-0005. The Delivery Order was issued by the United States Army Corps of Engineers, Baltimore District (USACE) on May 27, 2009.

The purpose of this RI is to determine whether the Load Line #1 MRS warrants further response action pursuant to the *Comprehensive Environmental Responsibility, Compensation, and Liability Act of 1980* (CERCLA) and the *National Oil and Hazardous Substances Pollution Contingency Plan*. More specifically, the RI Report is intended to determine the nature and extent of munitions and explosives of concern (MEC) and munitions constituents (MC) and subsequently determine the potential hazards and risks posed to human health and the environment by MEC and MC. The RI Report also presents additional data to assist in determining what remediation alternatives, if any, are necessary.

ES.1 MRS Description

Whenever possible, existing information and data were incorporated into this RI Report. Background information related to the MRS was taken from the *Final Archival Search Report* prepared by the USACE in 2004, the *Final MMRP Historical Records Review* (HRR) prepared by engineering-environmental Management, Inc. (e^2M) in 2007, and the *Final Site Inspection Report* prepared by e^2M in 2008. Previous data collected at the MRS under the Installation Restoration Program (IRP) were also reviewed, but were not considered applicable and were not included in the RI. The Load Line #1 MRS is a 0.41-acre area and is collocated with the 164-acre IRP Area of Concern (AOC) Load Line #1 Army Environmental Data Base Restoration Module No. RVAAP-08. The MRS is located at the north end of the Load Line #1.

Prior to the HRR, the MRS was considered as the entire 164-acre Load Line #1. It was determined in the HRR (e^2M, 2007) that the potential presence of MEC and/or MC was restricted to the areas associated with former buildings CB-13/CB-13B, the area near the former elevated building foundation slab at CB-14, the former popping furnace, and areas where triple-base propellant have historically been found. The HRR reduced the MRS acreage from approximately 164 acres to 4.63 acres at the northern end of the load line where the propellants were identified.

The principle sources of MEC at the Load Line #1 MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and munitions debris (MD), including propellants, to be present in surface soil at the Load Line #1 MRS (e^2M, 2008).

The *Final Site Inspection (SI) Report* (e^2M, 2008) stated that three pieces of triple-base propellant were found on the ground surface during the SI survey. Lead was detected in surface soil collected using the incremental sampling method (ISM) and was considered an MC associated with propellants. A low concentration of 2,4,6-trinitrotoluene was also detected; however, 2,4,6-trinitrotoluene was not considered an MC associated with propellants. Based on the recommendations in the SI Report (e^2M, 2008), the MRS was reduced to a 0.41-acre area located near the northwest side of the former elevated building CB-14 where the SI field activities identified triple-base propellants on the ground surface and elevated lead concentrations in soil.

Current activities at the Load Line #1 MRS include security, maintenance, environmental sampling, remediation, and natural resource management activities. Current human receptors for the MRS include facility personnel, contractors, and potential trespassers.

The OHARNG future use at the MRS is Military Use and Training. As part of the IRP cleanup at this AOC, this site was evaluated for the Risk Assessment Land Use of Mounted Training, No Digging, as documented in the *Final Interim Record of Decision* (USACE, 2007). The AOC is currently being re-evaluated for Unrestricted Guard Use under the IRP. In order to correlate the MMRP with the IRP, the most representative receptor for the MRS is the National Guard Trainee, which will be evaluated as part of this RI.

ES.2 Summary of Remedial Investigation Activities

Based on the presence of triple-base propellant nodules and elevated lead concentrations at the MRS, it was determined in the SI reporting stage that there was the potential for MEC and MC on the ground surface and in shallow surface soils at the MRS. The initial step in evaluating for MEC and MC at the Load Line #1 MRS consisted of performing visual surveys over 100 percent of the MRS.

The data needs and data quality objectives (DQOs) were determined at the planning stage of the RI activities and included characterization for MEC and MC associated with former activities at the MRS. The DQOs were developed to ensure the reliability of field sampling, chemical analyses, and physical analyses; the collection of sufficient data; the acceptable quality of data generated for its intended use; and that valid assumptions could be inferred from the data.

In April and May of 2011, Shaw performed two visual survey investigations to identify potential surface MEC and/or MD at the Load Line #1 MRS. No MEC or MD was found on the ground or shallow surface soils during either survey.

Environmental samples for MC were collected at the Load Line #1 MRS following the nonintrusive instrument assisted visual survey. Two ISM surface soil samples, together comprising 100 percent of the MRS acreage, were collected at depths between 0 and 0.5 foot. Surface soil at the RVAAP is typically defined as 0 to 1 foot for unrestricted use (residential) or 0 to 4 feet for National Guard receptors; however, the rationale for collecting the ISM samples at the 0-to-0.5-foot interval is because MC in surface soil would be expected to be concentrated in the top several inches rather than across the specified surface soil intervals for the individual receptors.

The DQOs stated that discrete samples (surface and subsurface soil) would be collected in areas with concentrated MEC or MD. No MEC or MD was identified at the Load Line #1 MRS during the visual survey activities and it was determined by the project team that additional sampling for MC was not warranted.

ES.3 MEC Hazard Assessment

During the RI field activities, 100 percent of the MRS was investigated and no MEC or MD items were identified. As a result, no MEC source was identified and the presence of an explosive safety hazard at the MRS is not anticipated. Therefore, the project team determined that calculation of a *MEC Hazard Assessment* score was not warranted for the Load Line #1 MRS.

ES.4 MC Risk Assessment

Site-related chemicals (SRCs) for the Load Line #1 MRS were determined for the surface soil samples collected during the RI field activities through the RVAAP data screening process as presented in the *Final Facility-Wide Human Health Cleanup Goals for the RVAAP* (Science Applications International Corporation, 2010). The SRCs identified in the environmental media samples collected during the RI were lead and nitroguanidine. The identified SRCs were then carried through the human health and ecological risk assessments process to evaluate for potential receptors. The risk assessments resulted in the following conclusions:

Protection of Human Health

A human health risk assessment was conducted for surface soil samples collected at the Load Line #1 MRS to determine if the identified SRCs were chemicals of potential concern (COPCs), and/or chemicals of concern (COCs) that may pose a risk to future human

receptors. The Ohio Army National Guard future use at the MRS is Military Use and Training and the AOC, with which the MRS is collocated, is currently being re-evaluated for Unrestricted Guard Use under the IRP. Evaluation of the future land use, in conjunction with the evaluation of agricultural-residential land uses and associated receptors, form the basis for identifying COPCs and COCs in this RI. Residential Land Use, specifically the Residential Farmer (Adult and Child) scenario, is included to evaluate COCs for unrestricted land use at the MRS as required by the CERCLA process.

Neither of the SRCs were identified as COPCs in the first screening step. Therefore, these SRCs were not further evaluated as COCs and are not likely to pose a concern to human receptors.

Protection of Ecological Receptors

Both of the SRCs, lead and nitroguanidine, were identified as chemicals of potential ecological concern (COPECs) in the soil samples collected for the RI at the Load Line #1 MRS. COPECs are determined in the ecological risk assessment and may differ from COPCs. Given the conservativeness of the ecological risk assessment and the low overall concentrations detected, the potential that exposure to the COPECs identified to adversely impact populations of ecological receptors at the Load Line #1 MRS is considered to be very low and not pose a concern to ecological receptors. Therefore, no further investigation (i.e., a Level III Baseline) or action is considered necessary at the Load Line #1 MRS for ecological purposes.

ES.5 Conceptual Site Model

The information collected during the RI field activities was used to update the conceptual site models (CSMs) for MEC and MC. The purpose of the CSMs is to identify all complete, potentially complete, or incomplete source-receptor interactions for current and reasonably anticipated future land use activities at the MRS. An exposure pathway is the course a MEC item or MC takes from a source to a receptor. Each pathway includes a source, activity, access, and receptor.

Two nonintrusive visual surveys were performed over 100 percent of the Load Line #1 MRS during the RI field activities. No MEC or MD items were observed on the ground surface of the MRS during the visual surveys; therefore, the MEC exposure pathway for surface soil is considered incomplete for all receptors.

Since no MEC or MD was identified during the visual survey, and taking into consideration the historical activities that occurred at the MRS, it is expected that triple-base propellants that may be present at the MRS are on the ground surface only. A subsurface investigation

was not warranted and, given the lack of a MEC source, the MEC exposure pathway for subsurface soil is considered incomplete for all receptors.

Sampling was performed at the Load Line #1 MRS to further characterize the nature and extent of contamination associated with previous activities at the MRS. The SRCs detected at the MRS during the RI consisted of the lead and nitroguanidine in surface soil. Although a MEC source was not found, the identified SRCs were conservatively evaluated as MC that may have resulted from the degradation of the propellants due to exposure to the elements. None of the SRC concentrations were determined to pose a hazard to human health or the environment. The MC CSM has been updated to reflect a lack of source and incomplete pathways for the receptors in the terrestrial environment.

ES.6 Conclusions and Recommendations

The following conclusions can be made for the Load Line #1 MRS based on the results of the RI field activities:

- Instrument-assisted nonintrusive visual survey coverage was performed over the entire Load Line #1 MRS during the RI and no subsurface anomalies were detected.
- No physical evidence of MEC or MD was found on the ground surface during the RI and no explosive hazard is anticipated to be present at the MRS.
- Although no MEC source was found during the RI, ISM surface soil samples were analyzed for MC and represent 100-percent coverage of the MRS.
- Detected concentrations of SRCs in surface soil (0 to 0.5 foot) do not pose potential threats to likely receptors at the MRS.

Based on these conclusions, it is determined that the Load Line #1 MRS has been adequately characterized and the DQOs presented in the Work Plan (Shaw, 2011) have been satisfied; therefore, no further action is recommended for this MRS under the MMRP. The Load Line #1 MRS is collocated with the Load Line #1 AOC and administratively, it is recommended that the environmental data collected at the MRS be made available for the IRP. Any future actions at the collocated MRS/AOC should be addressed under the IRP. Follow-up documents under the MMRP may include the preparation of a No Further Action Proposed Plan for public review followed by issuance of a Record of Decision.

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1.0 INTRODUCTION

This *Remedial Investigation (RI) Report* documents the finding and conclusions of the RI field activities for the Load Line #1 (RVAAP-008-R-01) Munitions Response Site (MRS) located at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. This RI Report is being prepared by Shaw Environmental & Infrastructure, Inc. (Shaw) under Delivery Order 0002 for Military Munitions Response Program (MMRP) environmental services at the RVAAP under the *Multiple Award Military Munitions Services Performance-Based Acquisition Contract* No. W912DR-09-D-0005. The Delivery Order was issued by the United States (U.S.) Army Corps of Engineers, Baltimore District (USACE) on May 27, 2009.

This report presents the results of the RI field activities that were conducted at the Load Line #1 MRS between April and May 2011. This report was developed in accordance with the *Final Work Plan for MMRP Remedial Investigation* (Shaw, 2011) at the RVAAP; hereafter, referred to as the Work Plan, and the United States Army's *Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study (RI/FS) Guidance* (U.S. Army, 2009).

1.1 Purpose

Environmental cleanup decision-making under the MMRP follows the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) prescribed sequence of RI, FS, Proposed Plan, and Record of Decision. The RI serves as the mechanism for collecting data to characterize MRS conditions, determining the nature and extent of the contamination, and assessing potential risks to human health and the environment from this contamination. While not all munitions and explosives of concern (MEC) or munitions constituents (MC) under the MMRP constitute CERCLA hazardous substances, pollutants or contaminants, the Defense Environmental Restoration Program (DERP) statute provides the U.S. Department of Defense (DoD) the authority to respond to releases of MEC/MC, and DoD policy states that such responses shall be conducted in accordance with CERCLA and the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP).

The purpose of this RI Report is to determine whether the Load Line #1 MRS warrants further response action pursuant to CERCLA and the NCP. More specifically, the RI Report is intended to determine the nature and extent of MEC and MC and subsequently identify the potential hazards and risks posed to human health and the environment by MEC and MC. The RI Report also presents additional data to assist in determining what remediation alternatives, if any, are necessary.

1.2 Problem Identification

The principle sources of MEC at the Load Line #1 MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and munitions debris (MD), including propellants, to be present in surface soil at the Load Line #1 MRS (engineering-environmental Management, Inc. [e^2M], 2008). The MRS consists of a 0.41-acre area located near the northwest side of the former elevated building CB-14 where triple-base propellants were observed on the ground surface and MC results for elevated lead concentrations and low detects for explosives were detected in surface soil during the 2007 site inspection (SI) activities.

It was concluded in the *Final Site Inspection Report* (e^2M, 2008) that there was a potential for surface MEC (triple-base propellant nodules) and MC in concentrations in surface soil posing a risk to human health or the environment at the MRS. It was recommended in the SI Report that further characterization for MEC and MC be performed at the MRS under the MMRP.

1.3 Physical Setting

This section presents the physical characteristics of the RVAAP, the Load Line #1 MRS and the surrounding environment that are factors in understanding fate and transport, receptors, and exposure scenarios for potential human health and ecological risks. The physiographic setting, hydrology, climate, and ecological characteristics of the RVAAP were compiled primarily from information originally presented in the SI Report (e^2M, 2008), which included the Load Line #1 MRS, and the *Integrated Natural Resources Management Plan* (INRMP) that was prepared for the Ohio Army National Guard (OHARNG) by AMEC Earth and Environmental, Inc. (AMEC) in 2008.

1.3.1 Location

The RVAAP (Federal Facility Identification No. OH213820736), which is located in northeastern Ohio within Portage and Trumbull counties, is approximately 3 miles east-northeast of the city of Ravenna. The RVAAP is approximately 11 miles long and 3.5 miles wide. The RVAAP is bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; Garret, McCormick, and Berry Roads to the west; the Norfolk Southern Railroad to the north; and State Route 534 to the east. In addition, the RVAAP is surrounded by the communities of Windham, Garrettsville, Newton Falls, Charlestown, and Wayland (**Figure 1-1**).

Note:
The scale is for the upper map only showing the RVAAP location

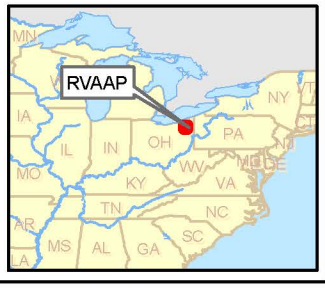

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FIGURE 1-1 RVAAP INSTALLATION LOCATION MAP

Administrative control of 20,423 acres of the 21,683-acre RVAAP have been transferred to the Army National Guard Directorate and subsequently licensed to the OHARNG for use as the Camp Ravenna Joint Military Training Center (CRJMTC). The remaining 1,260 acres of the RVAAP consist of several distinct parcels scattered throughout the confines of Camp Ravenna. These 1,260 acres consist of former industrial facilities that are being managed by the Base Realignment and Closure (BRAC) Division (e^2M, 2008).

The Load Line #1 MRS is a 0.41-acre parcel located in the eastern portion of the RVAAP within Portage County (**Figure 1-2**). The MRS is currently under the administrative control of the BRAC Division. **Table 1-1** summarizes the administrative description for the Load Line #1 MRS that includes the RVAAP Army Environmental Data Base Restoration Module numerical designation for the MRS, the current MRS acreage, and the current property owner of the MRS.

Table 1-1
RVAAP Administrative Description Summary of the Load Line #1 MRS

MRS Name	AEDB-R MRS Number	MRS Acreage (Acres)	Property Owner
Load Line #1	RVAAP-008-R-01	0.41	BRAC Division

AEDB-R denotes Army Environmental Data Base Restoration Module.
BRAC denotes Base Realignment and Closure.
MRS denotes Munitions Response Site.
RVAAP denotes Ravenna Army Ammunition Plant.

1.3.2 Current and Projected Land Use

Current activities at the Load Line #1 MRS include security, maintenance, environmental sampling, remediation, and natural resource management activities. Current human receptors for the MRS include facility personnel, contractors, and potential trespassers.

The OHARNG future use at the MRS is Military Use and Training. As part of the Installation Restoration Program (IRP) cleanup at this area of concern (AOC), this site was evaluated for the Risk Assessment Land Use of Mounted Training, No Digging, as documented in the *Final Interim Record of Decision* (USACE, 2007). The AOC is currently being re-evaluated for Unrestricted Guard Use under the IRP. In order to correlate the MMRP with the IRP, the most representative receptor for the MRS is the National Guard Trainee, which will be evaluated as part of this RI.

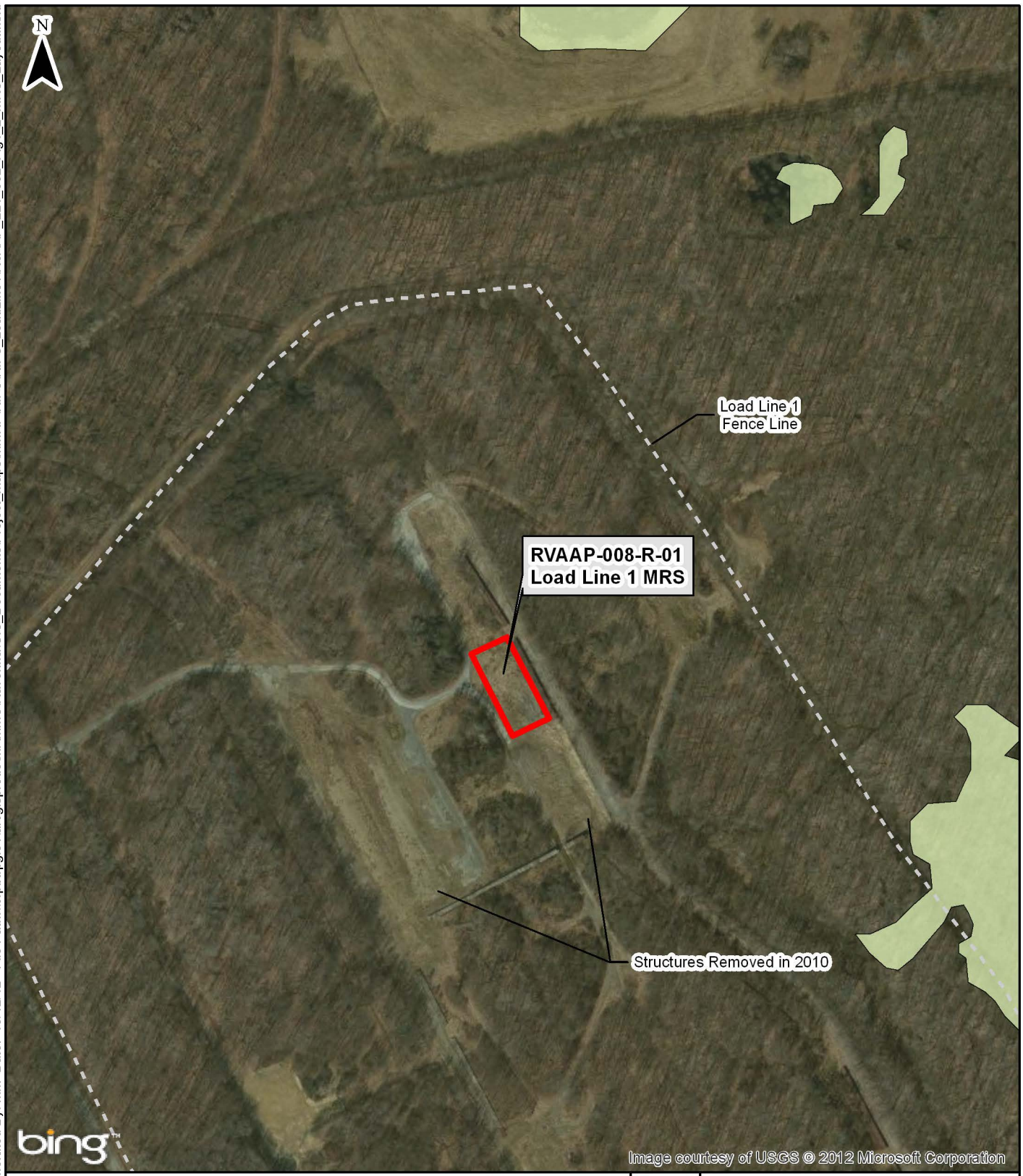

FIGURE 1-2 MRS LOCATION MAP

1.3.3 Topography

The RVAAP is located within the Southern New York section of the Appalachian Plateaus physiographic province. Rolling topography containing incised streams and dendritic drainage patterns are prevalent in the province. Rounded ridges, filled major valleys, and areas covered with glacially derived unconsolidated deposits were the product of glaciation in the Southern New York section. In addition, bogs, kettle lakes, and kames are evidence of past glacial activity in the province; however, none are located at the MRS. Old stream drainage patterns were disturbed and wetlands were created within the province as a result of past glacial activity (e^2M, 2008).

Topography across the Load Line #1 MRS is relatively flat with little change in elevation. The MRS is in a slight depression related to its immediate surroundings. Based on topographical maps, local surface drainage is to the east. There are no natural streams or ponds located within the MRS and the MRS is not located within a flood plain. The ground surface elevation at the MRS is approximately 990 feet above mean sea level (amsl). The topography for the Load Line #1 MRS and the immediate vicinity is presented in **Figure 1-3**.

1.3.4 Climate

The climate at the RVAAP is classified as humid continental, and the region is characterized by warm, humid summers and cold winters. The National Weather Service identified the average annual precipitation for Ravenna, Ohio as 40.23 inches, with February as the driest month and July as the wettest month. **Table 1-2** reflects the annual climate and weather normally encountered at nearby Youngstown Municipal Airport.

Table 1-2
Climatic Information, Youngstown Municipal Airport, Ohio

Temperature Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Maximum Temperature (degrees Fahrenheit)	32.4	36.0	46.3	58.2	69.0	77.1	81.0	79.3	72.1	60.7	48.4	37.3
Normal Minimum Temperature (degrees Fahrenheit)	17.4	19.3	27.1	36.5	46.2	54.6	58.7	57.5	50.9	40.9	33.0	23.4
Mean Precipitation (inches)	2.34	2.03	3.05	3.33	3.45	3.91	4.10	3.43	3.89	2.46	3.07	2.96
Mean Snowfall (inches)	13.1	9.6	10.4	2.2	0	0	0	0	Trace	0.6	4.5	12.3

Source: National Oceanic and Atmospheric Administration Climatography of the United States No. 81, 1971–2000.

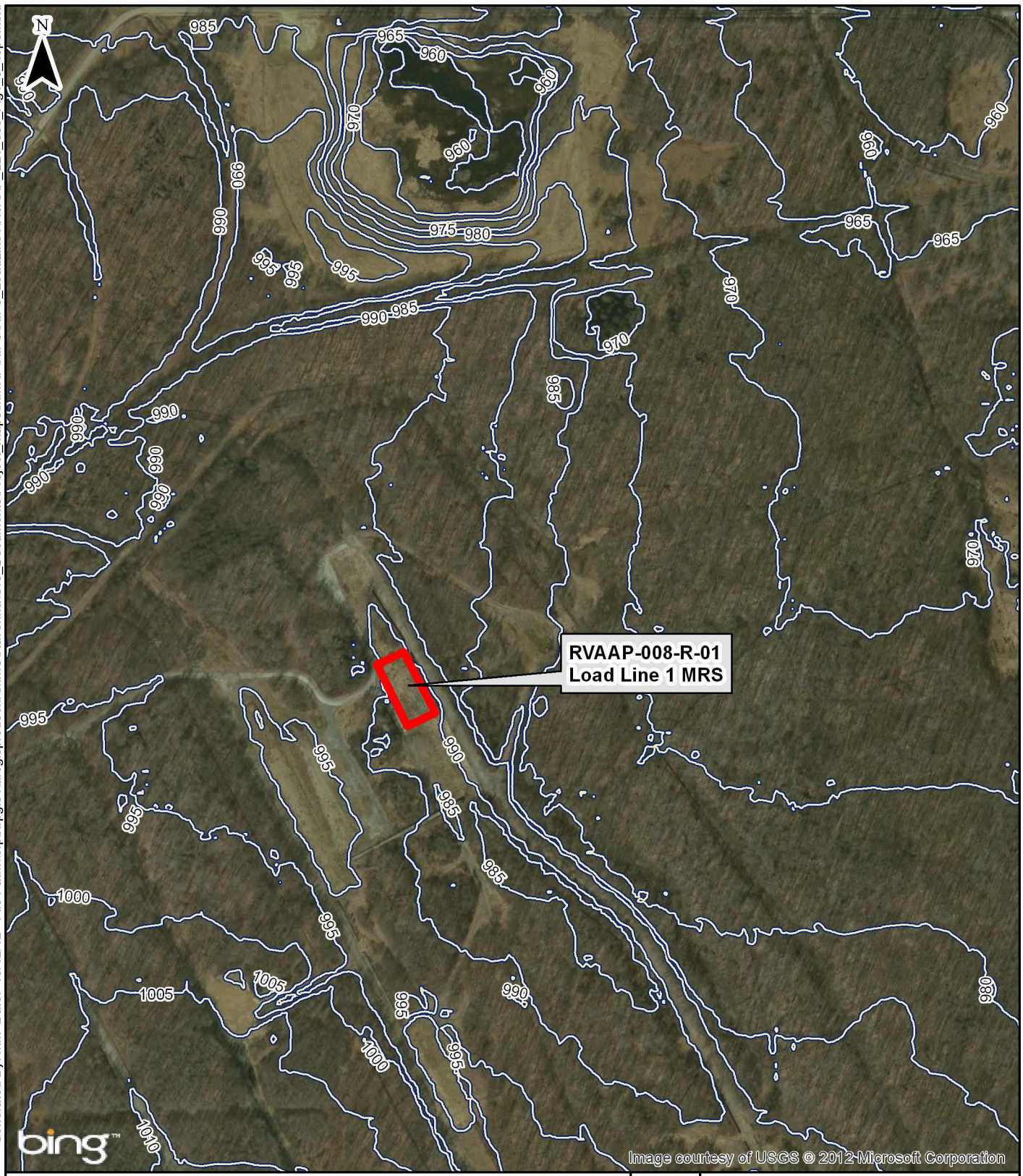

FIGURE 1-3 TOPOGRAPHY

1.3.5 Hydrology and Hydrogeology

The RVAAP is located within the Ohio River Basin. The major surface stream at the RVAAP is the west branch of the Mahoning River, which flows adjacent to the western end of the RVAAP, generally from north to south, before flowing into the Michael J. Kirwan Reservoir. After leaving the reservoir, the west branch joins the Mahoning River east of the RVAAP.

Surface water features within the RVAAP include a variety of streams, lakes, ponds, floodplains, and wetlands. Numerous streams drain the RVAAP, including approximately 19 miles of perennial streams. The combined stream length at the RVAAP is 212 linear miles (AMEC, 2008).

Three primary watercourses drain the RVAAP: (1) the south fork of Eagle Creek, (2) Sand Creek, and (3) Hinkley Creek. Eagle Creek and its tributaries, including Sand Creek, are designated as State Resource Waters. With this designation, the stream and its tributaries fall under the state's antidegradation policy. These waters are protected from any action that would degrade the existing water quality.

Approximately 153 acres of ponds are found on the RVAAP. Most of the ponds were created by beaver activity or small man-made dams and embankments. Some were constructed within natural drainage ways to function as settling ponds for effluent or runoff. No ponds are located at the Load Line #1 MRS (AMEC, 2008).

A planning level survey (i.e., desktop review of wetlands data and resources [National Wetlands Inventory maps, aerials, etc.]) for wetlands was conducted for the entire RVAAP, including the MRS. Wetlands located within the RVAAP include seasonally saturated wetlands, wet fields, and forested wetlands. Sand and gravel aquifers are present within the buried-valley and outwash deposits in Portage County. In general, the aquifer is too thin and localized to provide large quantities of water; however, yields are sufficient for residential water supplies. Wells located on the RVAAP were primarily located within the sandstone facies of the Sharon Member (MKM Engineers, Inc. [MKM], 2007).

Although groundwater recharge and discharge areas have not been delineated at the RVAAP, it is assumed that the extensive uplands areas at the RVAAP, primarily located at the western portion of the RVAAP, are regional recharge zones. Sand Creek, Hinkley Creek, and Eagle Creek are presumed to be major groundwater discharge areas (e^2M, 2008). The Load Line #1 MRS is located at the eastern lowland portion of the RVAAP that is not situated in the upland areas that are considered to be regional recharge zones.

Hydrology and Hydrogeology at the Load Line #1 MRS

No surface water features, wetlands, bogs, kettle lakes, or kames are located at the Load Line #1 MRS. The MRS is not located in a floodplain. The nearest surface water drainage is an unnamed drainage outlet at the northeast corner of Load Line #1 and is considered an intermittent surface water drainage channel.

Groundwater is present at the MRS at approximately 32 feet below ground surface (bgs) in unconsolidated sediments (MKM, 2007). Groundwater flow is generally to the northeast (Science Applications International Corporation [SAIC], 2003).

1.3.6 Geology and Soils

Based on regional geology, the RVAAP consists of Mississippian- and Pennsylvanian-age bedrock strata, which dips to the south at approximately 5 to 10 feet per mile. The bedrock is overlain by unconsolidated glacial deposits of varying thickness.

Bedrock is overlain by deposits of Wisconsin-age Lavery Till and Hiram Till in the western and eastern portions of the RVAAP, respectively. The thickness of the glacial deposits varies throughout the RVAAP ranging from ground surface in parts of the eastern portion of the RVAAP to an estimated 150 feet in the south-central portion of the RVAAP.

Bedrock is present near the ground surface in many locations at the RVAAP, including Load Line #1 at the east end of the RVAAP. Where glacial deposits are still present, their distribution and character are indicative of ground moraine origin. Laterally discontinuous groupings of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments are present. Glacial-age standing-water-body deposits may be present at the RVAAP, in the form of uniform light gray silt deposits over 50 feet thick.

At approximately 200 feet bgs, the Mississippian Cuyahoga Group is present throughout most of the RVAAP. In the northeastern corner of the RVAAP, the Meadville Shale Member of the Cuyahoga Group is present close to the surface. The Meadville Shale Member of the Cuyahoga Group is a blue-gray silty shale characterized by alternating thin beds of sandstone and siltstone.

The Sharon Member of the Pennsylvanian Pottsville Formation unconformably overlies the Meadville Shale Member of the Mississippian Cuyahoga Group. A relief of as much as 200 feet exists in Portage County, which can be seen in the Sharon Member thickness variations. The Sharon Member is made up of shale and a conglomerate.

The Sharon Member conglomerate unit is identified as highly porous, permeable, cross-bedded, frequently fractured, and weathered quartzite sandstone, which is locally conglomeratic and has an average thickness of 100 feet. A thickness of as much as 250 feet

exists in the Sharon Conglomerate where it was deposited in a broad channel cut into Mississippian rocks. In marginal areas of the channel, the conglomerate unit may thin out to approximately 20 feet, or in places, it may be missing owing to nondeposition on the uplands of the early Pennsylvanian erosional surface. Thin shale lenses occur intermittently within the upper part of the conglomerate unit.

The Sharon Member shale unit is identified as a light- to dark-gray fissile shale, which overlies the conglomerate in some locations; however, it has been eroded throughout the majority of the RVAAP. The Sharon Member outcrops in many locations in the eastern half of the RVAAP.

The remaining members of the Pottsville Formation overlie the Sharon Member in the western portion of the RVAAP. Due to erosion and because the land surface was above the level of deposition, the Pottsville Formation is not found in the eastern half of the RVAAP.

The Connoquenessing Sandstone Member, which is sporadic, relatively thin channel sandstone comprised of gray to white, coarse-grained quartz with a higher percentage of feldspar and clay than the Sharon Conglomerate, unconformably overlies the Sharon Member. The Mercer Member, which is found above the Connoquenessing Sandstone Member, consists of silty to carbonaceous shale with many thin and discontinuous lenses of sandstone in its upper part. The Homewood Sandstone Member unconformably overlies the Mercer Member and consists of the uppermost unit of the Pottsville Formation. The Homewood Sandstone Member ranges from well-sorted, coarse-grained, white quartz sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. The Homewood Sandstone Member occurs as a caprock on bedrock highs in the subsurface (e^2M, 2008).

Geology and Soils at the Load Line #1 MRS

The Load Line #1 MRS is located over the Sharon Sandstone formation and the bedrock elevation appears to be several feet bgs at approximately 985 feet amsl. **Figure 1-4** illustrates the bedrock formation beneath the MRS.

The soils identified at the RVAAP are generally derived from the Wisconsin-age silty clay glacial till. The major soil types found at the RVAAP are silt or clay loams, ranging in permeability from 6.0×10^{-7} to 1.4×10^{-3} centimeters per second (U.S. Department of Agriculture, 1978). The native soil type at the MRS is identified as Mitiwanga silt loam with 0- to 2-percent slopes (AMEC, 2008). The majority of native soil at the RVAAP has been reworked or removed during construction activities (MKM, 2007). **Figure 1-5** illustrates the soil types at the Load Line #1 MRS.

MRS Boundary

Geologic Formation

Sharon Sandstone - Conglomerate Unit

Bedrock Elevation Contour

0 500 1,000 Feet

Projection : NAD_1983_UTM_Zone_17N

U.S. ARMY
CORPS OF ENGINEERS
BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1 MRS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw® a world of Solutions™

Generated By: MM Date: 10/12/12 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS_Documents\Project_Maps\MMRP\RIFS\RIFS_LoadLine1\RVAAP_LL1_004_Fig1_4_Bedrock.mxd

Project Number: 136147

FIGURE 1-4 BEDROCK MAP

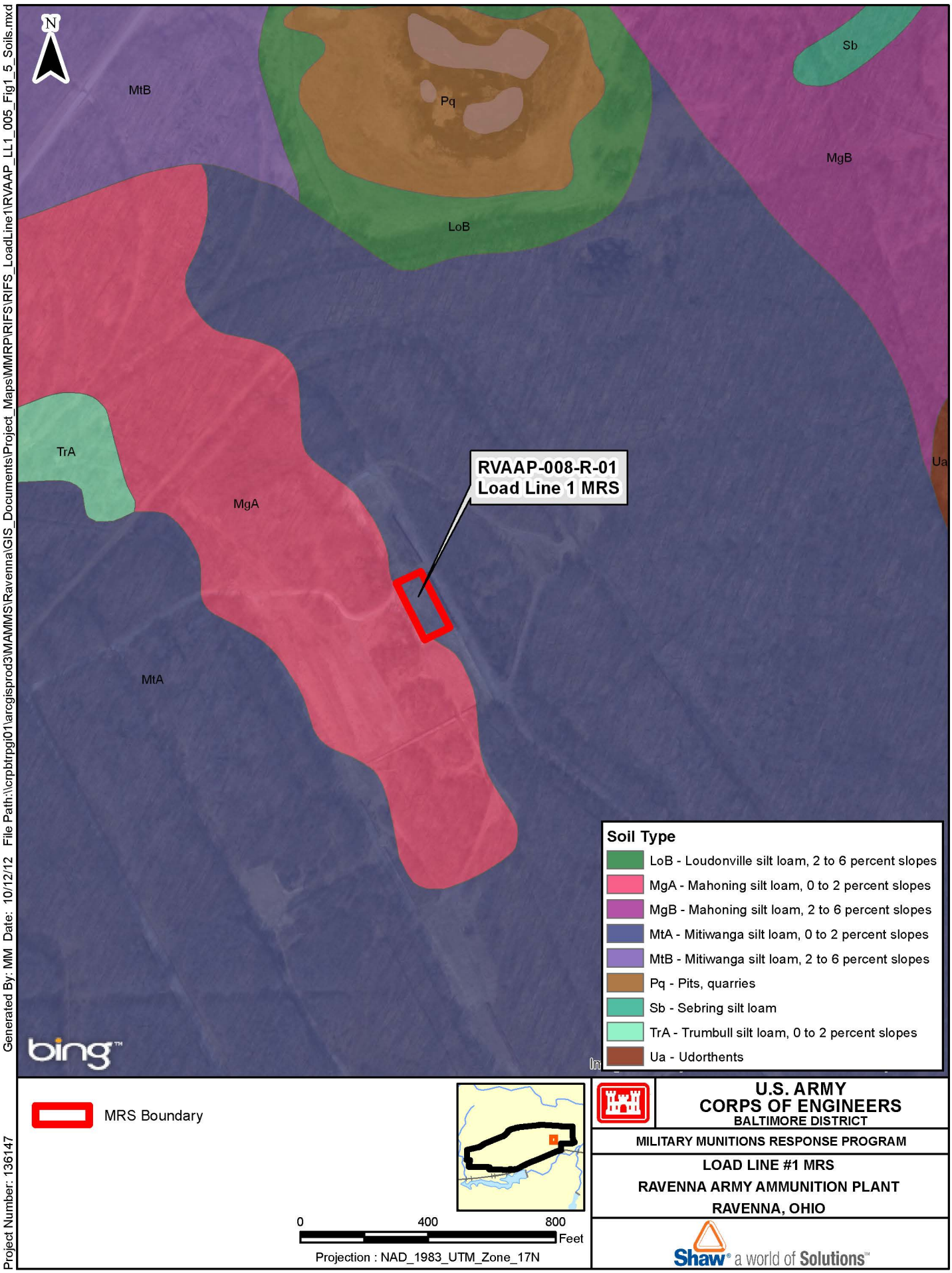

FIGURE 1-5 SOILS MAP

1.3.7 Vegetation

The RVAAP has a diverse range of vegetation and habitat resources. Habitats present within the RVAAP include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open water ponds and lakes, and semi-improved administration areas. Vegetation at the RVAAP can be grouped into three categories: (1) herb-dominated, (2) shrub-dominated, and (3) tree-dominated. Tree-dominated areas are most abundant, covering approximately 13,000 acres on the RVAAP. Shrub vegetation covers approximately 4,200 acres. A plant species survey identified 18 vegetation communities on the RVAAP. The RVAAP has seven forest formations, four shrub formations, eight herbaceous formations, and one nonvegetated formation (AMEC, 2008).

Vegetation at the Load Line #1 MRS

The vegetation community present at the Load Line #1 MRS is categorized as the "Dry Midsuccessional Cold-Deciduous Shrubland Alliance." This shrubland alliance is associated with relatively open areas characterized by shrub species covering more than 50 percent of the area, with relatively few large trees. This alliance often is found within previously disturbed areas, and is dominated by gray dogwood, northern arrowwood, blackberry, hawthorn, and multiflora rose (AMEC, 2008).

1.3.8 Endangered, Threatened, and Other Rare Species

Federal status as a candidate, threatened, or endangered species is derived from the Endangered Species Act (ESA) (16 United States Code [USC] 1538, et seq.) and is administered by the U.S. Fish and Wildlife Service (USFWS). While there are species under federal review for listing, there are currently no federally listed species or critical habitats at the RVAAP. State-listed plant and animal species are determined by the Ohio Department of Natural Resources (ODNR). Although biological inventories have not occurred within the MRS boundary and no confirmed sightings of state-listed species have been reported, there is the potential for state-listed or rare species to be within the MRS boundary. Information regarding endangered, threatened, and candidate species at the RVAAP was obtained from the CRJMTC Rare Species List (2010). **Table 1-3** presents state-listed species that have been identified to be on the RVAAP by biological inventories and confirmed sightings.

Table 1-3
Camp Ravenna Joint Military Training Center Rare Species List

Common Name	Scientific Name
State Endangered	
American bittern	*Botaurus lentiginosus*
Northern harrier	*Circus cyaneus*

Table 1-3 (continued)
Camp Ravenna Joint Military Training Center Rare Species List

Common Name	Scientific Name
Yellow-bellied sapsucker	*Sphyrapicus varius*
Golden-winged warbler	*Vermivora chrysoptera*
Osprey	*Pandion haliaetus*
Trumpeter swan	*Cygnus buccinator*
Mountain brook lamprey	*Ichthyomyzon greeleyi*
Graceful underwing moth	*Catocala gracilis*
Tufted moisture-loving moss	*Philonotis fontana var. caespitosa*
Bobcat	*Felis rufus*
Narrow-necked Pohl's moss	*Pohlia elongata var. elongata*
Sandhill crane (probable nester)	*Grus canadensis*
Bald eagle (nesting pair)	*Haliaeetus leucocephalus*
State Threatened	
Barn owl	*Tyto alba*
Dark-eyed junco (migrant)	*Junco hyemalis*
Hermit thrush (migrant)	*Catharus guttatus*
Least bittern	*Ixobrychus exilis*
Least flycatcher	*Empidonax minimus*
Caddisfly	*Psilotreta indecisa*
Simple willow-herb	*Epilobium strictum*
Woodland horsetail	*Equisetum sylvaticum*
Lurking leskea	*Plagiothecium latebricola*
Pale sedge	*Carex pallescens*
State Potentially Threatened Plants	
Gray birch	*Betula populifolia*
Butternut	*Juglans cinerea*
Northern rose azalea	*Rhododendron nudiflorum var. roseum*
Hobblebush	*Viburnum alnifolium*

Table 1-3 (continued)
Camp Ravenna Joint Military Training Center Rare Species List

Common Name	Scientific Name
Long beech fern	*Phegopteris connectilis*
Straw sedge	*Carex straminea*
Tall St. Johnswort	*Hypericum majus*
Water avens	*Geum rivale*
Shining lady's tresses	*Spiranthes lucida*
Swamp oats	*Sphenopholis pensylvanica*
Arborvitae	*Thuja occidentalis*
American chestnut	*Castanea dentata*
State Species of Concern	
Pygmy shrew	*Sorex hoyi*
Woodland jumping mouse	*Napaeozapus insignis*
Star-nosed mole	*Condylura cristata*
Sharp-shinned hawk	*Accipiter striatus*
Marsh wren	*Cistothorus palustris*
Henslow's sparrow	*Ammodramus henslowii*
Cerulean warbler	*Dendroica cerulea*
Prothonotary warbler	*Protonotaria citrea*
Bobolink	*Dolichonyx oryzivorus*
Northern bobwhite	*Colinus virginianus*
Common moorhen	*Gallinula chloropus*
Great egret (migrant)	*Ardea alba*
Sora	*Porzana carolina*
Virginia rail	*Rallus limicola*
Creek heelsplitter	*Lasmigona compressa*
Eastern box turtle	*Terrapene carolina*
Four-toed salamander	*Hemidactylium scutatum*
Mayfly	*Stenonema ithaca*

Table 1-3 (continued)
Camp Ravenna Joint Military Training Center Rare Species List

Common Name	Scientific Name
Moth	*Apamea mixta*
Moth	*Brachylomia algens*
Sedge wren	*Cistothorus platensis*
State Special Interest	
Canada warbler	*Wilsonia canadensis*
Little blue heron	*Egretta caerulea*
Magnolia warbler	*Dendroica magnolia*
Northern waterthrush	*Seiurus noveboracensis*
Winter wren	*Troglodytes troglodytes*
Back-throated blue warbler	*Dendroica caerulescens*
Brown creeper	*Certhia americana*
Mourning warbler	*Oporornis philadelphia*
Pine siskin	*Carduelis pinus*
Purple finch	*Carpodacus purpureus*
Red-breasted nuthatch	*Sitta canadensis*
Golden-crowned kinglet	*Regulus satrapa*
Blackburnian warbler	*Dendroica fusca*
Blue grosbeak	*Guiraca caerulea*
Common snipe	*Gallinago gallinago*
American wigeon	*Anas americana*
Gadwall	*Anas strepera*
Green-winged teal	*Anas crecca*
Northern shoveler	*Anas clypeata*
Redhead duck	*Aythya americana*
Ruddy duck	*Oxyura jamaicensis*

Source: Camp Ravenna Joint Military Training Center Rare Species List, April 27, 2010.

1.3.9 Cultural and Archeological Resources

A number of archeological surveys have been conducted at the RVAAP. Cultural and archeological resources have been identified at the RVAAP during past surveys. The Load Line #1 MRS has not been previously surveyed for cultural and archeological resources; however, due to the disturbed nature of the area from former operations and remediation activities, it is unlikely that cultural and/or archeological resources are present at the MRS.

1.4 History and Background

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

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

In addition to production and demilitarization activities at the load lines, other facilities at the RVAAP include MRSs that were used for the burning, demolition, and testing of munitions. These burning and demolition grounds consist of large parcels of open space or abandoned quarries. Potential contaminants at these MRSs include explosives, propellants, metals, and waste oils. Other AOCs present at the RVAAP include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities (SAIC, 2011).

Load Line #1 MRS History and Background

Load Line #1 is approximately 164 acres in area. It was used to melt and load TNT and Composition B explosives into large-caliber shells during World War II and the Korean War. Explosive dust, spills, and vapors collected on the floors and walls of several buildings as a result of load operations. The walls were periodically washed with water and steam. In 1971, the load line's freestanding equipment was removed.

Investigation and remediation activities under the IRP have been ongoing at the Load Line #1 AOC, in which the MRS is collocated, since 1996. From 1996 through 1998, salvage operations continued with the removal of the overhead steam lines and major rail spurs, and the removal of all telephone lines. The majority of the buildings were demolished and removed by 2000. The remainder of the floor slabs were demolished and removed in 2009.

The Load Line #1 MRS was originally a 4.63-acre area composed of several buildings associated with packing and shipping (CB-13/CB-13B), the location of the former popping furnace located adjacent to the former building CB-13B, and the area around the former propellant charge building (CB-14). Based on the recommendations in the SI Report (e^2M, 2008), the MRS was reduced to a 0.41-acre area located near the northwest side of the former elevated building CB-14 where triple-base propellants were observed on the ground surface and elevated lead concentrations and low concentrations of explosives were detected in surface soil during the SI activities. The MRS is located at the north end of the load line. **Figure 1-6** presents the current MRS boundaries and associated features investigated for the RI.

The principle sources of MEC at the Load Line #1 MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC/MD, including propellants, to be present in surface soil at the Load Line #1 MRS (e^2M, 2008).

FIGURE 1-6 SITE FEATURES MAP

1.5 Previous Investigations and Actions

This section briefly summarizes the investigations and actions as they pertain to the Load Line #1 MRS. This information was obtained primarily from the SI Report (e^2M, 2008).

1.5.1 2004 USACE Archives Search Report

The USACE conducted an archives search in 2004 under the DERP as a historical records search and SI for the presence of MEC at the RVAAP. The *Final Archives Search Report* (ASR) was prepared by the USACE in 2004 and identified 12 AOCs as well as 4 additional locations with the potential for MEC. Based on the ASR, Ramsdell Quarry Landfill, Erie Burning Grounds, Open Demolition Area #1, Load Line 12 and Dilution/Settling Pond, Building 1200-Dilution/Settling Pond, Quarry Landfill/Former Fuze and Booster Burning Pits, 40 MM Firing Range, Building 1037-Laundry Waste Water Sump, Anchor Test Area, Atlas Scrap Yard, Block D Igloo, and Tracer Burning Furnace were identified as potential MRSs containing MEC. Confirmed MEC was identified at Open Demolition Area #2, Landfill North of Winklepeck, Load Line #1 and Dilution/Settling Pond, and Load Line 3 and Dilution/Settling Pond (USACE, 2004).

1.5.2 2007 e^2M Historical Records Review

The *Final MMRP Historical Records Review* (HRR) was performed by e^2M in January 2007. The primary objective of the HRR was to perform a limited scope records search to document historical and other known information on MRSs identified at the RVAAP, to supplement the U.S. Army Closed, Transferring, and Transferred Range/Site Inventory, and to support the technical project planning process designed to facilitate decisions on those areas where more information was needed to determine the next step(s) in the CERCLA process. Of the 19 MMRP-eligible MRSs identified during the U.S. Army Closed, Transferring, and Transferred Range/Site Inventory, the HRR identified 18 MRSs that qualified for the MMRP due to the demolition and/or disposal activities that were conducted on the MRS which resulted in the possible presence of MEC and/or MC, and where the releases occurred prior to September 2002 (e^2M, 2008). These 18 MRSs identified during the HRR included the following:

- Ramsdell Quarry Landfill (RVAAP-001-R-01)
- Erie Burning Grounds (RVAAP-002-R-01)
- Open Demolition Area #2 (RVAAP-004-R-01)
- Load Line #1 (RVAAP-008-R-01)
- Load Line 12 (RVAAP-012-R-01)
- Fuze and Booster Quarry (RVAAP-016-R-01)

- Landfill North of Winklepeck (RVAAP-019-R-01)
- 40mm Firing Range (RVAAP-32-R-01)
- Firestone Test Facility (RVAAP-033-R-01)
- Sand Creek Dump (RVAAP-034-R-01)
- Building #F-15 and F-16 (RVAAP-046-R-01)
- Anchor Test Area (RVAAP-048-R-01)
- Atlas Scrap Yard (RVAAP-050-R-01)
- Block D Igloo (RVAAP-060-R-01)
- Block D Igloo TD (RVAAP-061-R-01)
- Water Works #4 Dump (RVAAP-062-R-01)
- Area Between Buildings 846 and 849 (RVAAP-063-R-01) (now identified as "Group 8")
- Field at the Northeast Corner of the Intersection (RVAAP-064-R-01)

Following the HRR, the Field at the Northeast Corner of the Intersection (RVAAP-064-R-01), otherwise known as the Old Hayfield MRS, was classified as an operational range. This MRS was removed from eligibility under the MMRP, reducing the number of active MRSs at the RVAAP to 17.

The HRR determined that the potential presence of MEC and/or MC at the Load Line #1 MRS was limited to an approximately 5-acre area at the northern portion of the AOC in the area of former Buildings CB-13/CB-13B and the former building slab for CB-14.

1.5.3 2008 e^{2}M MMRP Site Inspection Report

In 2007, e^{2}M conducted a SI at each of the 17 MRSs under the MMRP. The primary objectives of the SI activities were to collect the appropriate amount of information to support recommendations of "no further action, immediate response, or further characterization" concerning the presence of MEC and/or MC at each of the MRSs. The SI also included a review of the HRR for each of the applicable MRSs. Out of the 17 MRSs evaluated during the SI phase, 14 were recommended for additional characterization under the MMRP, which included the Load Line #1 MRS (RVAAP-008-R-01). A summary of the SI Report (e^{2}M, 2008) recommendations for the Load Line #1 MRS is presented in **Table 1-4** and discussed below.

Table 1-4
Site Inspection Report Recommendations

MRS	MRSPP Priority	Recommendation	Basis for Recommendation	
			MEC	MC
Load Line #1 MRS (RVAAP-008-R-01)	5	Further characterization of MEC and MC at reduced MRS footprint	MEC present	MC detected above screening criteria

MC denotes munitions constituent.
MEC denotes munitions and explosives of concern.
MRS denotes munitions response site.
MRSPP denotes Munitions Response Site Prioritization Protocol.
RVAAP denotes Ravenna Army Ammunitions Plant.

The Load Line #1 MRS was assigned a Munitions Response Site Prioritization Protocol (MRSPP) priority of 5. The MRSPP is a funding mechanism typically performed during the Preliminary Assessment/SI stage to prioritize funding for MRSs on a priority scale of 1 to 8 with a Priority 1 being the highest relative priority. Based on the MRSPP identified for the MRS in the SI Report (e^2M, 2008), the Load Line #1 MRS was selected for inclusion for "further characterization." The following paragraphs summarize the investigation activities performed at the Load Line #1 MRS during the 2007 SI and the conclusions and recommendations for the MRS as identified in the SI Report (e^2M, 2008).

As part of the SI, a visual survey was performed at the Load Line #1 MRS. Three pieces of triple-base propellant (1 inch by ¼ inch each) were found on the ground surface during the survey and were classified as MEC. One nodule was found on the northwestern side of the former elevated building CB-14 slab. The other two were located along the railroad track.

Lead was detected in surface soil collected using the incremental sampling method (ISM) and was considered an MC associated with propellants. A low concentration of TNT was also detected; however, TNT is not considered an MC associated with propellants. The concentration of TNT was found to be too low to pose an explosives hazard and be considered as MEC.

Based on the unexploded ordnance (UXO) survey and MC results for lead and low detects for explosives, the SI recommended further characterization to address MEC and MC concerns at the Load Line #1 MRS as the density of propellants at the MRS was not fully understood. The SI Report (e^2M, 2008) also recommended that the MRS footprint be reduced from the original 4.63 acres to the current 0.41 acres where the ISM sample with detected elevated lead concentrations was collected.

1.6 Remedial Investigation Report Organization

The contents and order of presentation of this RI Report are based on the requirements of the *MMRP RI/FS Guidance* (U.S. Army, 2009). Specifically, this RI Report includes the following sections:

- **Section 1.0**—Introduction
- **Section 2.0**—Project Objectives
- **Section 3.0**—Characterization of MEC and MC
- **Section 4.0**—Remedial Investigation Results
- **Section 5.0**—Fate and Transport
- **Section 6.0**—MEC Hazard Assessment
- **Section 7.0**—Human Health Risk Assessment
- **Section 8.0**—Ecological Risk Assessment
- **Section 9.0**—Revised Conceptual Site Model
- **Section 10.0**—Summary and Conclusions
- **Section 11.0**—References

Appendices included at the end of this RI are as follows:

- **Appendix A—**Field Documentation
- **Appendix B—**Data Validation Report
- **Appendix C—**Laboratory Analytical Data
- **Appendix D—**Investigation Derived Waste
- **Appendix E—**Photograph Documentation Log
- **Appendix F—**Ecological Risk Assessment Tables
- **Appendix G—**Munitions Response Site Prioritization Protocol Data Tables

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2.0 PROJECT OBJECTIVES

This section presents the preliminary conceptual site models (CSMs) for MEC and MC for the Load Line #1 MRS based on historical information and identified data gaps associated with the preliminary CSMs and the data quality objectives (DQOs) necessary to achieve the project objectives.

A CSM for a MRS provides an analysis of potential exposures associated with MEC and/or MC and an evaluation of the potential transport pathways MEC and/or MC take from a source to a receptor. Each pathway includes a source, activity, access, and receptor component, with complete, potentially complete, or incomplete exposure pathways identified for each receptor. Each component of the CSM analysis is discussed below.

- **Sources—**Sources are those areas where MEC or MC have entered (or may enter) the physical system. A MEC source is the location where materiel potentially presenting an explosive hazard (MPPEH) or ordnance is situated or are expected to be found. A MC source is a location where MC has entered the environment.
- **Activity—**The hazard from MEC and/or MC arises from direct contact as a result of some human or ecological activity. Interactions associated with activities describe ways that receptors are exposed to a source. For MEC, movement is not typically significant, and interaction will occur only at the source area as described above, limited by access and activity. However, there can be some movement of MEC through natural processes such as frost heave, erosion, and stream conveyance. For MC, this can include physical transportation of the contaminant and transfer from one medium to another through various processes such that media other than the source area can become contaminated. Interactions also include exposure routes (ingestion, inhalation, and dermal contact) for each receptor. Ecological exposure can include coming into contact with MEC or MC lying on the ground surface or through disturbing buried MEC/MC while digging or performing other activities such as burrowing.
- **Access—**Access is the ease with which a receptor can be exposed to a source. The presence of access controls help determine whether an exposure pathway to a receptor is complete, as fences or natural barriers can limit human access to a source area. Furthermore, the depth of MEC items in subsurface soils and associated MC may also limit access by a receptor. Ease of entry for adjacent populations (i.e., lack of fencing) can facilitate trespassing at the MRS, either intentional or accidental.

- **Receptors—**A receptor is an organism (human or ecological) that contacts a chemical or physical agent. The pathway evaluation must consider both current and reasonably anticipated future land use and activities, as receptors are determined on that basis. If present, MEC and/or MC on the ground surface and near the surface can be accessed by facility personnel, contractors, trespassers, and biota.

In general, the CSMs for each MRS are intended to assist in planning, interpreting data, and communicating MRS-specific information. The CSMs are used as a planning tool to integrate information from a variety of resources, to evaluate the information with respect to project objectives and data needs, and to evolve through an iterative process of further data collection or action. A discussion of the preliminary CSMs identified for the Load Line #1 MRS, as presented in the SI Report (e^2M, 2008), is presented in the following section. The data collected during the RI are incorporated into this model and is discussed in Section 4.0, "Remedial Investigation Results."

2.1 Preliminary CSMs and Project Approach

The preliminary CSMs for MEC and MC for the Load Line #1 MRS are based on MRS-specific data and general historical information including literature reviews, maps, training manuals, technical manuals, and field observations. The preliminary CSMs, which were originally developed during the SI process, are based on guidance from the USACE Engineer Manual 1110-1-1200, *Conceptual Site Models for Ordnance and Explosives and Hazardous, Toxic, and Radioactive Waste Projects* (USACE, 2003a). The preliminary MEC CSM and MC CSM are represented by the diagrams provided as **Figure 2-1** and **Figure 2-2**, respectively. A summary of each of the factors evaluated for the preliminary CSMs are discussed below.

- **Sources—**The potential presence of triple-base propellants on the ground surface was considered as the primary source of the potentially explosive MEC at the Load Line #1 MRS. Based on review of the archival records and available documentation, the principle sources of MEC at the Load Line #1 MRS were accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC/MD to be present in surface soil at the Load Line #1 MRS. Given the MRS history, the presence of MEC in the subsurface was not anticipated, as no burial activities were known to occur. The source of MC at the MRS also includes the potential residual contamination in soils as a result of the propellants on the ground surface.

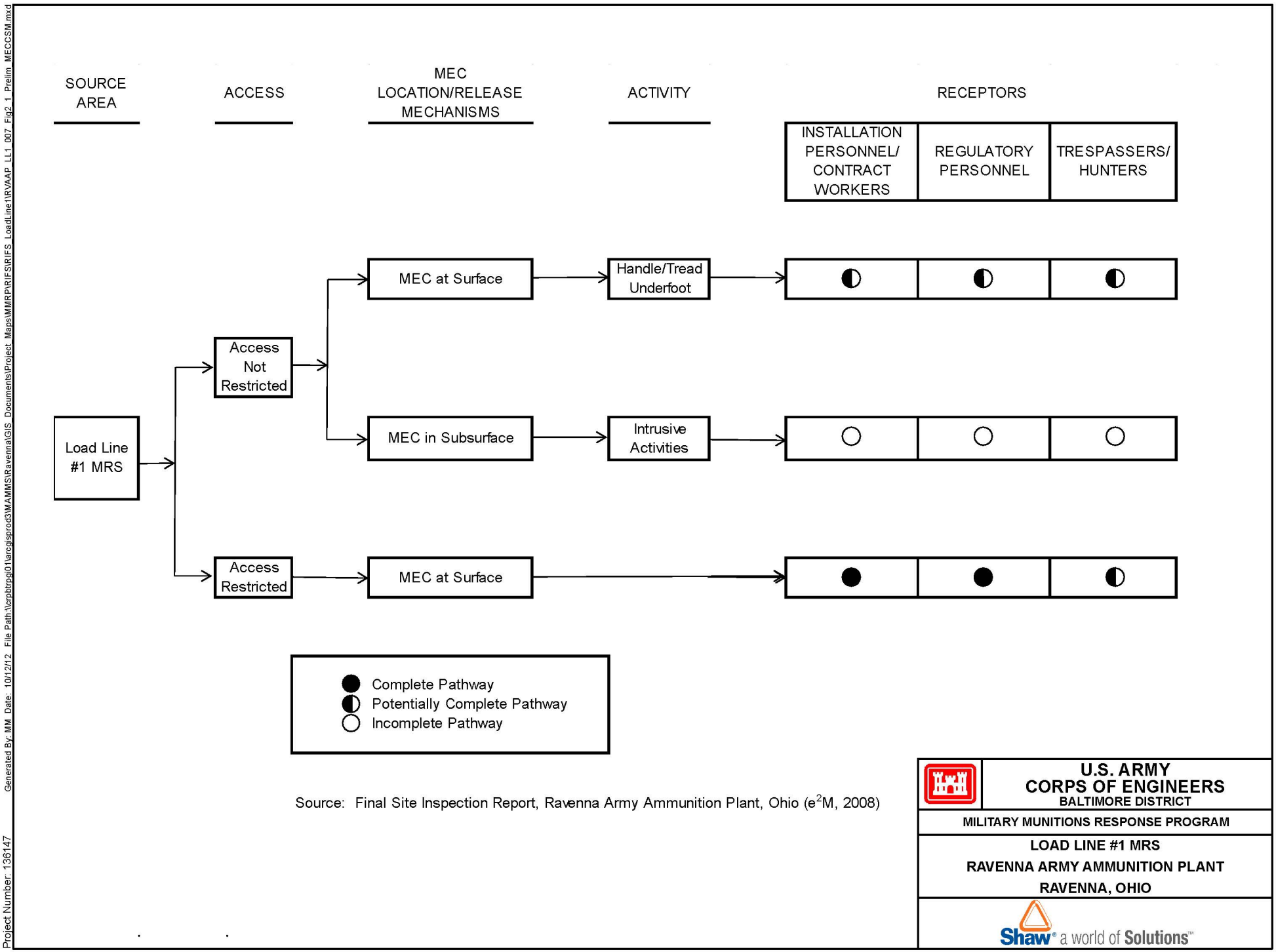
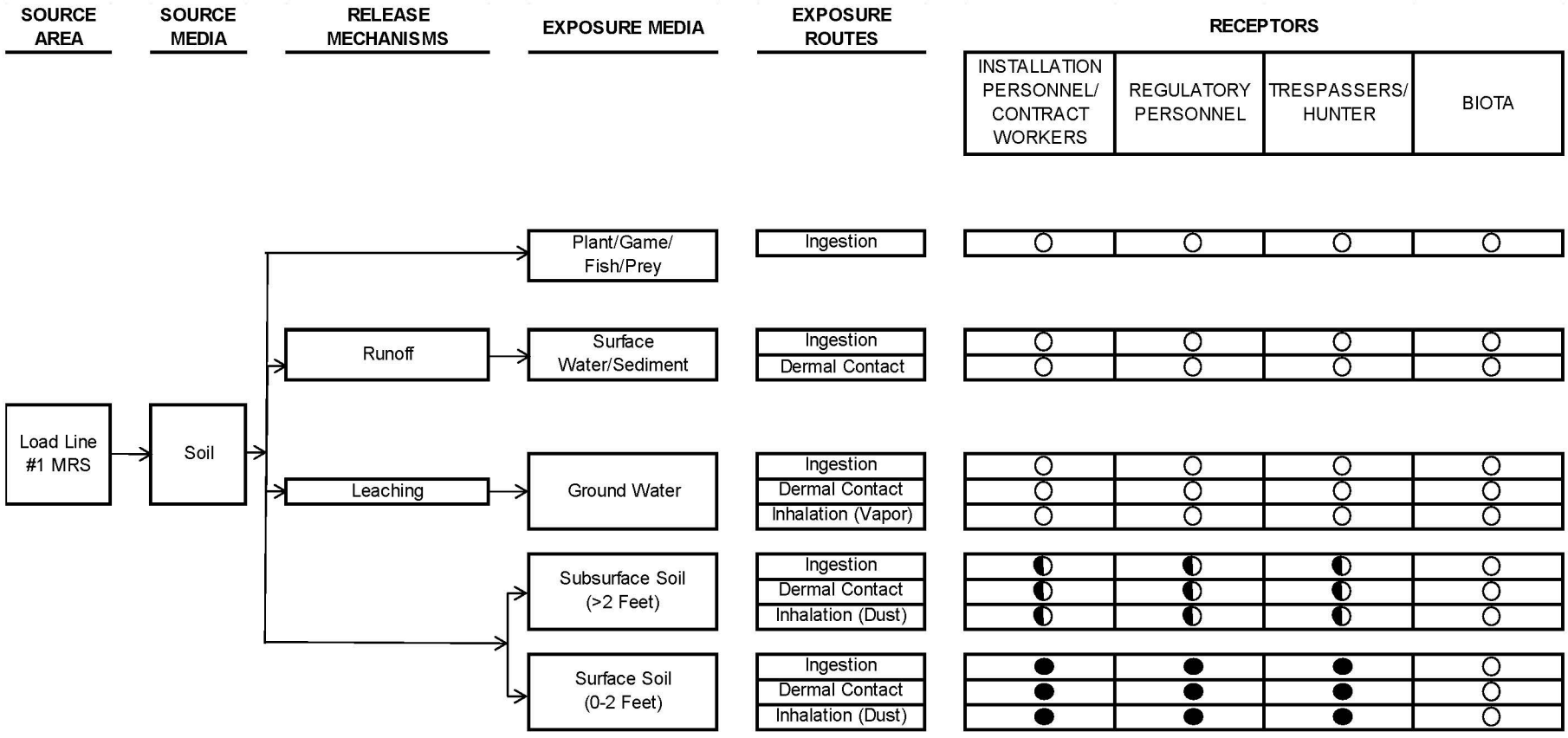


FIGURE 2-1 PRELIMINARY MEC CONCEPTUAL SITE MODEL



Source: Final Site Inspection Report, Ravenna Army Ammunition Plant, Ohio (e^2M, 2008)

U.S. ARMY
CORPS OF ENGINEERS
BALTIMORE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1 MRS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw® a world of Solutions™

Generated By: MM Date: 10/12/12 File Path:\\crpbtrpgi01\arcgisprod3\MAMMS\Ravenna\GIS Documents\Project Maps\MMRP\RIFS\RIFS LoadLine1\RVAAP LL1 008 Fig2 2 Prelim MCCSM.mxd

Project Number: 136147

FIGURE 2-2 PRELIMINARY MC CONCEPTUAL SITE MODEL

- **Activity—**Human activities considered for the preliminary CSM included maintenance of the grounds, environmental sampling under the IRP, natural resource management activities, and infrequent security checks.
- **Access—**Access to Load Line #1 at the time of the SI was controlled by a fenced perimeter; however, a section of fence was missing behind the former guard building. Once inside the load line, the MRS is not physically restricted and is accessible. The SI Report (e^2M, 2008) identified the future plans for the MRS as military training to include tracked vehicle maneuver training once the load line was remediated and turned over to the National Guard Bureau (currently the Army National Guard).
- **Receptors—**At the time of the SI, current and reasonably anticipated receptors included installation personnel, soldiers, contractors (including maintenance personnel), regulatory personnel, and possibly trespassers and hunters. The SI Report (e^2M, 2008) considered biota to be state-listed species identified as being present at the RVAAP.

The SI Report concluded that the MEC source at the MRS was triple-base propellants lying on the ground surface. Considering this, the human receptor pathway was considered as contact with MEC in surface soils by handling or treading underfoot (e^2M, 2008). **Figure 2-1** presents the CSM for MEC at the Load Line #1 MRS.

The SI field activities showed the presence of lead in surface soil on the northwestern side of the elevated building slab at CB-14. Complete pathways for MC were considered present for surface soil and potential pathways were considered present for subsurface soil. Exposures to MC were analyzed to include dermal contact and ingestion of contaminated soil. Transport of MC via groundwater, surface water, and sediments was also considered to be possible (e^2M, 2008). **Figure 2-2** presents the CSM for MC at the Load Line #1 MRS.

2.2 Applicable or Relevant and Appropriate Requirements and TBC Information

Applicable or relevant and appropriate requirements (ARARs) and "to be considered" (TBC) guidance for future anticipated and reasonable remedial actions at the RVAAP under the MMRP are currently under development. Once ARARs and/or TBC materials have been identified, preliminary remediation goals and remedial action objectives will also be developed. The ARARs, TBCs, preliminary remediation goals, and remediation action objectives will be included in the follow-on documents for this MRS as required under the CERCLA process.

2.3 Data Quality Objectives and Data Needs

The DQOs and data needs were determined at the planning stage and are outlined in the Work Plan (Shaw, 2011). The data needs included characterization for MEC and/or MC associated with the former activities at the MRS. The DQOs were developed to ensure the reliability of field sampling, chemical analyses, and physical analyses; the collection of sufficient data; the acceptable quality of data generated for its intended use; and valid assumptions could be inferred from the data.

2.3.1 Data Quality Objectives

The DQOs were developed for MEC in accordance with data needs, the *Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the RVAAP* (SAIC, 2011); hereafter referred to as the FWSAP, and the U.S. Environmental Protection Agency (EPA) *Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW* (2000). **Table 2-1** identifies the DQO process at the Load Line #1 MRS as presented in the Work Plan (Shaw, 2011).

Table 2-1
Data Quality Objectives Process at the Load Line #1 MRS

Step	Data Quality Objective
1. State the problem.	The MRS consists of a 0.41-acre area located near the northwest side of the former elevated building CB-14 where triple-base propellants were observed on the ground surface and MC results for elevated lead concentrations and low detects for explosives were detected in surface soil during the SI field activities. The principle sources of MEC at the Load Line #1 MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and MD, including propellants, to be present in surface soil at the Load Line #1 MRS (e^2M, 2008). Based on the findings and conclusions presented in the SI Report (e^2M, 2008), there is a potential for MEC on the ground surface and a potential for environmental impacts from MC at the MRS.
2. Identify the decision.	The goal of the investigation at the Load Line #1 MRS is to identify the areas impacted with MEC. In addition, MC sampling will be predetermined in order to further characterize the nature and extent of contamination associated with previous activities at the MRS. The information obtained during the RI will be used to assess the potential risk and hazards posed to human health and the environment.
3. Identify inputs to the decision.	• Historical information • Instrument-assisted visual survey • Incremental environmental media sampling
4. Define the study boundaries.	The RI investigation will be performed in the Load Line #1 MRS boundaries as defined at the conclusion of the SI Report (e^2M, 2008).

Table 2-1 (continued)
Data Quality Objectives Process at the Load Line #1 MRS

Step	Data Quality Objective
5. Develop a decision rule.	In order to define the amount of MEC (triple-base propellant) at the Load Line #1 MRS, Shaw will perform a visual survey of the entire MRS. First, the visual survey will investigate the surface area. Then, the team will perform a visual survey with the slag removed. Two ISM surface soil samples are proposed at the MRS in the Work Plan stage. In addition, discrete samples (surface and subsurface) will be collected in areas where concentrated MEC/MD is identified. The final location and number of discrete samples, if any, would be proposed at the conclusion of the MEC investigation.
6. Specify limit of decision errors.	QC procedures are in place so that all field work was performed in accordance with all applicable standards. Further details on the QC process implemented during the RI are located in Section 4 of the Work Plan (Shaw, 2011).
7. Optimize the design for obtaining data.	The information gathered as part of the field investigation at the Load Line #1 MRS will be used to determine what risks, hazards, if any, were present at the MRS. Shaw will perform a MEC HA to identify potential MEC hazards. In addition, MRS-specific HHRA and ERA will be performed on the analytical results. If unacceptable risks or hazards to human health and the environment are determined to exist at the MRS at the conclusion of the investigation, then the MRS will be identified for further evaluation under the CERCLA process.

CERCLA denotes Comprehensive, Environmental Responsibility, Compensation, and Liability Act of 1980.
ERA denotes ecological risk assessment.
HA denotes hazard assessment.
HHRA denotes human health risk assessment.
ISM denotes incremental sampling method.
MC denotes munitions constituents.
MD denotes munitions debris.
MEC denotes munitions and explosives of concern.
MRS denotes munitions response site.
QC denotes quality control.
RI denotes remedial investigation.
SI denotes site inspection.

2.3.2 Data Needs

For MEC, data needs include determining the types, locations, condition, and quantity of MEC items present at the MRS so that the potential hazard to human health can be assessed and remedial decisions can be made. The DQOs were developed in accordance with the FWSAP (SAIC, 2011), EPA Guidance (2000), and experience with MRSs containing MEC. These data needs for MEC were evaluated using the most applicable methods and technologies that are discussed in following sections.

For MC, data needs include sufficient information to determine the nature and extent of MC, determine the fate and transport of MC, and characterize the risk of MC to potential receptors by performing a human health risk assessment (HHRA) and an ecological risk assessment (ERA). More specifically, the data needed are concentrations of MC associated with the MRS in surface soil that pose a potential unacceptable risk to human health and ecological receptors. Data quality was assessed through the evaluation of sampling activities and field measurements associated with the chemical data in order to verify the reliability of the chemical analyses and the precision, accuracy, completeness, and sensitivity of information acquired from the laboratory. Representativeness and comparability were also evaluated with regard to the proper design of the sampling program and quality of the data set respectively. The reporting limits (a.k.a., sample quantitation limits or limits of quantitation) should be equal to or less than the screening criteria to support the HHRA and ERA in this RI whenever possible.

2.3.3 Data Incorporated into the RI

Whenever possible, existing data are incorporated into this RI. The following summarizes existing data and how that data were used:

- **Historical Records Review—**The HRR (e^2M, 2007) provides historical documentation regarding the MRS and identifies the types of activities previously conducted, the types of munitions used, and historical finds and incidents. These data were used to identify the expected baseline conditions and other hazards that may be present.

- **Installation Restoration Program Data—**Data collected under the IRP at various AOCs collocated with MRSs include analytes considered to be MC associated with previous activities at the MRS, although it should be noted that not all analytes are considered as MC. The IRP data set may be incorporated with sampling data collected during the MMRP RI on a MRS-specific basis in order to close data gaps. For the Load Line #1 MRS, the IRP data were reviewed and it was determined that incorporation of the data was not warranted as no IRP samples were located within the 0.41-acre MRS boundary investigated during the RI.

- **Site Inspection Data—**MC sampling was performed at the Load Line #1 MRS during the 2007 SI field activities. One ISM surface soil sample and a duplicate were collected at depths of 0 to 6 inches bgs from a sampling unit that consisted of the entire 0.41-acre MRS. The purpose of the predetermined ISM surface soil samples for the RI field activities were to further characterize the nature and extent of contamination associated with previous activities at the MRS by reducing the decision unit size and collecting more frequent samples within the MRS. In addition,

any samples collected during the RI field work would be considered more representative of current conditions at the MRS in comparison to samples collected in 2007. This is especially applicable due to the construction and remediation activities that have occurred at Load Line #1 and near the MRS since 2007. Therefore, the ISM sample result from the MMRP SI was not used for the purposes of this RI Report.

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3.0 CHARACTERIZATION OF MEC AND MC

This section documents the approaches used to investigate MEC and MC at the Load Line #1 MRS in accordance with the DQOs presented in Section 2.0, "Project Objectives." The MEC and MC characterization activities were conducted in accordance with Section 3.0, "Field Investigation Plan" of the Work Plan (Shaw, 2011).

3.1 MEC Characterization

Based on observations of triple-base propellant nodules at the MRS during the 2007 SI field activities, it was determined that there is a potential for MEC on the ground surface. In order to fully characterize the amount of MEC, Shaw performed visual surveys at the Load Line #1 MRS on two separate occasions. The following section summarizes the processes used to implement the visual surveys that were performed at the Load Line #1 MRS. The results of the visual surveys are discussed in Section 4.0.

3.1.1 Visual Survey Activities

Nonintrusive visual surveys were performed at the Load Line #1 MRS on two occasions during the RI field activities. As discussed in Section 3.2.3 of the Work Plan (Shaw, 2011), the first step of the RI field work at the Load Line #1 MRS was to perform a instrument-assisted visual survey over 100 percent of the MRS. The instrument-assisted visual survey, which occurred on April 29, 2011, was performed to investigate the ground surface for the presence of MEC. While performing the visual survey, any anomalies identified by the Schonstedt magnetometer were documented. Although subsurface MEC was not anticipated at the Load Line #1 MRS, the Schonstedt magnetometer was used to verify that ferrous items (i.e., potential MEC) were not present at the MRS.

Following the completion of the initial visual survey, the Work Plan (Shaw, 2011) specified that slag from the ground surface be removed and a second visual survey be performed. The goal of the second visual survey was to look solely for triple-base propellant nodules (approximately 1 by ¼ inch in size). Since the triple-base propellant nodules do not contain ferrous material, a magnetometer was not used for this survey. During the RI field activities, minimal slag was present at the MRS and removal of this material was not required. The second visual survey was conducted on May 20, 2011, and was performed over 100 percent of the MRS.

The surveys were performed by UXO-qualified personnel. The equipment used for the instrument-assisted survey consisted of a Schonstedt Model 52CX flux-gate magnetometer, which was used to locate ferrous items. All investigation activities were conducted in

accordance with the Work Plan's Section 3.2.3, "Load Line #1 (RVAAP-008-R-01)" (Shaw, 2011).

3.1.2 Field Instrument Quality Control

Prior to the instrument-assisted visual survey operations at the Load Line #1 MRS, a brief test program was performed at the instrument verification strip established at Load Line #7 at the RVAAP for field instrument quality control (QC) measures. The objectives of the test program were to validate the Schonstedt magnetometer handheld sensor meets the project objectives, ensure the instrument settings and survey parameters were optimized and the sensor was functioning properly on a daily basis, and certify the sweep personnel performing the magnetometer and dig and detector-aided visual survey tasks. This ensured that consistent data of known quality was being collected.

Prior to performing the visual surveys at the Load Line #1 MRS, inert seed items consisting of industry standard objects were buried at the depth and orientation indicated and separated along the analog test strip at intervals of approximately 5 to 10 feet. The industry standard objects consisted of 1- by 4-inch (small), 2- by 8-inch (medium), and 4- by 12-inch (large) pipe nipples made from Schedule 40 black carbon steel from McMaster Carr Hardware (or equivalent). After burial of the inert seed items, the UXO QC Specialist conducted a test program using experienced operators, whereby the handheld detector settings were optimized and documented for the soil conditions and reliable detection of the seed items. The results of the instrument verification strip indicate that the instrument functional test program would ensure the instruments used were of sufficient quantity and quality to meet the project objectives for the visual survey investigation.

3.2 MC Characterization

This section summarizes the MC characterization activities and decision making process at the Load Line #1 MRS. Sampling for MC was predetermined during the DQO decision-making process to further characterize the nature and extent of contamination associated with previous activities at the MRS. In accordance with the Work Plan (Shaw, 2011), ISM soil samples were proposed at two sampling units at the MRS. The determination as to whether additional MC characterization was required at the MRS was made based on historical evidence and the results of the MEC investigations. Additional discrete samples were proposed in areas identified with concentrated MEC/MD. The final location, type, and quantity of samples required approval from the USACE and the Ohio Environmental Protection Agency (Ohio EPA) following the MEC investigation. All MC samples were collected in accordance with the *Final Sampling and Analysis Plan and Quality Assurance Project Plan* included in Appendix D of the Work Plan (Shaw, 2011); hereafter, referred to

as the SAP. The results of the MC sampling activities are presented in Section 4.3, "Nature and Extent of SRCs."

3.2.1 Sampling Approach

The decision to collect ISM surface soil samples at predetermined sampling units was made during development of the DQOs in the Work Plan (Shaw, 2011) that stated that additional ISM and/or discrete samples may be required if locations at the MRS with concentrated areas of MEC/MD areas are identified during the RI field surveys. No MEC or MD was identified at the Load Line #1 MRS during the investigation activities; therefore, only the predetermined ISM samples were collected and additional sampling for MC was not warranted. The decision to not collect additional samples at the MRS is presented in the *Visual Survey Results and Proposed Munitions Constituents Sampling Locations for the Load Line #1 MRS (RVAAP-008-R-01)* technical memorandum included in **Appendix A**.

3.2.1.1 Surface Soil Sample Collection

The ISM surface soil samples were collected during the RI field activities in August 2011 to further characterize the nature and extent of contamination associated with previous activities at the MRS. There was no deviations from the Work Plan (Shaw, 2011) during the RI field activities. The combined proposed sampling units cover the entire MRS that is considered the decision unit. The sample depth was determined to be 0.5 foot bgs, which is the maximum depth that contamination from triple-base propellant on the ground surface would be expected to vertically migrate. The ISM samples were collected in accordance with the Work Plan (Shaw, 2011). **Table 3-1** summarizes the media samples for the RI and the rationale for the sample strategy.

Table 3-1
Summary and Rationale for Surface Soil Sampling at the Load Line #1 MRS

Sample Medium	Sample Type	Sample Depth (feet bgs)	No. of Samples[1]	Sampling Rationale
Surface Soil	ISM	0–0.5	2	To further characterize the nature and extent of contamination associated with previous activities at the MRS.

[1] *Number of samples does not include duplicate or other quality control samples.*
bgs denotes below ground surface. *MRS denotes munitions response site.*
ISM denotes incremental sampling method.

Detailed presentation of the procedures used to collect ISM samples are presented in the SAP (Shaw, 2011) and are based upon the procedures presented in the *Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program* (USACE, 2009). The methods used for the collection of the ISM surface soil samples during the RI are summarized below.

Each ISM surface soil sample consisted of 30 increments collected from locations selected in a systematic random pattern throughout the designated grid area (i.e., sampling unit). The 0.41-acre MRS is considered the ISM decision unit and was split into two predetermined sampling units (approximately 0.2 acres each) that are equally considered areas of anticipated use by potential receptors. Splitting the decision unit into multiple sampling units resulted in more frequent increments than collected during the SI Report (e^2M, 2008) that were used to further evaluate the nature and extent of contamination associated with previous activities at the MRS (**Figure 3-1**). The three key steps for collection of a systematic increment were: (1) subdivide the sampling unit into a uniform grid (i.e., pace out the area and divide into at least 30 grids for a 30-increment sample), (2) randomly select a single increment location in the first grid, and (3) collect increments from the same relative location within each of the other grids.

The sampling units were established by placing pin flags at the corners of each decision unit. The ISM samples were collected from the predetermined number of increment sample locations using a $^{7}/_{8}$-inch-diameter stainless steel step probe sample collection device. The increments of soil were placed into a plastic lined bucket and combined to make a single sample weighing between 1 to 2 kilograms.

The QC samples included a field duplicate sample, which was also designated as the matrix spike/matrix spike duplicate sample (MS/MSD). The collection of the QC samples required similar increments of soil as the original sample. Therefore, at the ISM sampling unit where a QC sample was required, an additional ISM sample was collected from within the same sampling unit consisting of at least 30 increments of soil. The field duplicate was labeled with a different sample number and submitted to the laboratory for processing as a blind field duplicate. All data and observations at each sample location were recorded in the sampling field logs included in **Appendix A**.

3.2.2 Sample Analysis

Analytical services for chemical samples were provided by the DoD Environmental Laboratory Accreditation Program (ELAP) and the National Environmental Laboratory Accreditation Conference accredited laboratory CT Laboratories, Inc. of Baraboo, Wisconsin. The selection of chemical analyses for the Load Line #1 MRS was based on the types of munitions historically identified at the MRS and the potential MC associated with those munitions. The only munitions identified for the Load Line #1 MRS were bulk triple-base propellants. Based on this information, the proposed analytical suites and methods were presented in the *MC Sampling Rationale* included in the SAP (Shaw, 2011) and included the following:

FIGURE 3-1 SURFACE SOIL SAMPLING UNIT LOCATIONS

- Lead, EPA Method SW846 6010B
- Explosives, EPA Method SW846 8330B
- Nitrocellulose, EPA Method SW8469056
- Total organic carbon (TOC), Lloyd Kahn Method
- pH, EPA Method SW846 9045D

In addition to the above analyses, the surface soils samples were also analyzed for geochemical parameters via EPA Method 6010B in order to potentially evaluate naturally high inorganic concentrations and distinguish them from potential contamination. The geochemical parameters analyzed for the Load Line #1 MRS include aluminum, calcium, magnesium, and manganese.

Each 1- to 2-kilogram sample was submitted to the contracted laboratory for processing and analysis. Processing consisted of drying out the sample and sieving the sample through a #10 sieve. Any material larger than the #10 sieve was discarded. The remaining air-dried, sieved material was then ground using a puck mill to reduce the particle size as sampling splitting and particle size reduction is necessary to reduce fundamental error. The final reduced portions of the ISM field samples were analyzed for lead, explosives, and nitrocellulose. The ISM field samples were analyzed for TOC and pH following processing of the sample and prior to grinding. The surface soil sampling units at the MRS are presented in **Figure 3-1**. A summary of the number and types of samples collected is presented in **Table 3-2**.

Table 3-2
Summary of Field Samples Collected and Required Analytical Parameters

Sample Name	Sample Type	Depth (ft bgs)	Analytical Parameters	No. of Samples	Field Duplicate
LL1SS-715(I)-0001-SS	ISM	0–0.5	• Lead • Geochemical Parameters[1] • Explosives • Nitrocellulose • TOC • pH	1	
LL1SS-716(I)-0001-SS LL1SS-717(I)-0001-SS				1	1

[1] *Geochemical metals include analyses for aluminum, calcium, magnesium, and manganese.*
ft bgs denotes feet below ground surface.
ISM denotes incremental sampling method.
MEC denotes munitions and explosives of concern.
TOC denotes total organic carbon.

The collected samples were properly packaged for shipment and dispatched to the contracted analytical laboratory, CT Laboratories in accordance with the SAP (Shaw, 2011). A separate signed custody record with sample numbers and locations listed was enclosed with each

shipment. When transferring the possession of samples, the individuals relinquishing and receiving signed, dated, and noted the time on the record. All shipments complied with applicable U.S. Department of Transportation regulations for environmental samples.

3.2.3 Laboratory Analyses

The surface soil samples were collected and analyzed according to the FWSAP (SAIC, 2011) and the SAP (Shaw, 2011). The FWSAP and associated addenda were prepared in accordance with USACE and EPA Guidance, and outline the organization, objectives, intended data uses, and quality assurance (QA)/QC activities to achieve the desired DQOs and to maintain the defensibility of the data. Project DQOs were established in accordance with EPA Guidance for the *Data Quality Objectives Process for Hazardous Waste Site Investigations* (2000). Requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data validation criteria for the RI are consistent with EPA requirements for National Priorities List sites. The DQOs for this project included analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data.

Strict adherence to the requirements set forth in the FWSAP (SAIC, 2011) and the SAP (Shaw, 2011) was required of the analytical laboratory so that conditions adverse to quality would not arise. The laboratory was required to perform all analyses in compliance with EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Analytical Protocols* (EPA, 2007). SW-846 chemical analytical procedures were followed for the analyses of metals, explosives, and nitrocellulose. The contracted laboratory was required to comply with all methods as written; recommendations were considered requirements.

The QA/QC samples for this project included field blanks, laboratory method blanks, laboratory control samples (LCSs), laboratory duplicates, and MS/MSDs. An equipment rinse sample was submitted for analysis, along with a field duplicate sample, to provide a means to assess the quality of the data resulting from the field sampling program. **Table 3-3** presents a summary of QA/QC samples utilized during the RI field activities for the Load Line #1 MRS.

Table 3-3
Summary of Quality Assurance/Quality Control Samples

Sample Type	Rationale
Field Duplicate	Analyzed to determine sample heterogeneity and sampling methodology reproducibility
Equipment Rinse	Analyzed to assess the adequacy of the equipment decontamination processes for soil

Table 3-3 (continued)
Summary of Quality Assurance/Quality Control Samples

Sample Type	Rationale
Laboratory Method Blanks	Analyzed to determine the accuracy and precision of the analytical method as implemented by the laboratory
Laboratory Duplicate Samples	Analyzed to assist in determining the analytical reproducibility and precision of the analysis for the samples of interest and provide information about the effect of the sample matrix on the measurement methodology
Matrix Spike/Matrix Spike Duplicate	

Shaw is the custodian of the project file and will maintain the contents of the files for this investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence, and chain-of-custody forms. These files will remain in a secure area under the custody of Shaw until they are transferred to the USACE, Baltimore District and the RVAAP. CT Laboratories retain all original raw data in a secure area under the custody of the laboratory project manager.

CT Laboratories performed in-house analytical data reduction under the direction of the laboratory project manager and QA officer. These individuals were responsible for assessing data quality and informing Shaw of any data that are considered "unacceptable" or required caution on the part of the data user in terms of its reliability. Data were reduced, reviewed, and reported as described in the laboratory QA manual and the laboratory standard operation procedures in the SAP (Shaw, 2011). Data reduction, review, and reporting by the laboratory were conducted as follows:

- Raw data produced by the analyst were turned over to the respective area supervisor.
- The area supervisor reviewed the data for attainment of QC criteria, as outlined in the established methods and for overall reasonableness.
- Upon acceptance of the raw data by the area supervisor, a report was generated and sent to the laboratory project manager.
- The laboratory project manager completed a thorough review of all reports.
- Final reports were generated by the laboratory project manager.

Data were then delivered to Shaw for data validation. CT Laboratories prepared and retained full analytical and QC documentation for the project in electronic storage media (i.e.,

compact disc), as directed by the analytical methods employed. CT Laboratories provided the following information to Shaw in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered in analysis.
- Tabulated results of inorganic and organic compounds identified and quantified.
- Analytical results for QC sample spikes, sample duplicates, and initial and continuing calibration verifications of standards and blanks, method blanks, and LCS information.

3.2.4 Data Validation

A systematic process for data verification and validation was performed by Shaw to ensure that the precision and accuracy of the analytical data were adequate for their intended use. This verification also attempted to minimize the potential of using false-positive or false-negative results in the decision-making process (i.e., to ensure accurate identification of detected versus nondetected compounds). This approach was consistent with the DQOs for the project and with the analytical methods, and was appropriate for determining chemicals of concern and calculating risk. Samples were identified through implementation of "definitive" analytical methods. These definitive data were then verified through the review process outlined in the SAP (Shaw, 2011).

Following receipt of the analytical data packages, Shaw performed data validation on all three surface soil ISM samples collected from the Load Line #1 MRS (including field duplicate and QC samples) to ensure that the precision and accuracy of the analytical data were adequate for their intended use. The review constituted comprehensive validation of 100 percent of the primary dataset and a comparison of primary sample and field duplicate sample. This validation also attempted to minimize the potential of using false-positive or false-negative results in the decision-making process (i.e., to ensure accurate identification of detected versus nondetected compounds). This approach was consistent with the DQOs for the project and with the analytical methods, and was appropriate for determining chemicals of concern and calculating risk.

Analytical results were reported by the laboratory in electronic format and were issued to Shaw on compact disc. Data validation was performed to ensure all requested data were received and complete. Data use qualifiers were assigned to each result based on laboratory QA review and verification criteria. Results were qualified as follows:

- "U"—Analyte was not detected or reported less than the level of detection.
- "J"—The reported result is an estimated value.

In addition to assigning qualifiers, the validation process also selected the appropriate result to use when reanalysis or dilutions were performed. Where laboratory surrogate recovery data or laboratory QC samples were outside of analytical method specifications, the validation chemist determined whether laboratory reanalysis should be used in place of an original reported result. If the laboratory results reported for both diluted and undiluted samples, diluted sample results were used for those analytes that exceeded the calibration range of the undiluted sample. A complete presentation of the validation process and results for the RI data is contained in the *Data Validation Report* in **Appendix B**.

3.2.5 Data Review and Quality Assessment

This section provides discussion of data review and the results of the data validation process and evaluates usability of data collected for this sampling event in accordance with the project QA program. QA is defined as the overall system for assuring the reliability of data produced. The system integrates the quality planning, assessment, and improvement efforts of various groups in the organization to provide the independent QA program necessary to establish and maintain an effective system for collection and analysis of environmental samples and related activities. The program also encompasses the generation of useable and complete data, as well as its review and documentation.

The QA program was designed to achieve the DQOs for the RI. The program was developed in accordance with the project specifications and the data were produced, reviewed, and reported by the laboratory in accordance with specifications outlined in the SAP (Shaw, 2011), FWSAP (SAIC, 2011), the *Quality Systems Manual, Version 4.2* (DoD, 2010) and the laboratory's QA manual. Laboratory reports included documentation verifying analytical holding time compliance. The DQOs were developed concurrently with the Work Plan (Shaw, 2011) to ensure the following:

- The reliability of field sampling, chemical analyses, and physical analyses
- The sufficiency of collected data
- The applicability of data for intended use
- The validity of assumptions inferred from the data

Attainment of the DQOs was assessed throughout the evaluation of all data collected using data quality indicators that are discussed in detail in this section. For this RI Report, a full data validation effort was performed to assess laboratory performance, including a review of the following:

- Completeness

- Chain-of-custody records
- Sample holding times
- QC results reported on summary forms as applicable to the analysis performed (i.e., initial and continuing calibrations; method, calibration, equipment, and trip blanks; LCS/MS/MSD; performance and interference check samples and instrument tunes; surrogates; internal standards; and serial dilutions)
- Detection and reporting limits
- Other contractual items

Criteria for QC results were compared to laboratory established criteria in accordance with the method and work plan requirements. Further details and discussion are provided in the *Data Validation Report* in **Appendix B**.

Data were qualified during the validation process from predetermined criteria for QC nonconformances. The quality of data collected in support of the RI sampling activities as noted in data tables is considered acceptable with qualifications, unless qualified as rejected (and denoted with "R" qualifier) during the validation process. Results were assessed for accuracy and precision of laboratory analyses to identify the limitations and quality of data. A QA review of the data was performed and the following data quality indicators were measured:

- **General Review—**The EPA Guidance, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A, Interim Final* (EPA, 1989), states that the data qualified during the validation process as estimated "J" or "UJ" may be included in quantitative assessments indicating the associated numerical value is an estimated quantity, i.e., the guidance states to "use J-qualified concentrations the same way as positive data that do not have this qualifier." In review of analytical information, the sample results qualified as "J" (i.e., estimated or nondetect estimated values) during the validation process are considered usable data points (EPA, 1989), and are included in the data summary tables of this report. The majority of the "J" qualified samples were the result of analytical column confirmation or accuracy recoveries outside criteria. There were no data rejections (i.e., R-flagged results) resultants from the data validation reviews.
- **Precision—**Laboratory duplicate pairs and/or laboratory spiked duplicate pairs were analyzed as per method requirements for each parameter and/or compound on a batch and matrix specific basis. Field duplicates were collected on the basis of 10-percent frequency per matrix to identify the cumulative precision of the

sampling and analytical process and were sent on a blind basis to the laboratory. Field duplicates are evaluated at less than or equal to a 50-percent relative percent difference (RPD) for organic parameters and less than or equal to a 25-percent RPD for inorganic parameters. Field duplicate pairs, laboratory duplicate pairs, and/or laboratory MSDs were evaluated for the surface soil samples.

The MS/MSD pair was outside RPD criteria for target compound 1,3,5-trinitrobenzene for the spiked sample LL1SS-715(I)-0001-SS; therefore, the spiked sample was qualified estimated "J" based upon this outlier. All laboratories duplicates and other MSD pairs were within RPD criteria limits; therefore, did not warrant further qualification. A blind field duplicate sample pair LL1SS-716(I)-0001-SS/LL1SS-017(I)-0001-SS was collected for all parameter groups. For the field duplicate pair, explosive compound nitroguanidine was detected at low levels in the parent sample and nondetect in the associated duplicate pair. The nitroguanidine detection did not pass method confirmation criteria; therefore, it was qualified estimated "J" based upon this outlier. For all other parameter groups, all criteria were met for the field duplicate. Although these results have been qualified as estimated due to the outliers noted, the data are still considered useable (EPA, 1989). Further discussion is provided in the *Data Validation Report* in **Appendix B**.

- **Accuracy—**Accuracy was evaluated for each matrix by reviewing the recovery results of the LCS, MS/MSD, and surrogate, as applicable, for each analytical method performed. The LCS, MS/MSD, and surrogate QC samples were analyzed as per method requirements for each parameter and/or compound on a batch and matrix specific basis.

  The MS/MSD recoveries for spiked sample LL1SS-715(I)-0001-SS exceeded recovery limits for lead, magnesium, and manganese. The associated serial dilution and/or postdigestion spike recoveries were within acceptable limits for these metals as well as the high sample concentrations related to the amount spiked; therefore, their results were reported without qualification in the parent sample. MS/MSD recoveries for sample LL1SS-715(I)-0001-SS were below the recovery limits for nitrocellulose; therefore, the parent sample result was qualified estimated nondetect with a "UJ" flag based upon this outlier. All other MS/MSD recoveries were within criteria.

  The rinse blank sample LL1-718-RB had a surrogate recovery that was more than double the spiked surrogate amount. The method and laboratory blanks, as well as the LCS, had acceptable surrogate recoveries. The sample was reanalyzed on the

confirmation column and the surrogate recovery was within the acceptable range. All other surrogates were within criteria for the surface soil samples.

All LCS recoveries were within criteria limits for all parameter groups; therefore, did not warrant qualification. As a result, no further actions were required. Although some data results have been qualified as estimated due to the outliers noted, the data are still considered useable (EPA, 1989). Further discussion is presented in the *Data Validation Report* in **Appendix B**.

- **QC Blanks—**Method blanks, calibration blanks, and rinse blanks were evaluated to identify potential non-site-related contamination from sample collection through laboratory analyses. Analytical results found within the "5 times" and "10 times" rules were qualified "B" and considered nondetect at the limit of detection (LOD) or level of contamination, whichever was greater. From EPA Guidance (1989), the definitions of the "5 times" and "10 times" rules are as follows:

  > "If the blank contains detectable levels of one or more organic or inorganic chemicals, then consider site sample results as positive only if the concentration of the chemical in the site sample exceeds five times the maximum amount detected in any blank for compounds that are not considered by EPA to be common laboratory contaminants. Consider ten times the maximum amount for common laboratory contaminants acetone, 2-butanone (methyl ethyl ketone), methylene chloride, toluene, and the phthalate esters. Treat samples containing less than five times (ten times for common laboratory contaminants) the amount in any blank as nondetects and consider the blank-related chemical concentration to be the quantitation limit for the chemical in that sample."

  All laboratory calibration blanks and rinse blank (LL1-718-RB) were nondetect (less than or equal to the limit of detection) for all target analytes, and therefore, did not warrant qualification. Trace amounts of calcium, magnesium, and manganese were detected in the laboratory method blank (less than or equal to LOD); however, these concentrations were well below detected sample concentrations and did not warrant qualification. As a result, no further actions were required. Further discussion is provided in the *Data Validation Report* in **Appendix B**.

- **Representativeness—**Representativeness is a measure of the degree to which the measured results accurately reflect the medium being sampled. It is a qualitative parameter that is addressed through the proper design of the sampling program in terms of sample location, number of samples, and actual material collected as a

"sample" of the whole. Representativeness applies to both sampling and analytical evaluations and should be 100 percent. Analytical representativeness is inferred from associated documentation (i.e., data validation reports, field records, etc.) for holding times, QC blanks, accuracy, and precision, as well as from the completeness evaluations. Sampling protocols were developed to assure that samples collected are representative of the media. Field handling protocols (i.e., storage, handling in the field, and shipping) were designed to protect the representativeness of the collected samples.

A QC field inspection was conducted for field sampling activities at the RVAAP in accordance with the Work Plan (Shaw, 2011). The inspection was activity-based and covered ISM surface soil sample collection conducted at the Group 8 MRS in February 2012. Although, the inspection was not conducted at the Load Line #1 MRS, it is considered applicable to the representatives of the ISM surface soil samples collected at the MRS. The *Quality Surveillance Summary Report* conducted at the Group 8 MRS is presented along with the field documentation in **Appendix A**.

- **Completeness—**Completeness is a measure of the amount of information that must be collected during the field investigation to allow for successful achievement of the objectives of the program and valid conclusions. Completeness is defined as the percentage of measurements that are judged to be usable. The percent completeness criterion is 90. In this data validation review, three categories of completeness quotients are calculated: (1) the overall sampling completeness, (2) the overall analytical completeness, and (3) the analytical completeness by parameter group.

  The sampling percent completeness is determined by taking the number of planned samples (including QC samples) and dividing that number by the number of samples actually collected during the current round of sampling. Three surface soil samples (including one field duplicate sample) and one rinse blank were collected and sent to the laboratory for analysis. Three surface soil samples (including one field duplicate sample) and one rinse blank were proposed in the Work Plan (Shaw, 2011) for this sampling event. Excluding rinse blanks, the overall sampling completeness was 100 percent (or three surface soil samples collected divided by three planned surface soil samples).

  The overall analytical percent completeness is calculated from the number of usable data inputs divided by the number of analyzed data inputs. The evaluation of completeness for the surface soil samples resulted in 72 useable data points of possible 72 data points, resulting in an overall analytical completeness quotient of

100 percent for all parameter groups. The completeness statistics were computed as follows:

- 72 represents the number of accepted analytes as usable data points (no analytes were rejected)
- 72 represents the number of analyzed inputs, which is equal to the number of analytes for all field samples

There were no rejected data points for any of the parameters explosives, metals, or nitrocellulose for this event; therefore, their analytical completeness quotients were each 100 percent. All of the overall and parameter-specific analytical completeness and soil sampling completeness quotients were above the predefined completeness goal of 90 percent. Further discussion is presented in the *Data Validation Report* in **Appendix B**.

- **Comparability—**Comparability is the confidence with which one data set can be compared to another. Comparability was controlled using standard operating procedures (SOPs) that have been developed to standardize the collection of measurements, samples, and approved analytical techniques with defined QC criteria. The laboratory chemical analyses were performed by an ELAP-accredited laboratory in accordance with the approved SAP (Shaw, 2011) using cited EPA methodology. Where applicable, the EPA-approved methods and DoD *Quality Systems Manual* provided the QC criteria guidelines for the analytical methods and the ELAP accrediting body provided the QA oversight (DoD, 2010). The laboratory adapted its processes accordingly into an applicable working SOP specific to their laboratory capabilities (i.e., instrumentation, prep method, sample volumes, etc.) in applying the EPA methods. The SOPs were followed throughout the process by the laboratory, as reviewed by the ELAP accrediting body. Furthermore, laboratory data were validated in accordance with established SOPs, and the validation qualifiers were applied when QC nonconformances were identified (as applicable). The consistent use of the laboratory SOPs provides confidence with which one data set could be compared to another previous data set.

Established field SOPs that were preapproved in the SAP (Shaw, 2011) for the RI program were applied to on-site work during this surface soil sampling round. The field SOPs were followed, as established in the SAP (Shaw, 2011) to ensure that protocols meet project DQOs. The recorded field documentation provided verification that proper field procedures were followed. The consistent application

of field SOPs over the course of the RI program from sampling event to sampling event lends confidence in the comparison of field data sets.

- **Sensitivity—**The sensitivities are dependent on the analytical method, the sample volumes, and percent moistures (solid matrix) used in laboratory determinative analysis. For each analyte, the method sensitivities (i.e., method detection limits [MDLs], method reporting limits [MRLs], LODs, etc.) and analyte detections presented in the analytical data were compared to the screening criteria for the each of the samples collected. The analytical laboratory updated their sensitivity reporting convention from MDLs/MRLs to MDLs/LODs/MRLs during the sampling and analysis phase for this RI. The screening criteria are presented in Attachment F, *Table 12 Proposed Human Health and Ecological Screening Level for Ravenna AAP MRSs* of the Work Plan (Shaw, 2011). Upon comparing the soil sample results to the minimum project screening criteria, the method sensitivity requirements were met. All MDLs, LODs, or MRLs were less than the project screening criteria. A summary of the complete laboratory analytical data is presented in **Appendix C**.

The Load Line #1 MRS data were determined to be of sufficient quality to make informed decisions for the surface soil samples collected. Further discussions of data qualifications are provided in the *Data Validation Report* in **Appendix B**.

3.3 Decontamination Procedures

Decontamination of dedicated sampling equipment was performed in accordance with the procedures presented in the SAP (Shaw, 2011) with the exception that the hydrochloric acid step was eliminated due to previous observations of surface corrosion on the sampling equipment when applied. The sampling equipment consisted of individual $^{7}/_{8}$-inch-diameter stainless steel step probes used to collect each of the ISM and the field duplicate surface soil samples. All sampling decontamination procedures were performed at Building 1036, the RVAAP contractors' building. In summary, the decontamination procedures consisted of the following:

- Wet the equipment to remove residual particulate matter and surface film from the equipment.
- Rinse the equipment with American Society of Testing and Materials (ASTM) Type 1 water.
- Rinse the equipment with methanol.
- Rinse with ASTM Type 1 water.

- Allow equipment to air dry.

Once dry, the sampling equipment was wrapped in aluminum foil to prevent cross contamination while in storage or transport to an MRS for sampling. In order to minimize waste, the liquids used in the decontamination process were applied using hand-held spray bottles.

Following the equipment decontamination process, an equipment rinse sample was collected by running distilled water through the sampling equipment for the identical analytical parameters as the environmental samples. The purpose of the equipment rinse sample was to assess the adequacy of the equipment decontamination process.

The results of the equipment blank analysis did not identify any interference or anomalies in the laboratory data and supports the adequacy of the equipment decontamination process. Evaluation of the equipment rinse sample analytical data to assess the adequacy of the equipment decontamination process is further discussed in Section 3.2.5, "Data Review and Quality Assessment." Summary of results of the equipment rinse sample are presented in **Appendix C.**

3.4 Investigation Derived Waste

The investigation derived waste (IDW) generated during the field activities at the Load Line #1 MRS consisted of solid waste that included personal protective equipment and equipment decontamination materials. Due to the minimal number of sampling equipment used and an effort to minimize waste generation, the decontamination liquids were applied using hand-held spray bottles and the spray and excess liquid was collected on absorbent pads. No free liquid wastes were generated.

The disposal of IDW was performed in accordance with the procedures presented in the Work Plan (Shaw, 2011). The IDW generated was containerized separately along with similar materials generated from other MRSs and were staged at Building 1036 in accordance with the FWSAP (SAIC, 2011). IDW management, which describes the waste characterization analyses performed, waste characterization screening, and IDW transport and disposal, is presented in **Appendix D**.

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4.0 REMEDIAL INVESTIGATION RESULTS

This section presents a discussion of the results of the RI data that were collected for MEC and MC at the Load Line #1 MRS in accordance with the procedures discussed in Section 3.0, "Characterization of MEC and MC." These results will be used to determine the nature and extent of MEC and associated MC, and subsequently determine the potential hazards and risks posed to likely human and environmental receptors. Once the risks are determined, they will then be integrated into the preliminary CSMs developed during the SI (e^2M, 2008) that were presented in Section 2.0. Photographs of the RI activities performed at the MRS are presented in **Appendix E**.

4.1 MEC Investigation Results

The following sections present the results of the RI field efforts that were performed to achieve the DQOs defined in Section 2.3.1, "Data Quality Objectives," and define the nature and extent of MEC at the Load Line #1 MRS. These efforts included visual surveys of the ground surface for triple-base propellant that was performed in accordance with the Work Plan (Shaw, 2011).

4.1.1 Visual Survey Results

A full coverage nonintrusive visual survey was performed at the Load Line #1 MRS on two separate occasions. No MEC or MD was found on the ground or shallow surface soils during the visual surveys.

4.2 MC Data Evaluation

This section presents the results of the RI data screening process for MC that may be indicative of impacts from triple-base propellants previously observed on the ground surface at the Load Line #1 MRS and to evaluate the occurrence and distribution of the site-related chemicals (SRCs) in surface soil. The data evaluated for the Load Line #1 MRS are inclusive of the results of the RI sampling event only. Analytical data from a previous sample collected during the 2007 SI field activities were not included in this evaluation since the data collected for the RI are considered more representative of current conditions at the MRS as summarized in Section 2.3.3, "Data Incorporated into the RI."

The data reduction and screening process presented herein describes the statistical methods and facility-wide background screening criteria used to distinguish constituents present at ambient concentrations from those present at concentrations that indicate potential impacts related to historical operations within the MRS. The nature and extent of identified SRCs within the sampled environmental media (surface soil) established for this RI Report are also presented below. A summary of the complete laboratory analytical results for the RI data and the laboratory data packages are in **Appendix C**.

4.2.1 Data Evaluation Methods

Data evaluation methods for the Load Line #1 MRS are consistent with those established in the *Final Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant* (SAIC, 2010); hereafter, referred to as the FWCUG Report. These methods consist of three general steps: (1) define data aggregate; (2) data verification, reduction, and screening; and (3) data presentation.

4.2.1.1 Definition of Aggregate

The data aggregate at the Load Line #1 MRS consists of surface soils collected over the lateral extent of the MRS using ISM. The 0- to 0.5-foot sample depth is the maximum anticipated depth that MC would be found within the likely area of release. The surface soil aggregate consists of sampling units of similar sizes and depth over the likely area of release and are considered comparable for screening for the evaluation of the nature and extent of SRCs associated with previous activities at the MRS.

For risk assessment purposes and consideration of MC exposure analysis, the surface soil aggregate encompasses only areas of equally probable anticipated use by receptors and the defined exposure unit (EU) for surface soil is the extent of the MRS to a depth of 0.5 foot. The surface soil aggregate will be used to define human health and ecological risk exposure in the risk assessments as discussed in Section 7.0, "Human Health Risk Assessment" and Section 8.0, "Ecological Risk Assessment."

4.2.1.2 Data Validation

Data validation was performed on all three surface soil ISMs collected from the Load Line #1 MRS (including field duplicates and QC samples) during the RI field activities to ensure that the precision and accuracy of the analytical data were adequate for their intended use. The review constituted comprehensive validation of 100 percent of the primary dataset as discussed in Section 3.2.4, "Data Validation," of this report.

4.2.1.3 Data Reduction and Screening

The data reduction process implemented to identify SRCs involves identifying frequency of detection summary statistics, comparison to RVAAP facility-wide background screening values (BSVs) for inorganics only, and evaluation of essential nutrients. QC and field duplicates were excluded from the screening data sets. All analytes having at least one detected value were included in the data reduction process. Summary statistics calculated for each data aggregate included the minimum, maximum, and average (mean) detected values and the proportion of detected results to the number of samples collected. For calculation of mean detected values, nondetected results were included by using one half of the reported detection limit as a surrogate value during calculation of the mean result for each compound. Following data reduction, the data was screened to identify SRCs using the processes outlined in the following sections. **Figure 4-1** shows the RVAAP data screening process to

identify chemicals as SRCs and perform selection for chemicals of potential concern (COPCs) and chemicals of concern (COCs) as necessary. The determination of COPCs and COCs is for human health evaluation only.

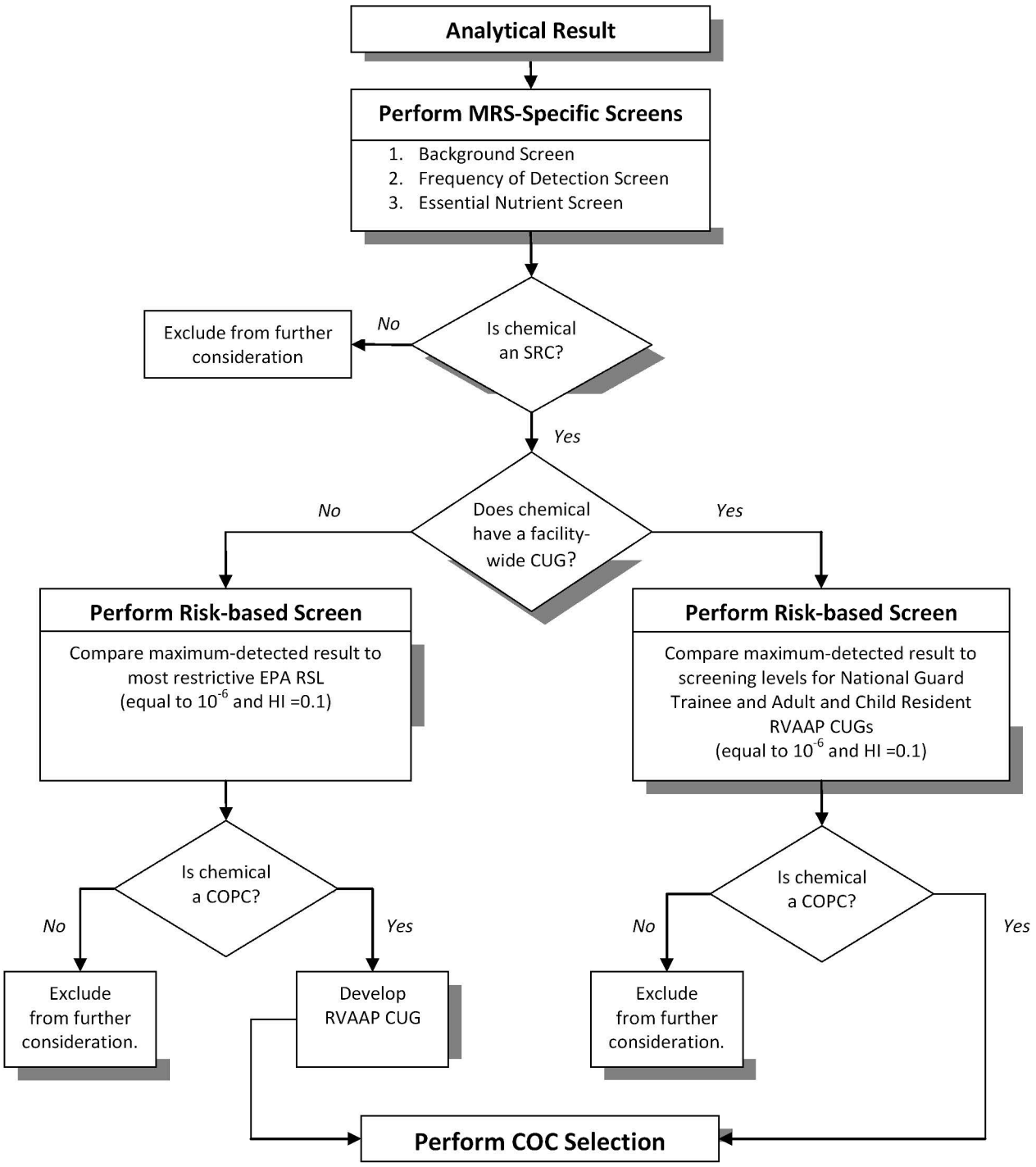
Frequency of Detection

Chemicals that are detected infrequently, except explosives and propellants, may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to the MRS activities or disposal practices. For sample aggregations, except for explosives and propellants, with at least 20 samples and frequency of detection of less than 5 percent, a weight of evidence approach may be used to determine if the chemical is MRS-related. Since surface soil samples were collected at only two locations (two ISM sampling units), frequency of detection was not utilized to support a weight of evidence approach for the Load Line #1 MRS data set.

Facility-Wide Background Screen

For inorganic constituents, if the maximum detected concentration (MDC) exceeded its respective BSV, it was considered to be an SRC. It should be noted that not all inorganic compounds analyzed as part of the RI sampling event have established screening levels or BSVs. Therefore, in the event an inorganic constituent was not detected in the background data set, the BSV was set to zero, and any detected result for that constituent was considered above background. This conservative process ensures that detected constituents are not eliminated as SRCs simply because they are not detected in the background data set. All detected organic compounds were considered to be above background because these classes of compounds do not occur naturally.

For the RI field efforts across the RVAAP MRSs being investigated under the MMRP, analyses were conducted for calcium, magnesium, and manganese to be potentially used for geochemical analysis. Aluminum was also analyzed for geochemical purposes at the Load Line #1 MRS where it is not considered an MC related to triple-base propellant. Geochemical analysis is typically used when metals are found to be only slightly elevated above background levels and risk assessment identifies potential risk to receptors due to metals. A geochemical analysis is then used to determine if MEC metals are background related or actually elevated due to site history. Use of the geochemical evaluation in this manner requires approval from the USACE and Ohio EPA prior to implementing geochemical evaluation results as a comparison tool for background results. A geochemical analysis was not required for the Load Line #1 MRS based on the evaluation of the metal results in Section 4.0, and the HHRA and ERA conclusions in Section 7.0 and Section 8.0, respectively.



COC = Chemical of Concern
COPC = Chemical of Potential Concern
CUG = Cleanup Goal
EPA = Environmental Protection Agency
HI = Hazard Index
MRS = Munitions Response Site
RSL = Regional Screening Level
SRC = Site Related Chemical

Note: The determination of COCs and COPCs is for human health and evaluation only.

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FIGURE 4-1 RVAAP DATA SCREENING PROCESS

Essential Nutrient Screen

Chemicals that are considered essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the food supply and are often added to foods as supplements. The EPA recommends that these chemicals not be evaluated as COPCs as long as they are present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and toxic at very high doses (i.e., much higher than those that could be associated with contact at the MRS) (USACE, 2005). A screen for essential nutrients was not required for the RI since no essential nutrients were analyzed for MC associated with the MRS.

4.2.1.4 Data Presentation

Data summary statistics and screening results for SRCs in surface soil collected at the Load Line #1 MRS are presented in **Table 4-1**. Analytical results for the Load Line #1 MRS inorganic and organic SRCs are presented by sample location in **Figure 4-2** and **Figure 4-3**, respectively, and indicate the extent and magnitude of contamination by highlighting SRCs that exceed the RVAAP BSVs. The SRCs are further evaluated in Section 7.0 and Section 8.0. The entire analytical laboratory data report for samples collected for the RI is presented in **Appendix C**.

4.2.2 Data Use Evaluation

During the RI field effort, surface soil samples were collected at two predetermined ISM sampling units to evaluate the nature and extent of SRCs associated with previous activities at the MRS. Available sample data were evaluated to determine suitability for use in the various key RI data screens, which includes evaluation of nature and extent of SRCs, fate and transport, and human and ecological risk assessments. Evaluation of data suitability for use in this RI Report involved two primary considerations: (1) representativeness with respect to current MRS conditions and (2) sample collection methods (i.e., discrete versus ISM).

The RI surface soil samples were collected using ISM and all data were incorporated into contaminant nature and extent evaluation. These samples are considered to be representative of current MRS conditions, were screened for SRCs, and carried forward into the human health and ecological risk assessments. An ISM surface soil sample and a duplicate soil sample were collected over the entire MRS as part of the 2007 SI field activities in order to confirm the presence or absence of MC. As discussed in Section 2.3.3, the RI sample results are intended to further characterize the nature and extent of contamination associated with previous activities at the MRS. A summary of the data use type for each of the Load Line #1 MRS samples to be included in the RI is presented in **Table 4-2**.

MRS Boundary

ISM Soil Sample Unit

Notes:
1) mg/kg = milligrams per kilogram
2) ft = foot

0 50 100 Feet

Projection : NAD_1983_UTM_Zone_17N

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Project Number: 136147

FIGURE 4-2 INORGANIC SITE-RELATED CHEMICALS

MRS Boundary

ISM Soil Sample Unit

Notes:
1) mg/kg = milligrams per kilogram
2) J = the reported result is an estimated concentration
3) ft = foot

0 50 100 Feet

Projection : NAD_1983_UTM_Zone_17N

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Project Number: 136147

FIGURE 4-3 ORGANIC SITE-RELATED CHEMICALS

4.3 Nature and Extent of SRCs

This section presents a summary of the nature and extent of SRCs for the environmental media samples collected during the RI field activities at the Load Line #1 MRS. Data from the ISM surface soil samples collected during the RI were screened to identify SRCs representing current conditions at the Load Line #1 MRS. The SRC screening data for surface soils (not including field duplicates or QC samples) included samples LL1SS-715(I)-0001-SS and LL1SS-716(I)-0001-SS, where ISM surface soil samples were taken from 0 to 0.5 foot bgs.

The ISM samples were collected from two same-sized sampling units (approximately 0.2 acres each) and at the same sample depth (0 to 0.5 foot) within the 0.41-acre MRS that constitutes the decision unit to further characterize the nature and extent of SRCs associated with previous activities at the MRS. All ISM surface soil samples collected during the RI sampling event were submitted for laboratory analyses for lead, explosives, nitrocellulose, TOC, and pH.

The samples were also submitted for geochemical parameters that included aluminum, calcium, magnesium and manganese for the rationale discussed in Section 4.2.1.3, "Data Reduction and Screening." However, since a geochemical analysis was not performed for the MRS, the geochemical parameters are not evaluated further.

4.3.1 Inorganics

Lead exceeded the BSV of 26.1 milligrams per kilogram (mg/kg) in both RI samples and was retained as an SRC. The maximum concentration (109 mg/kg) detected was from sampling unit LL1SS-715(I)-0001-SS. The inorganic results for the ISM MEC metal samples are presented in **Table 4-1**. **Figure 4-2** presents the distribution of the lead in surface soils.

4.3.2 Explosives and Propellants

Evaluation of the RI data results indicates that the propellant nitroguanidine was detected in both ISM sampling unit locations and is retained as an SRC. The maximum concentration detected was 0.25 mg/kg at sample LL1SS-715(I)-0001-SS. No other explosives or propellants were detected at either of the ISM sample locations. The detected data results are presented in **Table 4-3**. The sample distribution for the detected nitroguanidine results are shown in **Figure 4-3**.

Table 4-1
SRC Screening Summary in Surface Soil Samples

Analyte	Chemical Abstract Service Number	Frequency of Detection	Minimum Detect (mg/kg)	Maximum Detect (mg/kg)	Mean Result (mg/kg)	BSV (mg/kg)	SRC?	SRC Justification
Explosives and Propellants								
Nitroguanidine	556-88-7	2/2	0.22	0.25	0.24	NA	Yes	Detected organic MC
Inorganics								
Lead	7439-92-1	2/2	70.9	109	89.9	26.1	Yes	MC above BSV

BSV denotes background screening value.
MC denotes munitions constituents associated with triple-base propellant.
mg/kg denotes milligrams per kilogram.
MRS denotes munitions response site.
NA denotes not applicable.
SRC denotes site-related chemical.

Table 4-2
Data Use Summary Table for Environmental Samples Collected for the Load Line #1 MRS

Sample Location ID	Collection Date	Depth (ft bgs)	Sample Type	Data Use Type	Analysis	Comments
Surface Soil						
LL1SS-715(I)-0001-SS	8/15/11	0–0.5	ISM	N&E, F&T, R	• Lead • Geochemical Metals[1] • Explosives • Nitrocellulose • TOC • pH	Northern half of Load Line #1 MRS (100- by 90-foot ISM grid)
LL1SS-716(I)-0001-SS	8/15/11	0–0.5	ISM	N&E, F&T, R		Southern half of Load Line #1 MRS (100- by 90-foot ISM grid)

[1] Geochemical parameters include analyses for aluminum, calcium, magnesium and manganese.
F&T denotes fate and transport.
ft bgs denotes feet below ground surface.
ISM denotes incremental sampling method.
MEC denotes munitions and explosives of concern.
MRS denotes munitions response site.
N&E denotes nature and extent.
R denotes risk assessment data use.
TOC denotes total organic carbon.

Table 4-3
Detected Results in Surface Soil Samples

Detected Analyte	Location ID:	LL1SS-715		LL1SS-716	
	Sample ID:	LL1SS-715(I)-0001-SS		LL1SS-716(I)-0001-SS	
	Sample Date:	August 15, 2011		August 15, 2011	
	Depth (feet bgs):	0–0.5		0–0.5	
	Background[1]	Result	VQ	Result	VQ
Explosives (mg/kg)					
Nitroguanidine	*NA*	0.25	J	0.22	J
Inorganics (mg/kg)					
Lead	*26.1*	**109**		**70.9**	

[1] *Background values taken from the Final Facility-Wide Human Health Cleanup Goals at the RVAAP, Ravenna, Ohio (SAIC, 2010).*

Bold numbering indicates concentration is greater than the RVAAP background value for inorganic site-related chemical.

bgs denotes below ground surface.

J denotes result is less than the reporting limit, but greater than or equal to the method detection limit.

mg/kg denotes milligrams per kilogram.

NA denotes not available.

RVAAP denotes Ravenna Army Ammunition Plant.

VQ denotes validation qualifier.

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5.0 FATE AND TRANSPORT

This section describes the fate of contaminants in the environment and potential transport mechanisms. Contaminant fate refers to the expected final state that an element, compound, or group of compounds will achieve following release to the environment. Contaminant transport refers to migration mechanisms away from the source area. Section 5.1 and Section 5.2 discuss fate and transport associated with MEC and MC at the MRS, respectively.

5.1 Fate and Transport of MEC

Section 4.1, "MEC Investigation Results," discusses the nature and extent of MEC at the Load Line #1 MRS. Three triple-base propellant nodules (1 by ¼ inch each) that constitute MEC were identified at the MRS during the SI; however, no MEC was found at the MRS during the RI field activities. It is expected that any propellants at the MRS were on the ground surface only and were not buried. The propellants found during the SI were not found during RI activities, and no record of removal is documented for these propellants. Since no propellants were identified during the RI, an explosive safety hazard is not considered to be present at the MRS. Therefore, a discussion of the fate and transport of MEC at the MRS is not warranted.

5.2 Fate and Transport of MC

A MEC source was not observed at the Load Line #1 MRS during the RI field activities; however, surface soil samples were collected during the RI for MC at locations predetermined in the Work Plan (Shaw, 2011). The sample locations were chosen to further evaluation the nature and extent of SRCs associated with previous activities at the MRS. The SRCs detected are consistent with the chemical constituents associated with the triple-base propellants that have been historically observed on the ground surface at the MRS. Therefore, for the purposes of this fate and transport discussion, the SRCs will be conservatively evaluated as MC associated with the previously observed propellants. A discussion of the fate and transport mechanisms is presented herein.

The release of MC is a process unique to the military. The sources and magnitude are distinctly different from the release of chemicals from industrial processes typically investigated under the IRP (Strategic Environmental Research and Development Program and Environmental Security Technology Certification Program, 2012). Once a MC released from MEC enters an environmental medium, the fate and transport of MC are dependent on a wide variety of factors. Migration pathways often include air, water, soil, and the interfaces between the phases of the contaminant (i.e., solid, liquid, or gas). The fate and transport of contaminants occur in all three environments: (1) terrestrial, (2) aquatic, and (3) atmospheric.

Terrestrial environments are comprised of soil and groundwater, aquatic environments are comprised of surface water and sediment, and air is the only component of the atmospheric environment.

Several important physical and chemical properties from the impacted media affect the fate and persistence of contamination, which governs their distribution and behavior in environmental media. Depending upon the specific chemical and soil conditions, chemicals may be transferred from surface soil to subsurface soil, to stream/wetland sediments or surface water, and from all media to the air. The propensity of a chemical to react to equilibrium conditions in the environment and transfer between media is an important factor determining the mobility of a compound.

In the terrestrial environment, if the contaminant is released to soil, the contaminant may volatilize, adhere to the soil by sorption, leach into the surface water bodies or groundwater, or degrade because of chemical (abiotic) or biological (biotic) processes. If the contaminant is volatilized, the compound may be released to the atmosphere. Constituents that are dissolved eventually may be transported to an aquatic environment.

Once a contaminant is released to the aquatic environment, it can either volatilize or remain in the aquatic environment. In the aquatic environment, contaminants may be dissolved in the surface water or sorbed to the sediment. Contaminants may move between dissolved and sorbed states depending on a variety of physical and chemical factors.

In the atmospheric environment, contaminants may exist as vapors or as particulate matter. The transport of contaminants relies mostly on wind currents, and continues until the contaminants are returned to the earth by wet or dry deposition. Degradation of organic compounds in the atmosphere can occur due to direct photolysis, reaction with other chemicals, or reaction with photochemically generated hydroxyl radicals.

5.2.1 Contaminant Sources

This section presents a discussion of the detected lead and nitroguanidine concentrations that are identified as SRCs in the environmental media at the Load Line #1 MRS. The SRCs were detected in surface soil to a maximum depth of 0.5 foot bgs. The physical and chemical properties and potential release mechanisms and routes of migration for each of these SRCs are discussed below.

- Lead is a naturally occurring metal found in small amounts in the earth's crust. Lead salts were used as a ballistic modifying agent in triple-base propellants to modify the general laws of combustion (Folly and Mader, 2004). The use of lead in the manufacture of propellants has been phased out over the years due to its

toxicity. The most common form of lead (Pb) found in nature is Pb^{+2}, although lead also exists to a lesser extent as Pb^{+4} and in the organic form with up to four lead-carbon bonds (Kabata-Pendias, 2001). Most lead deposited on surface soil is retained and eventually becomes mixed into the surface layer. However, lead can migrate into subsurface environments. The migration of lead in the subsurface environment is controlled by the solubility of lead complexes and adsorption to aquifer materials. Adsorption to soil and aquifer material greatly limits the mobility of lead in the subsurface environment. The capacity of soil to adsorb lead increases with pH, cation exchange capacity, organic carbon content, redox potential, and phosphate levels. At pH values above 6, lead adsorbs on clay surfaces or forms lead carbonate. Lead exhibits a high degree of adsorption in clay-rich soil (Kabata-Pendias, 2001).

- Nitroguanidine (also called 1-nitroguanidine) is used as an explosive propellant notably in triple-base propellant smokeless powder. The nitroguanidine reduces the propellant's flash and flame temperature without sacrificing chamber pressure. Nitroguanidine is manufactured from guanine, a naturally occurring substance typically found in the excrement of bats and birds (guano). It is not flammable and is an extremely low sensitivity explosive; however, its detonation velocity is high. Nitroguanidine is expected to have high mobility in soil and volatilization from soils is not anticipated to be a primary fate process given an estimated Henry's Law constant of 4.45×10^{-16} atmospheric cubic meters per mole based upon its vapor pressure and water solubility (Gorontzy et al., 1994). In aquatic environments, nitroguanidine is not expected to adsorb to suspended solids or sediment. Volatilization is also not anticipated (Gorontzy et al., 1994). The aquatic fate of nitroguanidine is dominated by photolysis and is not anticipated to bioconcentrate (Haag et al., 1990). In the atmosphere, nitroguanidine is expected to exist solely in the particular phase and be removed from the atmosphere through either wet or dry deposition. As it absorbs light at approximately 260 nanometers and above, nitroguanidine is susceptible to direct photolysis (NIST Chemistry WebBook, 2010).

5.2.2 Summary of Fate and Transport

Based on current soil conditions at the RVAAP, which consisted primarily of silty clay loam with low permeability and an MRS-specific pH of approximately 8.4, it is expected that lead would tend to bind to the soil and is considered relatively immobile. Therefore, any MC would be expected to be found in the top several inches where it was deposited and subsurface has mostly likely not been impacted. Nitroguanidine is considered mobile in soil; however, the impact to subsurface soils at the MRS has not been evaluated. The low permeability of the soil and the low concentrations detected suggest that significant sources

of nitroguanidine were not deposited on or leached into the ground surface as a result of either dumping of triple-base propellants at the MRS or other activities (i.e., munitions loading operations) conducted at this portion of Load Line #1 when the facility was in operation.

The depth to groundwater at the nearest well location to the MRS (approximately 400 feet southeast) is 32 feet bgs. Evaluation of the most recent *Final Facility-Wide Groundwater Program, Report on the July 2011 Sampling Event* (Environmental Quality Management, Inc., 2012) identified several inorganics to exceed screening criteria at Load Line #1; however, lead was not identified as a SRC indicating that groundwater has not been impacted by the presence of elevated lead concentrations in surface soil at the MRS. Although, the impact of nitroguanidine on the groundwater directly beneath the MRS has not been evaluated, groundwater results from the July 2011 sampling event that included samples at Load Line #1, exhibited elevated concentrations of explosives but no propellants. Although mobile in soil, it does not appear that nitroguanidine in surface soil at the MRS has impacted groundwater at Load Line #1.

6.0 MEC HAZARD ASSESSMENT

In accordance with the Work Plan (Shaw, 2011), an evaluation of the MEC hazard at the Load Line #1 MRS was to be prepared in accordance with the *Interim Munitions of Concern Hazard Assessment Methodology* (EPA, 2008); hereafter referred to as the MEC HA Guidance. The MEC HA process was developed to evaluate the potential explosive hazard associated with conventional MEC present at a MRS under a variety of MRS-specific conditions, including various cleanup scenarios and land use assumptions.

Section 1.3 of the MEC HA Guidance explicitly states, "The MEC HA addresses human health and safety concern associated with potential exposure to MEC at a MRS." However, no MEC or MD items were identified at the MRS during 2011 RI field activities which has been interpreted to indicate that no MEC source or explosive safety hazard is present at the MRS. As a result the project team determined that calculation of a MEC HA score was not warranted for the Load Line #1 MRS.

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7.0 HUMAN HEALTH RISK ASSESSMENT

The purpose of this HHRA is to document whether SRCs identified at the Load Line #1 MRS may pose a risk to current or future human receptors, and to identify which, if any, MRS conditions need to be addressed further under the CERCLA process. This risk assessment has been prepared in accordance with the Work Plan (Shaw, 2011) using the streamlined approach to risk decision-making, as described in the FWCUG Report (SAIC, 2011). In particular, the *RVAAP Position Paper for the Application and Use of Facility-Wide Cleanup Goals* (USACE, 2012); hereafter referred to as the Position Paper, describes the use of the Facility-Wide Cleanup Goals (FWCUGs) in the following steps:

- Identify COPCs at the 1×10^{-6} (one in a million) excess cancer risk level or noncarcinogenic hazard quotient (HQ) of 0.1 for the MRS by comparing concentrations to BSVs, eliminating essential nutrients, and comparing the concentrations of SRCs to the final FWCUGs.
- Identify COCs at the 1×10^{-5} (one in one hundred thousand) excess cancer risk level or noncarcinogenic HQ risk value of 1 by comparing concentrations to specific final FWCUGs, and using a "sum of ratios" approach to account for cumulative effects. This method sums the ratios of the SRC concentrations to the final FWCUG for all COPCs. A sum of ratios greater than 1 represents an unacceptable risk, and cancer and noncancer effects are considered separately.

The following sections discuss the HHRA approach, the data used in the HHRA, and the COPC and COC evaluation for the samples collected at the Load Line #1 MRS during the RI field activities.

7.1 Data Used in the HHRA

The available data set used in this HHRA consisted of two ISM surface soil samples (LL1SS-715(I)-0001-SS and LL1SS-716(I)-0001-SS) collected as part of the RI field effort, which are considered to be representative of current conditions. A third sample (LL1SS-717(I)-0001-SS) was collected as a field duplicate and is; therefore, excluded from the risk evaluation process. The samples included in the HHRA data set are identified in **Table 7-1**. The sample collection locations are presented in **Figure 3-1**.

7.2 COPC Identification

The section presents the evaluation of the MRS data and the identification of COPCs for the intended receptors based on future land use. The OHARNG future use at the MRS is Military Use and Training. As part of the IRP cleanup at this AOC, this site was evaluated for the

Risk Assessment Land Use of Mounted Training, No Digging, as documented in the *Final Interim Record of Decision* (USACE, 2007). The AOC is currently being re-evaluated for Unrestricted Guard Use under the IRP. In order to correlate the MMRP with the IRP, the most representative receptor for the MRS is the National Guard Trainee, which will be evaluated as part of this RI.

Evaluation of the future land use, in conjunction with the evaluation of agricultural-residential land uses and associated receptors form the basis for identifying COPCs and COCs in this RI. Residential Land Use, specifically the Residential Farmer (Adult and Child) scenario, is included to evaluate COCs for unrestricted land use at the MRS as required by the CERCLA process.

The media of concern that was evaluated in the risk assessment for human health consists solely of surface soil that was biased by collecting samples across the entire MRS at a sample depth of 0 to 0.5 foot bgs. The 0.5-foot sample depth across the MRS is the focus of this HHRA since it is the maximum depth that MC associated with the propellants has historically been found.

The Load Line #1 MRS is considered as a single EU based on future land use and the COPC identification was completed for surface soil (0 to 0.5 foot bgs) as presented in **Table 7-2**. This table provides the frequency and percent detection of each substance detected in the samples included in the risk assessment. The minimum and maximum detected concentrations are provided as well as the location of the maximum detection and the range of reporting limits. The applicable BSVs used are provided in the FWCUG Report (SAIC, 2010) and are discussed in further detail in Section 4.2.1.3. These tables also include a column identifying whether the MC was identified as an SRC, based on consideration of the background screening and consideration as an essential nutrient (Section 4.2.1.3).

The data for this RI was evaluated in accordance with the initial evaluation step presented in the Position Paper (USACE, 2012) to further establish COPCs and characterize source areas of contamination. This evaluation process consisted of the following progression:

1. The maximum concentrations of inorganics (lead) were compared to the BSV in the FWCUG Report (SAIC, 2010). In some cases, a geochemical evaluation may be conducted to further evaluate background conditions; however, none was needed in this case. A concentration of an inorganic above its respective BSV will require it to be retained as a COPC for further evaluation.

Table 7-1
Summary of Surface Soil Samples (0–0.5 foot bgs) used for Human Health Risk Assessment

Sample Location	Sample Number	Sample Date	Depth of Sample (feet bgs)	Analyses
LL1SS-715	LL1SS-715(I)-0001-SS	August 15, 2011	0–0.5	• Lead • Explosives • Nitrocellulose • TOC • pH
LL1SS-716	LL1SS-716(I)-0001-SS	August 15, 2011	0–0.5	

bgs denotes below ground surface.
TOC denotes total organic carbon.

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Table 7-2
Statistical Summary and Human Health Screening of Surface Soil (0–0.5 foot bgs)—Residential Farmer and National Guard Trainee

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg						Location of MDC	Mean (mg/kg)	BSV (mg/kg)	SRC?	RFA FWCUG[1] (mg/kg)	RFC FWCUG[1] (mg/kg)	NGT FWCUG[1] (mg/kg)	RSL[2] (mg/kg)	COPC?	COPC Justification
			Detected Concentrations				Reporting Limits											
			Min.	VQ	Max.	VQ	Min.	Max.										
Inorganics																		
Lead	2 / 2	100	70.9		109		0.25	0.25	LL1SS-715	89.95	26.1	Yes	-	-	-	400	No	Below risk screening criteria
Explosives																		
Nitroguanidine	2 / 2	100	0.22	J	0.25	J	0.25	0.26	LL1SS-715	0.235	-	Yes	-	-	-	610	No	Below risk screening criteria

[1] *FWCUG is lower of noncarcinogenic FWCUG at a hazard index of 0.1 and excess carcinogenic FWCUG risk of 10-6.*
[2] *RSL is for residential soil and is based on noncancer risk adjusted to a hazard index of 0.1 (as opposed to published value based on a hazard index of 1), except lead.*
- denotes that no value is available for this criterion.
BSV denotes background screening value (surface soil).
COPC denotes chemical of potential concern.
EPA denotes U.S. Environmental Protection Agency.
FWCUG denotes Final Facility-Wide Cleanup Goal.
J denotes result should be considered estimated.
Max. denotes maximum.
MDC denotes maximum detected concentration.
mg/kg denotes milligrams per kilogram.
Min. denotes minimum.
NGT denotes National Guard Trainee.
RFA denotes Residential Farmer Adult.
RFC denotes Residential Farmer Child.
RSL denotes regional screening level.
RVAAP denotes Ravenna Army Ammunition Plant.
SRC denotes site-related chemical.
U.S. denotes United States.
VQ denotes validation qualifier.

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2. The maximum concentrations of inorganics (lead) were compared to the BSV in the FWCUG Report (SAIC, 2010). In some cases, a geochemical evaluation may be conducted to further evaluate background conditions; however, none was needed in this case. A concentration of an inorganic above its respective BSV will require it to be retained as a COPC for further evaluation.

3. Chemicals identified as essential nutrients (i.e., calcium, chloride, iodine, magnesium, potassium, phosphorus, and sodium) were screened out as long as they were present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and toxic at very high doses (i.e., much higher than those that could be associated with contact).

4. Chemicals meeting the "less than 5 percent detected" rule (i.e. frequency of detection) may be screened out; however, in order for this to occur, the chemical must have a statistically valid data set with a sample size of at least 20. Due to the small number of samples, no chemicals were eliminated on this basis at the MRS.

5. To establish COPCs, all chemicals that have not been eliminated to this point were evaluated using the following steps:

   – The final FWCUGs developed for the Residential Farmer (Adult and Child) and the National Guard Trainee receptors for each chemical were used. If there were no final FWCUGs developed for a particular chemical, then the EPA *Regional Screening Levels* (RSLs) for the Residential Receptor were used (EPA, 2011). If neither a final FWCUG nor an RSL is available, then a cleanup goal can be developed in concurrence with the USACE and the Ohio EPA. Final FWCUGs or RSLs were available for all chemicals not previously eliminated.

   – The final FWCUGs at the 1×10^{-6} (one in a million) excess cancer risk level and noncarcinogenic risk HQ using the 0.1 risk value for each of the receptors will be selected.

   – A comparison of the selected final FWCUG to the exposure point concentration (EPC) was completed. The EPCs used in this screening step were the maximum values detected.

   – The chemical was retained as a COPC if the EPC exceeded the most stringent risk value for the Residential Farmer (Adult and Child) or the National Guard Trainee for either one of the 1×10^{-6} excess cancer risk values and the noncarcinogenic HQ using the 0.1 risk value.

The Work Plan (Shaw, 2011) specifies that in addition to screening the final FWCUGs for the Residential Farmer (Adult and Child) and the National Guard Trainee, evaluation will also be made against the remaining OHARNG receptors in order to ensure that the most conservative receptor is identified. For the chemicals detected at the Load Line #1 MRS, the final FWCUGs for the Residential Farmer (Adult and Child) or National Guard Trainee FWCUGs were lower than those for any other OHARNG receptor. As a result, the National Guard Trainee, the most conservative OHARNG receptor, and the Residential Farmer (Adult and Child) receptor were considered for COPC evaluation.

Table 7-2 presents the screening results for COPCs for the Residential Farmer (Adult and Child) and the National Guard Trainee in accordance with the FWCUG Report (SAIC, 2010). These tables include the final FWCUGs that are based on the lower of the 1×10^{-6} (one in a million) excess cancer risk level and an HQ of 0.1 for noncancer effect values. If a chemical was detected for which there was no final FWCUG, the EPA RSLs (2011) were used. These values are only shown in **Table 7-2** if there are no final FWCUGs available. The RSLs are based on the lower of values derived considering excess cancer risk of 1×10^{-6} (one in a million) and noncancer hazard considering an HQ of 1. The RSLs derived based on noncancer hazard were adjusted to an HQ of 0.1 in order to be consistent with the noncancer final FWCUGs. The RSL for lead, however, was not adjusted in this manner, since it was not derived using the HQ approach. The RSL for lead in soil is based on the value recommended by the EPA as generally safe for residential settings.

The COPCs are identified by comparing the maximum detected concentration to the applicable screening criteria. Substances that are considered SRCs, and for which the maximum concentration is greater than the lowest final FWCUG, or the RSL if no final FWCUGs are available, are considered COPCs. The entire MRS was adequately characterized to the anticipated depth that MC, if any, would be expected to be found (0 to 0.5 foot bgs) and no COPCs were identified for either the Residential Farmer (Adult and Child) or the National Guard Trainee. Therefore, an evaluation for COCs was not required. **Table 7-2** presents the summary of the human health data screen process and evaluation for COPCs.

7.3 Uncertainty Analysis

There are various sources of uncertainty in the evaluation of exposure and risk that are common to all risk assessments. These general sources of uncertainty are not described here. However, those specific to this assessment are discussed in the following sections. These uncertainties generally relate to sampling considerations, the determination of EPCs, and the selection of appropriate receptors. There are numerous uncertainties related to the final 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. Therefore, these uncertainties are not discussed here unless there is a particular issue relevant to this evaluation.

Uncertainty can arise from sampling techniques or approaches. In this assessment, surface soil was sampled using ISM techniques. These techniques provide a good representation of average concentrations over the area sampled. While it may not identify small areas of higher concentrations, this approach is useful for estimating exposure, which is expected to occur over an area and not discrete locations.

Several substances detected at the MRS have no final FWCUGs. In these cases, the RSLs were used as the screening values for all receptors. This provides a conservative evaluation, since the RSLs used are based on residential exposure.

The selection of the maximum detected concentration as the EPC for the ISM samples provides a conservative evaluation of potential exposures in the area with the highest concentrations. The selection of receptors also represents an uncertainty to the risk assessment. The Residential Farmer (Adult and Child) is assumed to be the future receptors in the COPC evaluation, representing a conservative evaluation of possible future exposures. Therefore, risks are not expected to be underestimated for other future uses.

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8.0 ECOLOGICAL RISK ASSESSMENT

This ERA evaluates the potential for adverse effects posed to ecological receptors from potential releases at the Load Line #1 MRS. This ERA is consistent with the process described in the EPA *Ecological Risk Assessment Guidance for Superfund* (1997) and the *Ohio EPA Ecological Risk Assessment Guidance Document* (2008); hereafter referred to as the EPA Guidance and Ohio EPA Guidance, respectively. Other supporting documents used in the preparation of this ERA include the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003b) and the *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE, 2010). The ERA also follows the Unified Approach to ERAs established at sites under environmental investigation at the RVAAP.

The ERA 8-step approach as described in EPA (1997) guidance consists of an initial screening-level ERA (SLERA). The SLERA comprises Steps 1, 2, and the first part of Step 3 (often referred to as Step 3a), in which a refinement of the chemicals initially selected as chemicals of potential ecological concern (COPECs) is performed prior to determining whether additional investigation is necessary. If the SLERA indicates that additional investigation is warranted, it is followed by a more comprehensive baseline ERA (BERA) by completing the second part of Step 3 (i.e., "Step 3b") through Step 7. Step 8 is a risk management step that occurs after information presented in the previous steps of the ERA has been fully considered. The Ohio EPA Guidance (2008) presents a similar "tiered" approach that allows for a progression through four levels of the ERA as required by the findings and conclusions of each level: Level I Scoping, Level II Screen, Level III Baseline, and Level IV Field Baseline. Levels I and II are approximately equivalent to Steps 1 and 2 of a SLERA. Level III includes food chain modeling using exposure dose and toxicity estimates for generic receptors using conservative assumptions, and is incorporated as part of Step 3a in the SLERA if it is considered necessary to refine COPECs. The Level IV Field Baseline is equivalent to the BERA (Steps 3b through 7), where conservative assumptions used in the Level III Baseline are modified using MRS-specific information.

Consistent with the RVAAP Unified Approach for performing ERAs, a SLERA was performed on the Load Line #1 MRS, which is presented in this section. As stated previously, the SLERA includes Steps 1 through 3a of the 8-step process for ERAs (EPA, 1997). This is equivalent to a Levels I and II evaluation according to the Ohio EPA process, and is also consistent with the ERA approach described in USACE Guidance (2003b and 2010). Because the conclusion of the Load Line #1 MRS SLERA was that no chemicals require additional evaluation, a BERA is not considered necessary for this MRS, and the ERA process is terminated following the completion of the SLERA.

8.1 Scope and Objectives

The goal of the SLERA is to evaluate the potential for adverse ecological effects to ecological receptors from MC at the Load Line #1 MRS. This objective is met by characterizing the ecological communities in the vicinity of the MRS, determining the particular contaminants present, identifying pathways for receptor exposure, and estimating the magnitude of the likelihood of potential adverse effects to identified receptors. The SLERA addresses the potential for adverse effects to the wildlife, threatened and endangered species, and wetlands or other sensitive habitats that may be associated with the MRS.

The objective of this SLERA is to provide an estimate of the potential for adverse ecological effects associated with contamination resulting from former activities at the Load Line #1 MRS. The results of the SLERA will contribute to the overall characterization of the MRS and may be used to determine the need for additional investigations or to develop, evaluate, and select appropriate remedial alternatives. In addition to the EPA Guidance (1997) and the Ohio EPA Guidance (2008), other guidance documents used to perform the SLERA include the general guidelines of the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996), *Region 5 Biological Technical Assistance Group Ecological Risk Assessment Guidance Bulletin No. 1* (EPA, 1996). The SLERA fits into Steps 1 and 2 of the EPA Guidance (1997), and Level I through a maximum of Level III evaluation using the Ohio EPA Guidance (2008) process. As noted previously, this SLERA for the Load Line #1 MRS includes only Levels I and II evaluations.

The SLERA uses MRS-specific analyte concentration data for surface soil from the Load Line #1 MRS. Risks to ecological receptors were evaluated by performing a multistep screening process in which, after each step, the detected analytes in soil were either deemed to pose negligible risk and eliminated from further consideration or carried forward to the next step in the screening process to a final conclusion of being a COPEC. COPECs are analytes whose concentrations are great enough to pose potential adverse effects to ecological receptors. Following the determination of COPECs, an ecological CSM is developed that describes the selection of receptors, exposure pathways, and assessment and measurement endpoints (USACE, 2003b and 2010).

8.2 Management Goals for the RVAAP

The INRMP (AMEC, 2008) has been developed for the OHARNG as the primary guidance document and tool for managing natural resources at the RVAAP (AMEC, 2008). Several of these management goals have relevance to the SLERA because they articulate overarching objectives regarding ecological resources that should be considered when identifying whether adverse impacts associated with a release have occurred. Specifically, the following goals listed in the INRMP are pertinent to the Load Line #1 MRS SLERA:

- Protect and maintain populations of rare plant and animal species on the RVAAP in compliance with federal and state laws and regulations.
- Manage wildlife resources in a manner compatible with the military mission and within the limits of the natural habitat.
- Manage wetlands and other surface waters in accordance with applicable federal, state, and local regulations and to protect water quality and ecological function while facilitating the military mission.
- Manage soil to maintain productivity, and prevent and repair erosion in accordance with state and federal laws and regulations.

8.3 Problem Formulation

The problem formulation step of the SLERA includes descriptions of habitats; biota; threatened, endangered, and other rare species; selection of EUs; and identification of COPECs at the MRS.

8.3.1 Ecological Significance

Topography across the Load Line #1 MRS is relatively flat with little change in elevation. The MRS is in a slight depression related to its immediate surroundings. Based on topographical maps, local surface drainage is to the east. There are no natural streams or ponds located within the MRS and the MRS is not located within a flood plain (AMEC, 2008).

The vegetation community present at the Load Line #1 MRS is categorized as the "Dry Midsuccessional Cold-Deciduous Shrubland Alliance" (AMEC, 2008). This shrubland alliance is associated with relatively open areas characterized by shrub species covering more than 50 percent of the area, with relatively few large trees. This alliance often is found within previously disturbed areas, and is dominated by gray dogwood, northern arrowwood, blackberry, hawthorn, and multiflora rose. Additional details pertaining to the ecological setting are provided in the following sections.

8.3.1.1 Terrestrial and Aquatic Resources

This section summarizes the terrestrial and aquatic resources identified for the Load Line #1 MRS that is evaluated in this ERA.

Special Interest Areas

Special interest areas are ecosystems that are not federally protected and have no legal standing, but are areas that host state-listed species, are representative of historic ecosystems, or are otherwise noteworthy. The ODNR and the USFWS did not identify any special interest areas on or near the Load Line #1 MRS during their natural heritage data searches (AMEC, 2008).

Wetlands

Numerous wetland surveys, including planning level surveys and jurisdictional surveys have been conducted at the RVAAP. No wetlands have been identified at the Load Line #1 MRS (AMEC, 2008).

Animal Populations

The plant communities at the RVAAP provide diverse habitats that support many species of animals. Through casual observations and various studies, the following number of species have been identified at the RVAAP: 35 land mammals, 214 birds, 34 reptiles and amphibians, 46 fish (including 2 hybrids), 4 crayfish, 17 mollusks (clams), 12 aquatic snails, 45 terrestrial snails, 64 damselflies and dragonflies, 64 butterflies, 793 moths, and 800 beetles (AMEC, 2008).

Nearly the entire load line is covered by open shrub land habitat. Common bird species that could be expected to use the forest/riparian habitat adjacent to the creek include the song sparrow (*Melospiza melodia*), gray catbird (*Dumetella carolinensis*), and rufous-sided towhee (*Pipilo erythrophthalmus*). Common large mammals include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), and woodchuck (*Marmota monax*), while the eastern cottontail (*Sylvilagus floridanus*), white-footed mouse (*Peromyscus leucopus*), and short-tailed shrew (*Blarina brevicauda*) are common small mammals present at the RVAAP (ODNR, 1997) that may use the habitat present at the Load Line #1 that includes the MRS.

Threatened and Endangered and Other Rare Species Information

The relative isolation and protection of habitat at the RVAAP has created an important area of refuge for a number of plant and animal species considered rare by the State of Ohio. No federally listed species are known to reside at the RVAAP. To date, 77 state-listed species are confirmed to be on the RVAAP and are listed in **Table 1-3**. The Load Line #1 MRS has

not been specifically surveyed for threatened or endangered species; however, none are known to exist at the MRS (CRJMTC, 2010).

8.3.2 Selection of Exposure Units

From the ecological assessment viewpoint, an EU is the area where ecological receptors potentially are exposed to the SRCs. Although some ecological receptors are likely to gather food, seek shelter, reproduce, and move around, spatial boundaries of the ecological EUs are the same as the spatial boundaries of aggregates defined for historical use, nature and extent, fate and transport, and the HHRA.

Surface soil to a maximum depth of 0.5 foot is representative of the terrestrial EU at the Load Line #1 MRS. No other EUs are identified for this MRS.

8.4 Data Used in the SLERA

The available data set used in this SLERA consists of two ISM surface soil samples (LL1SS-715(I)-0001-SS and LL1SS-716(I)-0001-SS) collected as part of the RI field effort. A third sample (LL1SS-717(I)-0001-SS) was collected as a field duplicate and is therefore excluded from the risk evaluation process. An ISM sample was collected at the MRS during the SI, but was not included in this SLERA since the samples collected during the RI were intended to further delineate the extent of MC identified during the 2007 SI field activities and are considered to be representative of current conditions.

Surface soil at a depth of 0 to 0.5 foot from two ISM sampling units was identified as the only medium of concern at this MRS as described in the Work Plan (Shaw, 2011). The 0- to 0.5-foot sample depth and was selected as the EU depth since it is the maximum extent of vertical migration expected of MC associated with triple-base propellant on the ground surface. Each ISM sample was comprised of 30 increments that were combined and homogenized. The ISM data are considered relevant for estimating ecological exposure because they provide the best representation of current MRS conditions, and because the ISM approach provides an accurate estimate of average concentrations that receptors would be exposed to at the MRS. Only surface soil (0- to 0.5-foot sampling interval) samples were used in the SLERA because surface soil had been previously identified as the only medium of concern at the Load Line #1 MRS (Shaw, 2011), and because most ecological exposure occurs within the top 1 foot of soil. Also, it is expected that much of the native soil at the load line has been reworked, removed, or used as cover material as part of past remediation and demolition activities, which would likely decrease the attractiveness to burrowing receptors. Therefore, the 0- to 0.5-foot interval is assumed to represent the zone of maximum exposure for most ecological receptors.

From the MC chemical results of samples described above, a COPEC selection process was performed to develop a subset of SRCs that are identified as COPECs. Note that all detected chemicals are included in the COPEC screening step, but the screen incorporates the same criteria described in Section 4.2.1.3 to eliminate chemicals that are not SRCs (i.e., infrequently detected chemicals, background comparisons, and essential nutrients). A list of the Load Line #1 MRS samples used for the SLERA is presented in **Table 8-1** by medium and sample type. The locations at the Load Line #1 MRS where the samples were collected are presented in **Figure 3-1**.

8.4.1 Data Organization

Chemical analytical data were reviewed and evaluated for quality, usefulness, and uncertainty. Data identified as being of acceptable quality for use in the ERA were summarized in a manner that presents the pertinent information to be applied in the ERA. All data used in the ERA were validated.

The data for each chemical are sorted by medium. Chemicals not detected at least once in a medium are not included in the risk assessment. Available background data was identified, if available. The source of background information included data from the FWCUG Report (SAIC, 2010).

8.4.2 Data Evaluation

The data evaluation normally entails two components: (1) a frequency of detection analysis and (2) an evaluation of common laboratory contaminants. The purpose of the frequency of detection analysis is to eliminate from further consideration any chemicals detected in 5 percent or less of the samples for a given medium, excluding chemicals present in multiple media, or deemed to be persistent, bioaccumulative, and toxic (PBT). However, for this MRS, no frequency of detection screening was performed because only two samples were available. Also, ISM samples represent an average concentration over a given area, and using a frequency of detection is not an appropriate criterion for ISM samples.

The analytical data included qualifiers from the analytical laboratory quality control or from the data validation process that reflect the level of confidence in the data. Some of the more common qualifiers and their meanings are as follows (EPA, 1989):

- **U Qualifier—**Chemical was analyzed for but not detected; the associated value is the sample quantitation limit.
- **J Qualifier—**Value is estimated, probably below the contract-required quantitation limit.

Table 8-1
Summary of Surface Soil Samples (0–0.5 foot bgs) used for Ecological Risk Assessment

Sample Location	Sample Number	Sample Date	Depth of Sample (feet bgs)	Analyses
LL1SS-715	LL1SS-715(I)-0001-SS	August 15, 2011	0–0.5	• Lead • Explosives • Nitrocellulose • TOC • pH
LL1SS-716	LL1SS-716(I)-0001-SS	August 15, 2011	0–0.5	

bgs denotes below ground surface.
TOC denotes total organic carbon.

- **R Qualifier**—Quality control indicates that the data are unusable (chemical may or may not be present).

"J"-qualified data are used in the risk assessment. "U"-qualified data were treated as nondetects. "R"-qualified data, if identified, would not be included in the risk assessment; however, no "R"-qualified data were found.

8.4.3 Media Evaluation

The media evaluation was performed after the frequency of detection and common laboratory contaminant evaluation, using the chemicals that were not eliminated during those two steps. The purpose of the media evaluation is to determine whether SRCs have impacted media associated with the MRS. The evaluation methods were media-specific, and included comparison against the applicable BSVs. The MDCs of chemicals in soil were compared to selected BSVs and eliminated from further consideration in the Level II Screen if the maximum concentrations were less than the BSV. If the MDCs of a chemical exceeded its BSV, the chemical was carried forward to the media screening step.

8.4.4 COPEC Selection Criteria

The criteria used to identify COPECs in the SLERA are described in the following sections.

8.4.4.1 Comparison to Ecological Screening Values

The MDCs of chemicals detected in various media were compared with ecological screening values (ESVs) for ecological endpoints following recommendations obtained from the Ohio EPA Guidance (2008). Chemicals that exceed the ESVs, or for which no ESVs are available, were retained as COPECs. The following ESV hierarchy was used for the ecological evaluation of soil:

- EPA: *Ecological Soil Screening Levels* (online updates from http://www.epa.gov/ecotox/ecossl/) (2010)
- Oak Ridge National Laboratory: *Preliminary Remediation Goals for Ecological Endpoints*, ES/ER/TM-162/R2 (Efroymson et al., 1997a)
- EPA: *Ecological Screening Levels, EPA Region 5* (August 2003)
- Los Alamos National Laboratory: *ECORISK Database, Release 2.5* (November 2010)
- Talmage et al.: *Nitroaromatic Munitions Compounds: Environmental Effects and Screening Values*, Rev. Environ. Contamin. Toxicol., 161:1–156 (1999)

The ESVs used for the SLERA are presented in **Appendix F**. Chemicals that were considered PBT were retained as COPECs even if they were detected at concentrations below their ESVs, unless the ESV was protective of food chain effects (Ohio EPA, 2008). PBT compounds include those chemicals listed in Ohio EPA Guidance (2008), including chemicals whose log octanol-water partition coefficient values are greater than or equal to 3, and chemicals listed as important bioaccumulative compounds in the EPA Guidance (2000).

8.4.4.2 Essential Nutrients

Evaluating essential nutrients is a special form of risk-based screening applied to certain ubiquitous elements that are generally considered to be required nutrients. Essential nutrients such as calcium, iron, magnesium, potassium, and sodium are usually eliminated as COPECs because they are generally considered to be innocuous in environmental media. Other essential nutrients, including chloride, iodine, and phosphorus, may be eliminated as COPECs, provided that their presence in a particular medium is unlikely to cause adverse effects to biological health. A screen for essential nutrients was not required for the SLERA since no essential nutrients were analyzed for MC associated with the MRS.

8.4.5 Summary of COPEC Selection

The results of the COPEC screening for surface soil are presented in **Table 8-2** for the ISM samples. The table presents the following information:

- Chemical name
- Frequency of detection
- Range of detected concentrations
- Range of detection limits
- Arithmetic mean (average) of site concentrations
- Site background concentration
- Determination as to whether the chemical is site related
- ESV
- HQ
- Determination as to whether the chemical is a PBT pollutant
- Determination as to whether the chemical is a COPEC

One half the reporting limit was used as a surrogate concentration for nondetects for calculating the arithmetic mean of concentrations. The HQ is calculated as the detected

concentration divided by the ESV. An HQ greater than 1 indicates that the concentration in the medium exceeds the conservative ESV, and may indicate that a potential ecological threat exists. Chemicals with HQs less than 1 are considered to be of low concern, and are not carried forward as COPECs, unless the chemical is a PBT pollutant and its screening value is not protective of food chain effects. A description and summary of the COPECs identified in surface soil is presented in the following section.

8.4.5.1 Soil COPEC Selection

Lead exceeded both its BSV and ESV, and the single explosives chemical detected, nitroguanidine, lacked an ESV. These two chemicals were considered as SRCs. Following the initial COPEC screen, both chemicals were identified as COPECs. The results of the soil screening process used to evaluate for COPECs are presented in **Table 8-2**.

8.4.5.2 COPEC Selection Conclusions

The Level II report identifies MRS-specific receptors, relevant and complete exposure pathways and other pertinent information (Ohio EPA, 2008). These components represent preliminary information for a Level III ERA. The following section presents the ecological CSM, including selection of MRS-specific ecological receptor species, relevant and complete exposure pathways and candidate ecological assessment endpoints and measures.

8.5 Ecological Conceptual Site Model

The ecological CSM depicts and describes the known and expected relationships among the stressors, pathways, and assessment endpoints that are considered in the risk assessment, along with a rationale for their inclusion. Two ecological CSMs are presented for this Level II Screen. One ecological CSM is associated with the media screening conducted during the Level II Screen (**Figure 8-1**). The other ecological CSM (**Figure 8-2**) represents a preliminary CSM for a Level III Baseline, should one be considered necessary. The ecological CSMs for the Load Line #1 MRS were developed using the available MRS-specific information and professional judgment. The contamination mechanism, source media, transport mechanisms, exposure media, exposure routes, and ecological receptors for the ecological CSMs are described below.

8.5.1 Contamination Source

The contamination source includes releases of triple-base propellant onto the ground surface at the northern portion of Load Line #1 where munitions loading activities occurred when Load Line #1 was in operation. Section 1.4, “History and Background,” of this RI Report describes the types of historical operations that took place at the MRS.

Table 8-2
Statistical Summary and Ecological Screening of Soil Samples (0–0.5 foot bgs)

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg						Mean (mg/kg)	BSV[1] (mg/kg)	SRC?[2]	ESV[1] (mg/kg)	Below ESV?	Hazard Quotient	PBT?[1]	COPEC?[3]
			Detected Concentrations				Reporting Limits									
			Min.	VQ	Max.	VQ	Min.	Max.								
Inorganics																
Lead	2 / 2	100	70.9		109		0.25	0.25	89.95	26.1	Yes	11	No	9.9	No	Yes
Explosives																
Nitroguanidine	2 / 2	100	0.22	J	0.25	J	0.25	0.26	0.235	NA	Yes	NA	NA	NA	No	Yes

[1] See Appendix D.
[2] Chemicals with MDCs lower than the background screening value are not considered to be site-related (background screening values are for metals only).
[3] Selection of COPECs:
Yes denotes COPEC exceeds the ESV, and BSV, or is a PBT pollutant.
No (a) denotes that chemical is an essential nutrient.
No (b) denotes that chemical is not site-related (MDC is less than BSV).

- denotes that no value is available for this criterion.
bgs denotes below ground surface.
BSV denotes background screening value.
COPEC denotes chemical of potential ecological concern.
ESV denotes ecological screening value.
J denotes estimated concentration (difference in concentrations between the primary and confirmation column results exceeds 40%).
Max. denotes maximum.
MDC denotes maximum detected concentration.
mg/kg denotes milligrams per kilogram.
Min. denotes minimum.
NA denotes not applicable.
PBT denotes persistent, bioaccumulative, and toxic.
SRC denotes site-related chemical.
VQ denotes validation qualifier.

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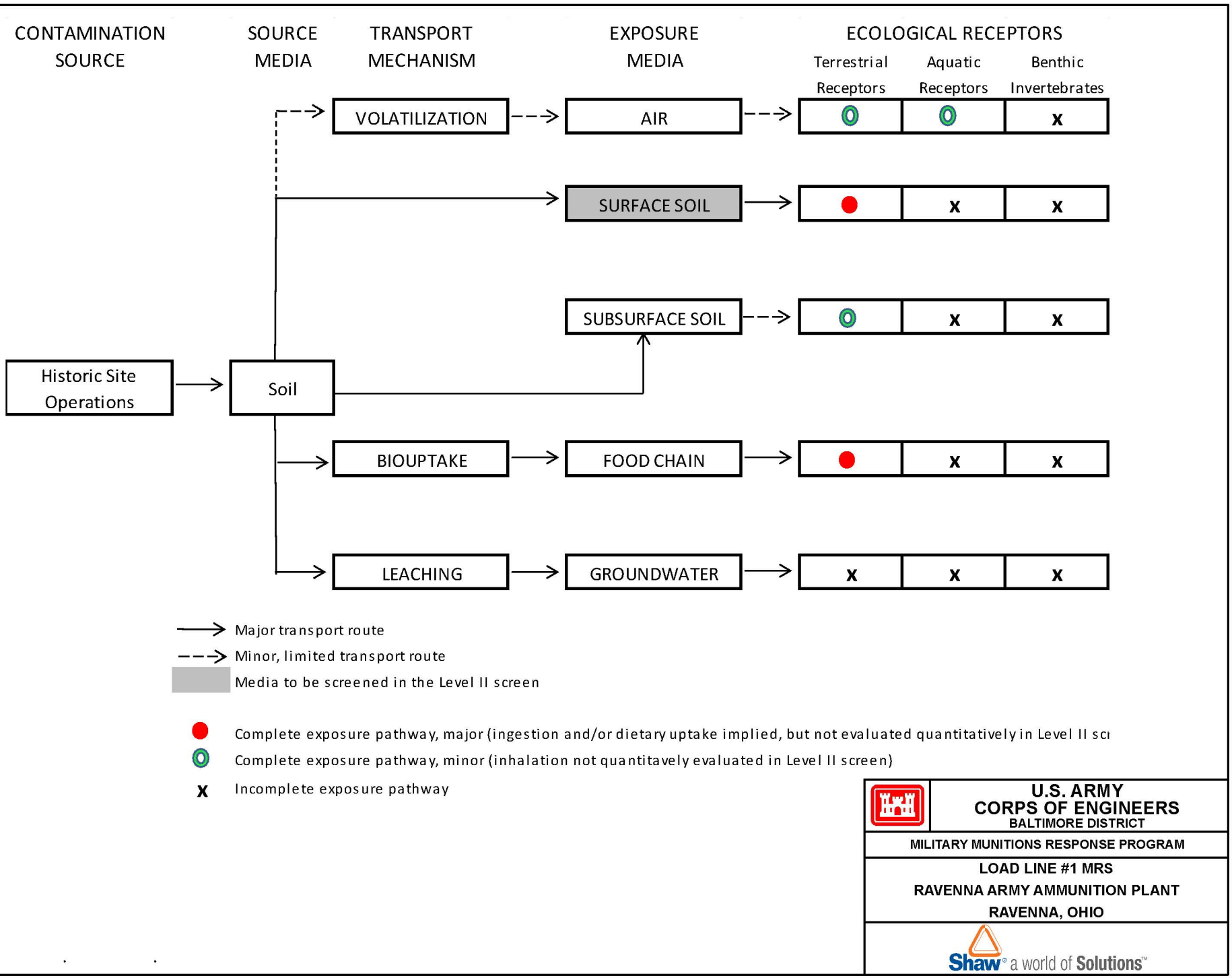

FIGURE 8-1 ECOLOGICAL CSM FOR LEVEL II SCREEN

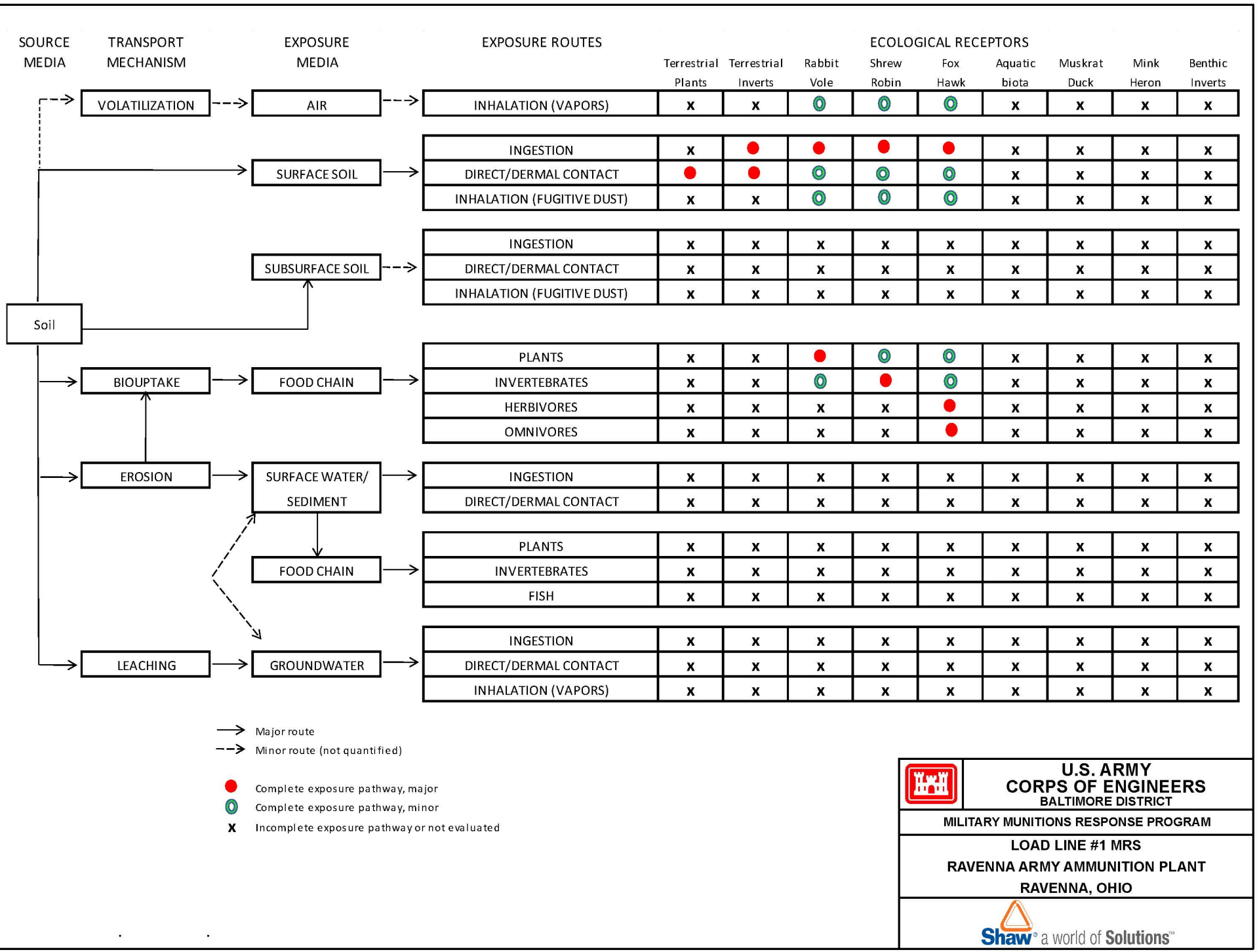

FIGURE 8-2 ECOLOGICAL CSM FOR LEVEL III BASELINE

8.5.2 Source Medium

The source medium is surface soil within the identified MRS boundaries where triple-base propellants have been historically found on the ground surface. For this ERA, surface soil is defined as 0 to 0.5 feet bgs and is the depth that concentrated MC would be expected to occur based on the identified source.

8.5.3 Transport Mechanisms

Potential transport mechanisms at the MRS include volatilization into the air, biota uptake, erosion to surface water and sediment, and leaching to groundwater. Biota uptake is a transport mechanism because some of the MRS contaminants are known to accumulate in biota, which may act as a vehicle to spatially disperse contaminants, as well as represent a secondary exposure medium for upper trophic level receptors that prey on the biota.

8.5.4 Exposure Media

Sufficient time has elapsed for contaminants in the source medium to have migrated to potential exposure media, resulting in possible exposure of receptors that are exposed to these media. Potential exposure media include air, surface soil, and the food chain. Surface soil (typically 0 to 1 foot bgs for the RVAAP) was not collected greater than 0.5 foot bgs at the MRS since most MC would be expected to have concentrated in the top several inches of soil. Subsurface soil includes soil at depths that ecological receptors typically do not come into contact with (greater than 1 foot bgs), and is not being evaluated at the Load Line #1 MRS. Groundwater is not considered an exposure medium because ecological receptors are unlikely to contact groundwater. Therefore, surface soil (0 to 0.5 foot bgs) and biota comprising of prey items for higher-trophic-level receptors are the two principal exposure media for the Load Line #1 MRS.

8.5.5 Exposure Routes

Exposure routes are functions of the characteristics of the media in which the sources occur, and reflect how both the released chemicals and receptors interact with those media. For example, for MRSs with aquatic habitat, chemicals in surface water may be dissolved or suspended as particulates and be highly mobile, whereas those same constituents in soil may be much more stationary. The ecology of the receptors is important because it dictates their home range, whether the organism is mobile or immobile, local or migratory, burrowing or above ground, plant eating, animal eating, or omnivorous.

For the Level II Screen CSM (**Figure 8-1**), specific exposure routes were not identified because the screen is not receptor specific and only focuses on comparison of MDCs of chemicals in the exposure media against published ecological toxicological benchmark concentrations derived for those media. However, the preliminary Level III Baseline

ecological CSM (**Figure 8-2**) identifies specific exposure routes and indicates whether the exposure routes from the exposure media to the ecological receptors are major or minor. Major exposure routes are evaluated quantitatively, whereas minor routes are evaluated qualitatively. The preliminary Level III Baseline ecological CSM (**Figure 8-2**) shows major exposure routes of soil to ecological receptors and an incomplete exposure route of groundwater.

The major exposure routes for chemical toxicity from surface soil include ingestion (for terrestrial invertebrates, voles, shrews, robins, foxes, and hawks) and direct contact (for terrestrial invertebrates). The ingestion exposure routes for voles, shrews, robins, foxes, and hawks include soil, as well as plant and/or animal food items (i.e., food chain transfer) that were also exposed to the surface soil. Minor exposure routes for surface soil include direct contact and inhalation of fugitive dust. Inhalation and dermal contact, however, are typically not assessed in terrestrial ERAs because these routes are not well studied for wildlife. Additionally, most wildlife also have protective features such as fur or feathers which typically result in dermal contact being a negligible exposure pathway (though dermal contact with soil is a potentially significant exposure route for soil-dependent terrestrial animals such as invertebrates) (USACE, 2010).

Exposure to groundwater is an incomplete pathway for all ecological receptors because receptors typically do not come into direct contact with groundwater. If the groundwater outcrops via seeps or springs into wetlands or ditches, it becomes treated as surface water and would be evaluated as such in the ERA.

8.5.6 Ecological Receptors

For the Level II Screen, specific ecological receptors were not identified; rather, terrestrial biota is considered as a whole. However, for the Level III Baseline evaluation, specific terrestrial ecological receptors are identified as part of the ecological CSM (**Figure 8-2**). The terrestrial receptors include terrestrial invertebrates (earthworms), voles, shrews, robins, foxes, and hawks (USACE, 2003b). These receptors are discussed in more detail in the following sections.

8.5.6.1 Selection of MRS-Specific Ecological Receptor Species

The selection of ecological receptors for the MRS-specific analysis screen was based on animal species that are likely to occur in the terrestrial and aquatic habitats at the MRS. Three criteria were used to identify the MRS-specific receptors (USACE, 2003b).

1. **Ecological Relevance**—The receptor has or represents a role in an important function such as nutrient cycling (i.e., earthworms), and population regulation (i.e., hawks). Receptor species were chosen to include representatives of all applicable

trophic levels identified by the ecological CSM for the MRS. These species were selected to be predictive of assessment endpoints (including protected species/species of special concern and recreational species).

2. **Susceptibility**—The receptor is known to be sensitive to the chemicals detected at the MRS, and given their food and habitat preferences, their exposure are expected to be high. The species have a likely potential for exposure based upon their residency status, home range size, sedentary nature of the organism, habitat compatibility, exposure to contaminated media, exposure route, and/or exposure mechanism compatibility. Ecological receptor species were also selected based on the availability of toxicological effects and exposure information.

3. **Management Goals**—The receptor represents natural resources at the MRS and/or is selected for the protection of rare plant and animal populations. These considerations were included to perpetuate the ecosystem functions present at the MRS.

At the Load Line #1 MRS, the following types of ecological receptors are likely to be present: terrestrial invertebrates, meadow voles (*Microtus pennsylvanicus*), short-tailed shrews (*Blarina brevicauda*), American robins (*Turdus migratoris*), red foxes (*Vulpes vulpes*), and red-tailed hawks (*Buteo jamaicensis*). Each of these receptors is described in the following paragraphs.

Terrestrial Invertebrate Exposure to Soil

Terrestrial invertebrate exposure to soil is applicable to soils for the Load Line #1 MRS. Earthworms represent the receptor for the terrestrial invertebrate class, and there is sufficient habitat present for them onsite. Earthworms have ecological relevance because they are important for decomposition of detritus and for energy and nutrient cycling in soil (Efroymson et al., 1997b), and as prey items for other species. Earthworms are probably the most important of the terrestrial invertebrates for promoting soil fertility due to the volume of soil that they process.

Earthworms are susceptible to exposure to and toxicity from COPECs in soil. Earthworms are nearly always in contact with soil and ingest soil, which results in constant exposure. Earthworms are sensitive to various chemicals. Toxicity benchmarks are available for earthworms (Efroymson et al., 1997b). Although management goals for earthworms are not immediately obvious, the role of earthworms in soil fertility and as a food source is significant. Thus, there is sufficient justification to warrant earthworms as a candidate receptor for the Load Line #1 MRS.

Mammalian Herbivore Exposure to Soil

Mammalian herbivore exposure to soil is applicable for the Load Line #1 MRS. Cottontail rabbits and meadow voles represent mammalian herbivore receptors, and there is suitable habitat present for them at the MRS. Both species have ecological relevance by consuming vegetation, which helps in the regulation of plant populations and in the dispersion of some plant seeds. Small herbivorous mammals such as cottontail rabbits and voles are prey items for top terrestrial predators.

Both cottontail rabbits and meadow voles are susceptible to exposure to and toxicity from COPECs in soil and vegetation. Herbivorous mammals are exposed primarily through ingestion of plant material and incidental ingestion of contaminated surface soil containing chemicals. Exposures by inhalation of COPECs in air or on suspended particulates, as well as exposures by direct contact with soil, were assumed to be negligible. Dietary toxicity benchmarks are available for many COPECs for mammals (Sample et al., 1996), and there are management goals for rabbits because they are an upland small game species protected under Ohio hunting regulations. There are no specific management goals for meadow voles at the Load Line #1 MRS. Meadow voles have smaller home ranges than rabbits, which make them potentially more susceptible to localized contamination. Therefore, they are a more conservative selection as a representative mammalian herbivore than rabbits, and are selected as candidate receptors for this foraging guild at the Load Line #1 MRS.

Insectivorous Mammal and Bird Exposure to Soil

Insectivorous mammal and bird exposure to soil is applicable for the Load Line #1 MRS. Short-tailed shrews and American robins represent the receptors for the insectivorous mammal and bird terrestrial exposure class, respectively. There is sufficient, suitable habitat present at the MRS for these receptors. Both species have ecological relevance because they help to control aboveground invertebrate community size by consuming large numbers of invertebrates. Shrews and robins are a prey item for terrestrial top predators.

Both short-tailed shrews and American robins are susceptible to exposure to and toxicity from COPECs in soil as well as contaminants in vegetation and terrestrial invertebrate. Insectivorous mammals such as short-tailed shrews and birds such as American robins are primarily exposed by ingestion of contaminated prey (i.e., earthworms, insect larvae, and slugs), as well as ingestion of soil. In addition, shrews ingest a small amount of leafy vegetation, and the robin's diet consists of 50 percent each of seeds and fruit. Dietary toxicity benchmarks are available for mammals and birds (Sample et al., 1996). Both species are recommended as receptors because there can be different toxicological sensitivity between mammals and birds exposed to the same contaminants. There are management goals for robins because they are federally protected under the *Migratory Bird Treaty Act of 1993*, as

amended. There are no specific management goals for shrews at the MRS. Based on the management goals for robins, plus the susceptibility to contamination and ecological relevance for both species, there is sufficient justification to warrant shrews and robins as candidate receptors for the Load Line #1 MRS.

Terrestrial Top Predators

Exposure of terrestrial top predators is applicable to the Load Line #1 MRS. Red foxes and red-tailed hawks represent the mammal and bird receptors for the terrestrial top predator exposure class, and there is a limited amount of suitable habitat available for them at the MRS. Both species have ecological relevance; as representatives of the top of the food chain for the MRS terrestrial EUs, they control populations of prey animals such as small mammals and birds.

Both red foxes and red-tailed hawks are susceptible to exposure to and toxicity from COPECs in soil, vegetation, and/or animal prey. Terrestrial top predators feed on small mammals and birds that may accumulate constituents in their tissues following exposure at the MRS. There is a potential difference in toxicological sensitivity between mammals and birds exposed to the same COPECs so it is prudent to examine a species from both the *Mammalia* and *Aves* classes. Red foxes are primarily carnivorous but consume some plant material. The red-tailed hawk consumes only animal prey. The fox may incidentally consume soil. There are management goals for both species. Laws (Ohio Trapping Season Regulations for foxes, and federal protection of raptors under the *Migratory Bird Treaty Act,* 16 USC 703-711 [1993, as amended]) also protect these species. In addition, both species are susceptible to contamination and have ecological relevance as top predators in the terrestrial ecosystem. Thus, there is sufficient justification to warrant these two species as candidate receptors for the Load Line #1 MRS.

8.5.7 Relevant and Complete Exposure Pathways

Relevant and complete exposure pathways for the ecological receptors at the Load Line #1 MRS were described in the previous section. As previously discussed, there are relevant and complete exposure pathways for various ecological receptors including terrestrial invertebrates, and terrestrial herbivores, insectivores, and carnivores. Thus, these types of receptors could be exposed to COPECs in surface soil at the Load Line #1 MRS.

8.6 Ecological Endpoint (Assessment and Measurement) Identification

The protection of ecological resources, such as habitats and species of animals, is a primary motivation for conducting SLERAs. Key aspects of ecological protection are presented as management goals. These are general goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For

example, environmental protection is mandated by a variety of legislation and government agency policies (i.e., CERCLA and the NCP). Other legislation includes the ESA; 16 USC 1531-1544 (1993, as amended); and the *Migratory Bird Treaty Act,* 16 USC 703-711 (1993, as amended). To evaluate whether a management goal has been met, assessment endpoints, measures of effects, and decision rules were formulated. The management goals, assessment endpoints, measures of effects, and decision rules are discussed below.

Because only terrestrial habitat is present at the Load Line #1 MRS, there is only one primary management goal for this MRS. However, the assessment endpoints differ between the general screen and the MRS-specific analysis screen. The management goal for the SLERA is to protect terrestrial animal populations from adverse effects due to the release—or the potential release—of chemical substances associated with past MRS activities.

Ecological assessment endpoints are selected to determine whether this management goal is met at the unit. An ecological assessment endpoint is a characteristic of an ecological component that may be affected by exposure to a stressor (i.e., COPEC). Assessment endpoints are "explicit expressions of the actual environmental value that is to be protected" (EPA, 1992). Assessment endpoints often reflect environmental values that are protected by law, provide critical resources, or provide an ecological function that would be significantly impaired if the resource was altered. Unlike the HHRA process, which focuses on individual receptors, the SLERA focuses on populations or groups of interbreeding nonhuman, nondomesticated receptors. Population responses are also better defined and predictable than are community and ecosystem responses (USACE, 2010). In the SLERA process, risks to individuals are assessed only if they are protected under the ESA or other species-specific legislation, or if the species is a candidate for listing as a threatened or endangered species. Because threatened and endangered species are not a concern at the Load Line #1 MRS, potential impacts to populations are the appropriate criterions for consideration.

Due to the uniqueness of local flora and fauna communities, as well as varying societal values placed on these ecological features, a universally applicable list of assessment endpoints does not exist. The Ohio EPA Guidance (2008) was used to select assessment endpoints for this SLERA.

For the Level II Screen, the assessment endpoints are any potential adverse effects on ecological receptors, where receptors are defined as any plant or animal population, communities, habitats, and sensitive environments (Ohio EPA, 2008). Although the assessment endpoints for the Level II Screen are associated with Management Goal 1, specific receptors are not identified with the assessment endpoints.

Table 8-3 shows the management goal for terrestrial resources, associated assessment endpoints, measures of effect, and decision rule by assessment endpoint number. Furthermore, the table provides definitions of Assessment Endpoints 1, 2, 3, and 4 for terrestrial receptors. As stated, the assessment endpoint table includes a column describing the conditions for making a decision depending on whether the HQ is less than or more than 1. If the HQ is greater than 1, the scientific management decision point options from the Ohio EPA Guidance (2008) are provided (i.e., no further action, risk management, monitoring, remediation, or further investigation).

For the Level III Baseline evaluation, the assessment endpoints are more specific and stated in terms of types of specific ecological receptors associated with the management goal. Assessment endpoints 1, 2, 3, and 4 entail the growth, survival, and reproduction of terrestrial receptors such as terrestrial invertebrates; herbivorous mammals; worm-eating/insectivorous mammals and birds; and carnivorous, top-predator mammals and birds, respectively. Assessment endpoints 1 through 4 are associated with Management Goal 1 (protection of terrestrial populations and communities).

The assessment endpoints are evaluated using measurement endpoints. The EPA defines measurement endpoints as ecological characteristics used to quantify and predict change in the assessment endpoints. They consist of measures of receptor and population characteristics, measures of exposure, and measures of effect. For example, measures of receptor characteristics include parameters such as home range, food intake rate, and dietary composition. Measurement endpoints should be selected to provide insights related to the specific assessment endpoint (USACE, 2010). Measures of exposure include attributes of the environment such as contaminant concentrations in soil, sediment, surface water, and biota. The measurement endpoints of effect for the Level II Screening evaluation consist of the comparison of the MDCs of each contaminant in soil to ESV benchmarks.

Measurement endpoints for the Level III Baseline include the comparison of estimated doses of chemicals in various receptor animals such as voles, shrews, and American robins to toxicity reference values (TRVs).

In the Level II Screen, MDCs in soil were used as the EPC for comparison to generic soil or sediment screening values that are expected not to cause harm to ecological populations. Any COPECs retained following the Level II Screen are potentially subject to a Level III Baseline analysis using EPCs that are more representative of the exposures expected for the representative receptors. The Level III Baseline analysis includes evaluation of exposure of a variety of receptors to the reasonable maximum exposure concentrations of COPECs at each EU, using default dietary and uptake factors. The representative ecological receptors may not all be present at each EU. However, all representative receptors are evaluated at this step.

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Table 8-3
Management Goal, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for a Level II Screening

Management Goal	Assessment Endpoint	Measures of Effect	Decision Rule
Management Goal 1: The protection of terrestrial populations, communities, and ecosystems	**Assessment Endpoint 1:** Growth, survival, and reproduction of soil invertebrate communities and tissue concentrations of contaminants low enough such that higher trophic levels that consume them are not at risk Receptors: earthworms	**Measures of Effect 1:** Earthworm soil toxicity benchmarks and measured RME concentrations of constituents in soil	**Decision Rule for Assessment Endpoint 1:** If HQs, defined as the ratios of COPEC RME concentrations in surface soil to soil toxicity benchmarks for adverse effects on soil invertebrates, are less than or equal to 1, then Assessment Endpoint 1 has been met and soil-dwelling invertebrates are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs and applicable media, or further investigation such as a Level III and Level IV Field Baseline.
	Assessment Endpoint 2: Growth, survival, and reproduction of herbivorous mammal populations and low enough concentrations of contaminants in their tissues so that higher trophic level animals that consume them are not at risk Receptor: meadow vole	**Measures of Effect 2:** Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	**Decision Rule for Assessment Endpoint 2:** If HQs, based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on herbivorous mammals are less than or equal to 1, Assessment Endpoint 2 is met, and the receptors are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline.
	Assessment Endpoint 3: Growth, survival, and reproduction of worm-eating and insectivorous mammal and bird populations and low enough concentrations of contaminants in their tissue so that predators that consume them are not at risk Receptors: shrews and robins	**Measures of Effect 3:** Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	**Decision Rule for Assessment Endpoint 3:** If HQs based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on worm-eating and insectivorous mammals and birds is less than or equal to 1, then Assessment Endpoint 3 is met, and these receptors are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline Decision Rule for Assessment Endpoint 4.
	Assessment Endpoint 4: Growth, survival, and reproduction of carnivorous mammal and bird populations Receptor: red-tailed hawk and red fox	**Measures of Effect 4:** Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	**Decision Rule for Assessment Endpoint 4:** If HQs based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on carnivorous mammals and birds are less than or equal to 1, then Assessment Endpoint 4 is met, and the receptors are not at risk. If the HQs are greater than 1, a SMDP is reached, at which point it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline.

COPEC denotes chemical of potential ecological concern.
HQ denotes hazard quotient.
NOAEL denotes no observed adverse effect level.
RME denotes reasonable maximum exposure.
SMDP denotes scientific management decision point.
TRV denotes toxicity reference value.

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For the Level III Baseline, decision rules for COPECs were obtained from Ohio EPA Guidance for chemicals (2008). Briefly, for COPECs, the first decision rule is based on the ratio (or HQ) of the dose to a given receptor species (i.e., a vole, representing herbivorous mammals) associated with a chemical's concentration in the environment (numerator) to the ecological effects or toxicity reference value (denominator) of the same chemical. A ratio of 1.0 or less means that ecological risk is negligible, while a ratio of greater than 1.0 means that ecological risk from that individual chemical is possible and that additional investigation should follow to confirm or refute this prediction.

The second decision rule is that if "no other observed significant adverse effects on the health or viability of the local individuals or populations of species are identified" and the HQ does not exceed 1, "the site is highly unlikely to present significant risks to endpoint species" (Ohio EPA, 2008). Potential outcomes for the Level III Baseline include the following: no significant risks to endpoint species so no further analysis is needed; conduct field baseline assessment to quantify adverse effects to populations of representative species that were shown to be potentially impacted based on hazard calculations in the Level III Baseline; and remedial action taken without further study.

8.7 Level II Screen Weight of Evidence Discussion

Prior to making the determination as to whether a Level III Baseline is warranted, it is appropriate to evaluate various lines of evidence that might suggest whether or not additional ecological investigation is needed at this MRS. Of primary importance in a SLERA is determining whether any ecological threats exist, and if so, whether they are related to chemical contamination (USACE, 2010). To make this determination, additional factors should be considered in the Unified Approach ERA Process for RVAAP sites. Some of these factors are discussed in the following paragraphs.

Due to the highly conservative nature of the Level II Screen, the identification of COPECs does not necessarily indicate that the potential for adverse effects is realistic at this MRS. For example, HQs developed during the initial (screening) steps of a SLERA assume chemicals are 100-percent bioavailable.

Another source of uncertainty in the Level II Screen results from the fact that toxicity studies upon which the benchmark values are based are highly conservative. These studies typically use native (i.e., laboratory) organisms comprised of a single genetic strain that have no inherent resistance to chemical insults. Nonlaboratory organisms have both a more diverse genetic makeup and exposure history to ambient levels of chemicals (both natural and anthropogenic in origin) that favor the development of resistances to chemical exposure in nature. Also, toxicity studies usually dose the test organisms with a chemical that is fully bioavailable (i.e., in solution) and that uses the most toxic chemical form. However, when a

chemical is released to the environment, it reacts with other compounds and is affected by ambient conditions that often reduce the chemical's ability to be absorbed by and/or retained in an organism (i.e., metals released to terrestrial systems often sorb to soil, reducing their bioavailability). The form of the chemical may change in the natural environment as well, which often results in the reduction of its toxic properties. For example, under reducing conditions, hexavalent chromium is readily transformed to less toxic trivalent chromium in soil (however, it should be noted that conversion to a more toxic form in the environment is also possible, such as the conversion of inorganic mercury to methyl mercury by microorganisms under certain conditions).

Because of these factors, the correlation between the total concentration of a chemical in a given medium and its toxic effect is often quite poor, and predictions regarding potential toxicity must be used with caution. Although any chemical with an HQ greater than 1 must be identified as a COPEC and is recognized as being a potential concern (Ohio EPA, 2008), the uncertainties associated with the HQs must be considered when making recommendations based on the results of the SLERA, particularly with regards to the interpretation of the HQ values. HQs are not measures of risk, are not population-based statistics, and are not linearly scaled statistics. Therefore, an HQ greater than 1, even exceedingly so, does not definitively indicate that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Tannenbaum, 2005; Bartell, 1996). Furthermore, the spatial area affected and the magnitude of the HQ exceedance must be taken into account when considering the potential for local populations (rather than individuals) to experience adverse effects, because population-level effects are the endpoints of concern in the SLERA. To account for some of these uncertainties, HQs less than 10 are considered to represent a low potential for environmental effects, HQs greater than or equal to 10 but less than 100 are considered to represent a significant potential that effects could result from greater exposure, and HQs greater than 100 represent the highest potential for expected effects (Wentsel et al., 1996).

The findings of the Level II Screen are discussed in additional detail in this section to support final recommendations for this stage of the risk assessment process.

8.7.1 Weight of Evidence Discussion for Soil

As presented in Section 8.4.5.1, "Soil COPEC Selection," two COPECs were identified in the ISM soil samples, including one metal (lead) and one explosives compound (nitroguanidine). **Table 8-4** presents the concentrations of all COPECs by soil sample, and **Table 8-5** presents the HQs associated with each COPEC in the individual samples.

The HQ for lead was below 10 in both soil samples (range = 6.4 to 9.9; **Table 8-5**). The ESV for lead is an ecological soil screening level (EPA, 2008) that is based on the protection of a

woodcock, an avian insectivore. Although woodcocks or other similar species in this feeding guild may occasionally visit the Load Line #1 MRS, the use of a screening value protective of this feeding guild is highly conservative because the MRS is too small (0.41 acres) to support populations of woodcocks, which have an average home range of over 50 acres (Sample et al., 1996), or other avian insectivores. The lead BSV of 26.1 mg/kg is greater than the ESV of 11 mg/kg, and the fact that naturally occurring concentrations of lead are more than double the risk-based screening value illustrates the highly conservative nature of the ESVs. Lead in the two ISM samples collected at the Load Line #1 MRS exceeded the BSV as well, by a factor of approximately four to five times. Therefore, lead in soil can be characterized as moderately elevated at the Load Line #1 MRS.

No ESV was identified for nitroguanidine; therefore, no HQs were calculated, and its potential toxicity to ecological receptors is unknown. However, this chemical was only detected in the two samples at estimated concentrations that approximate its reporting limit. Although an ESV is not available for nitroguanidine, a review of the ESVs for other explosives compounds reveals that its reported concentrations of 0.25 mg/kg and 0.26 mg/kg exceed the ESV of only one other explosives compound, 2,6-dinitrotoluene, which has an ESV of 0.0328 mg/kg. The fact that nitroguanidine was detected at a concentration that is not toxic for related compounds provides some limited assurance that its presence is not a significant threat to ecological receptors. Furthermore, explosives compounds typically are not bioaccumulative and this chemical was not identified as a PBT compound. Therefore, although the presence of this chemical represents a small uncertainty in this SLERA, nitroguanidine is unlikely to pose a significant threat to ecological receptors. The ESVs identified for the RVAAP and used for the SLERA at the Load Line #1 MRS is presented in **Appendix F**.

Table 8-4
Concentrations of COPECs in ISM Surface Soil Samples

				Sample Location:		**LL1SS-715**	
				Sample Number:		**LL1SS-715(I)-0001-SS**	
				Sample Date:		**August 15, 2011**	
				Sample Depth (foot bgs):		**0–0.5**	
COPEC	**BSV**	**ESV**	**Units**	**Result**	**VQ**	**Result**	**VQ**
Inorganics							
Lead	26.1	11	mg/kg	***109***		***70.9***	
Explosives							
Nitroguanidine	-	-	mg/kg	*0.25*	J	*0.26*	J

Table 8-4 (continued)
Concentrations of COPECS in ISM Surface Soil Samples

Detects in bold exceed the ESV. Detects in italic exceed the BSV or indicate that a BSV is not available.
- denotes that a value is not available for this criterion.
bgs denotes below ground surface.
BSV denotes background screening value.
COPEC denotes chemical of potential ecological concern.
ESV denotes ecological screening value.
ISM denotes incremental sampling method.
J value denotes estimated value.
mg/kg denotes milligrams per kilogram.
VQ denotes validated qualifier.

Table 8-5
Summary of Hazard Quotients for COPECs in ISM Soil Samples

Sample Location:	LL1SS-715	LL1SS-716
Sample Number:	LL1SS-715(I)-0001-SS	LL1SS-716(I)-0001-SS
Sample Date:	August 15, 2011	August 15, 2011
Sample Depth (foot bgs):	0–0.5	0–0.5
COPEC	HQ[1]	HQ[1]
Inorganics		
Lead	9.9	6.4
Explosives		
Nitroguanidine	-	-

[1] *Only HQs greater than 1 are presented.*
- denotes no value is available for this criterion.
bgs denotes below ground surface.
COPEC denotes chemical of potential ecological concern.
HQ denotes hazard quotient.
ISM denotes incremental sampling method.

8.8 Level II Screen Recommendations

Most of the MC detected in the Load Line #1 MRS soil was detected at concentrations that are unlikely to be ecologically relevant. Lead in soil was present at concentrations that exceeded both its ESV and BSV; however, HQs for lead were below 10, which indicate that the potential for impacts is expected to be low. Furthermore, due to the very small size of the MRS (0.41 acres), and although individual ecological receptors may occasionally be exposed to the elevated lead, it is unlikely that populations would be regularly exposed to lead at the Load Line #1 MRS. Because the protection of populations of receptors are the appropriate assessment endpoints for this MRS (see **Table 8-3**), adverse ecological impacts associated with these endpoints are not expected. Nitroguanidine was detected in both ISM samples at

estimated concentrations approximating its reporting limit. Although no ESV was available, its detected concentrations are below the ESVs for all other related (i.e., explosives) compounds except 2,6-dinitrotoluene.

In summary, slightly elevated concentrations of lead and trace amounts of one explosives compound were detected in the soil at the Load Line #1 MRS, and the potential for localized ecological impacts cannot be completely discounted. However, given the fact that the terrestrial area evaluated for the Load Line #1 MRS is less than 1 acre in size, and that the Phase II Screen uses highly conservative assumptions, it is unlikely that exposure to the surface soil COPECs identified in this SLERA would adversely impact populations of ecological receptors at the Load Line #1 MRS. Therefore, no further investigation (i.e., a Level III Baseline) or action is considered necessary at the Load Line #1 MRS for ecological purposes.

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9.0 REVISED CONCEPTUAL SITE MODELS

This section presents the revised CSMs for MEC and MC at the Load Line #1 MRS based on the results of the data collected for the RI and previous information provided in the SI Report (e^2M, 2008) and the HRR (e^2M, 2007). The preliminary CSMs for MEC and MC were discussed in Section 2.0. The summary of the RI results were presented in Section 4.0. Potential human health and environmental risks were evaluated in Section 7.0 and Section 8.0, respectively. Following the integration of the RI results into the CSMs for MEC and MC, the MRSPP evaluation for the MRS was reevaluated to include the results of the RI and is discussed at the end this section.

9.1 MEC Exposure Analysis

This section summarizes the RI data results for the MEC exposure pathway analysis for the MRS. As discussed in Section 2.1, "Preliminary CSMs and Project Approach," each pathway includes a source, activity, access, and receptor, with complete, potentially complete, and incomplete exposure pathways identified for each receptor. A pathway is considered complete when a source (MEC) is known to exist and when receptors have access to the MRS while engaging in some activity that results in contact with the source. A pathway is considered potentially complete when a source has not been confirmed, but is suspected to exist and when receptors have access to the MRS while engaging in some activity which results in contact with the source. Lastly, an incomplete pathway is any case where one of the four components (source, activity, access, or receptors) is missing from the MRS.

9.1.1 Source

A MEC source is the location where MPPEH or ordnance is situated or expected to be found. The principle sources of MEC at the Load Line #1 MRS were reported to be accidental releases during the loading of munitions during World War II and the Korean War. These activities resulted in the potential for MEC and MD, including propellants, to be present in surface soil at the Load Line #1 MRS (e^2M, 2008). The 2007 SI UXO survey activities resulted in the discovery of three pieces of triple-base propellant on the ground surface at the MRS. At the conclusion of the SI Report (e^2M, 2008), it was determined that the extent of MEC lying on the ground surface at the MRS was not fully understood. The propellants of interest are not ferrous or detectable using a magnetometer; therefore, minimal uncertainty exists regarding whether propellants are present below ground surface. However, based on historical operations at the MRS, the MEC source would be expected to be found on or very close to the ground surface only.

During the RI field activities, no MEC or MD was identified during the two 100-percent nonintrusive visual surveys. In addition, MEC clearance activities did not identify any

subsurface anomalies. Therefore, a subsurface investigation was not warranted. Based on the RI survey results, no MEC source is considered to be present at the Load Line #1 MRS.

9.1.2 Activity

Activity describes ways that receptors are exposed to a source. Current activities at the Load Line #1 MRS include security, maintenance, environmental sampling, remediation, and natural resource management. The OHARNG future use at the MRS is Military Use and Training. As part of the IRP cleanup at this AOC, this site was evaluated for the Risk Assessment Land Use of Mounted Training, No Digging, as documented in the *Final Interim Record of Decision* (USACE, 2007). The AOC is currently being re-evaluated for Unrestricted Guard Use under the IRP.

9.1.3 Access

Access describes the degree to which a MEC source or environment containing MEC is available to potential receptors. The RVAAP boundary fence is well maintained to prevent unauthorized access into the installation and although access to Load Line #1 is intended to be controlled by a fenced perimeter; there is a section of fence missing behind the former guard building and various gaps and holes in the Load Line #1 perimeter fence exist. Therefore, once inside the RVAAP, Load Line #1 can be accessed, including the MRS.

Future land use will consist of military training. Access restrictions based on the future land use have not been developed.

9.1.4 Receptors

A receptor is an organism (human or ecological) that comes into physical contact with MEC. Human receptors identified for the Load Line #1 MRS include both current and anticipated future land users. Ecological receptors (biota) for the purposes of the revised MEC CSM are based on plant and animal species that are likely to occur in the terrestrial habitats at the MRS. The terrestrial receptors identified include terrestrial invertebrates (earthworms), voles, shrews, robins, foxes, and hawks as presented in the *RVAAP Facility-Wide Ecological Risk Assessment Work Plan* (USACE, 2003b).

Current human receptors for the MRS include facility personnel, contractors, and potential trespassers. The National Guard Trainee has been identified as a future land-use receptor in accordance with the *RVAAP's Facility-Wide Human Health Risk Assessor Manual* (USACE, 2005). Exposure scenarios for the National Guard Trainee are provided in the FWCUG Report (SAIC, 2010). The HHRA identified the National Guard Trainee to be the more sensitive of the identified current and future human receptors that has the potential to be exposed to MEC based on the anticipated future land use.

9.1.5 MEC Exposure Conclusions

The information collected during the RI was used to update the preliminary MEC CSM for the Load Line #1 MRS and to identify all actual, potentially complete, or incomplete source-receptor interactions for the MRS for current and anticipated future land uses. Evaluation of the end use receptors for future land use in the revised CSM is consistent with the RVAAP HHRA approach (USACE, 2005). The revised MEC Exposure Pathway Analysis is presented on **Figure 9-1**.

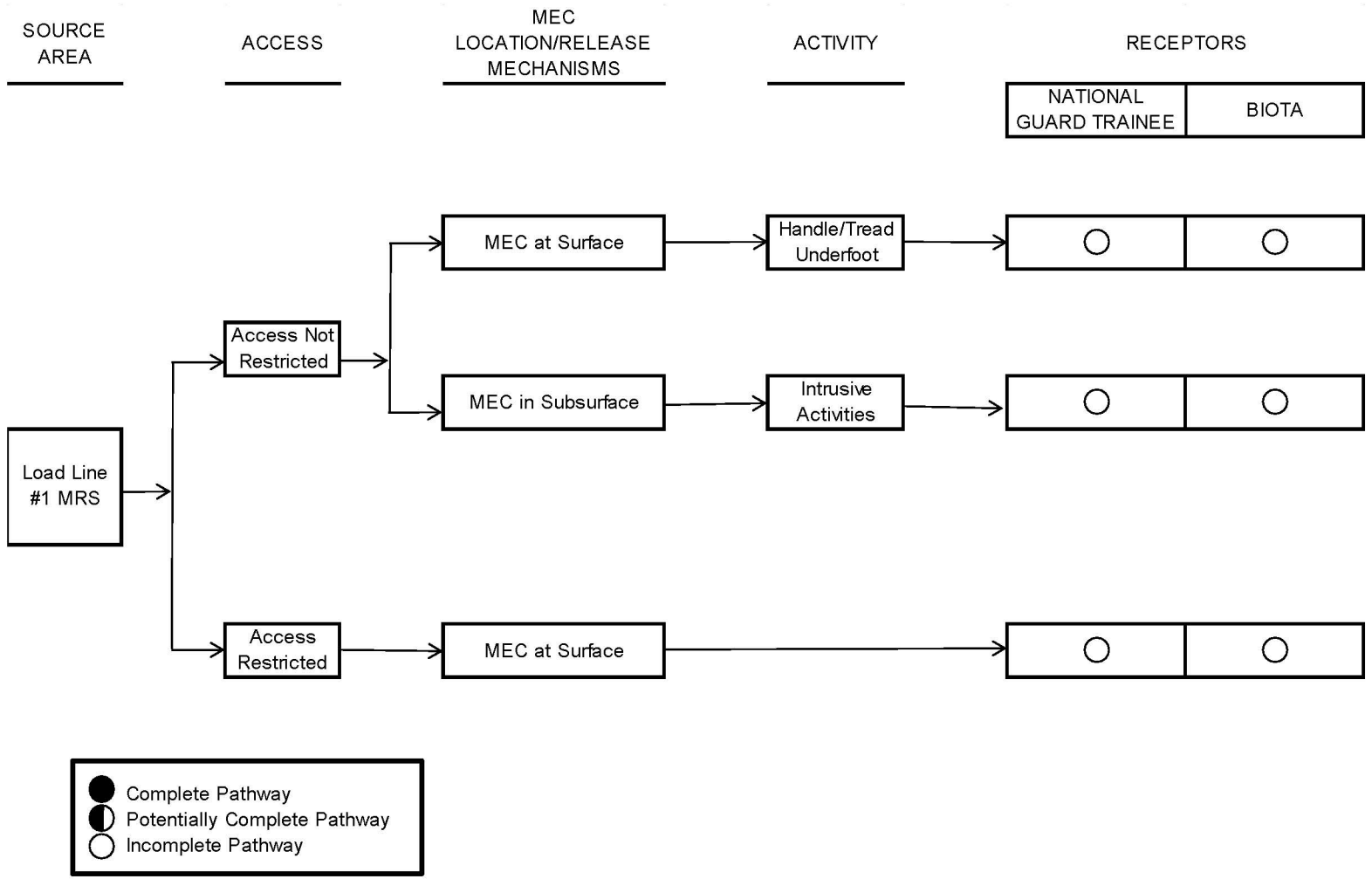
Two nonintrusive visual surveys were performed over 100 percent of the Load Line #1 MRS during the RI field activities. No MEC or MD items were observed on the ground surface of the MRS during the visual survey; therefore, the MEC exposure pathway for surface soil is considered incomplete for all receptors.

Since no MEC or MD was identified during the visual survey and taking into consideration the historical activities that occurred at the MRS, it is expected that triple-base propellants that may be present at the MRS are on the ground surface only. A subsurface investigation was not warranted. Given the lack of a MEC source, the MEC exposure pathway for subsurface soil is considered incomplete for all receptors.

9.2 MC Exposure Analysis

A MC is defined as any material originating from MPPEH or munitions, or other military munitions including explosive and nonexplosive materiel, and emission degradation, or breakdown elements of such ordnance and munitions (10 USC 2710(e)(4)). The information collected during the RI was used to update the CSM for MC at the Load Line #1 MRS and identify all complete, potentially complete, or incomplete source-receptor interactions for the MRS for current and reasonably anticipated future land-use activities.

An MC source is an area where MC has entered (or may enter) the environment. MC contamination may result from a corrosion of munitions or from low-order detonation. No MEC source was identified at the MRS during the RI field activities that could have been a potential source of MC most likely due to degradation of propellants on the ground surface. Additionally, MC that is found at concentrations high enough to pose an explosive hazard is considered MEC.



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MILITARY MUNITIONS RESPONSE PROGRAM

LOAD LINE #1 MRS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

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FIGURE 9-1 REVISED MEC CONCEPTUAL SITE MODEL

Sampling was performed at the Load Line #1 MRS to further characterize the nature and extent of contamination associated with previous activities at the MRS. The SRCs detected at the MRS consisted of lead and nitroguanidine in surface soil. Although a MEC source was not found, the identified SRCs may have resulted from degradation of the propellants due to exposure to the elements. None of the detected concentrations were determined to pose potential threats to likely receptors at the MRS. The MC CSM has been updated to reflect a lack of source and incomplete pathways for the receptors in the terrestrial environment (**Figure 9-2**).

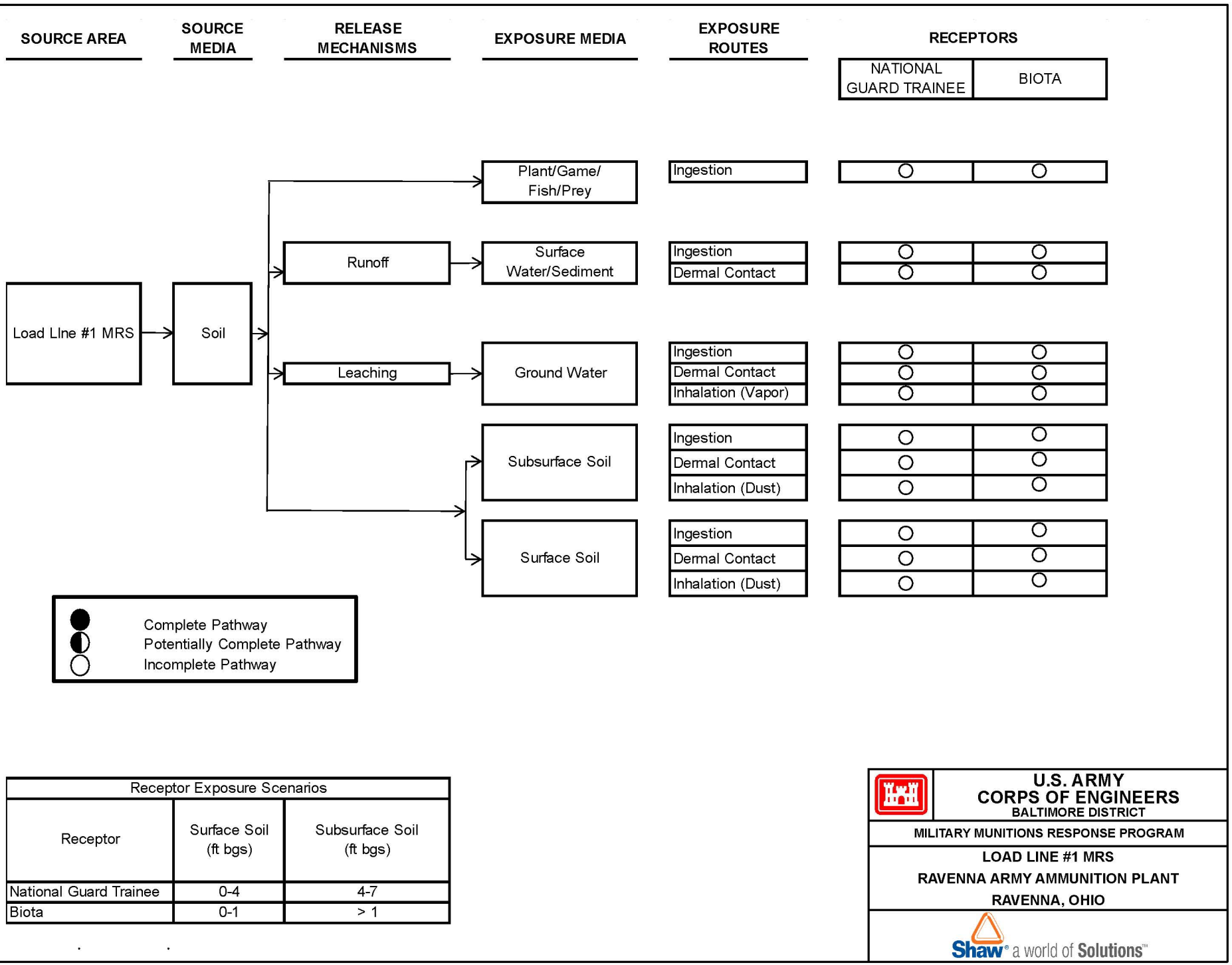
9.3 Uncertainties

There are minimal levels of uncertainties associated with the MEC and MC results at the Load Line #1 MRS. The propellants of interest are not ferrous or detectable using a magnetometer; therefore, minimal uncertainty exists regarding whether propellants are present below ground surface. However, given the MRS history, the presence of MEC in the subsurface was not anticipated, as no burial activities were known to occur (e^2M, 2008). The nonintrusive instrument-assisted visual survey conducted during the RI field work did not find evidence of any surface propellants or other ferrous MEC/MD items, which satisfies the DQOs and reduces uncertainties associated with buried MEC at the MRS.

No MEC or MD was found during the RI field activities. It is therefore uncertain whether the detected SRCs are actually associated with MEC previously identified directly on the ground surface at the MRS or are byproducts associated with the historical activities (munitions loading operations) conducted at this portion of the Load Line #1.

9.4 Munitions Response Site Prioritization Protocol

The DoD proposed the MRSPP (32 Code of Federal Regulations Part 179) to assign a relative potential risk priority to each defense MRS in the MMRP Inventory for response activities. These response activities are to be based on the overall conditions at each location and taking into consideration various factors related to explosive safety and environmental hazards (68 Federal Regulations 50900 [32 Code of Federal Regulations 179.3]). The revised MRSPP document for the Load Line #1 MRS is being prepared separately from the RI and is included as **Appendix G** for reference only.



Receptor Exposure Scenarios		
Receptor	Surface Soil (ft bgs)	Subsurface Soil (ft bgs)
National Guard Trainee	0-4	4-7
Biota	0-1	> 1

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LOAD LINE #1 MRS
RAVENNA ARMY AMMUNITION PLANT
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FIGURE 9-2 REVISED MC CONCEPTUAL SITE MODEL

10.0 SUMMARY AND CONCLUSIONS

This section summarizes results of the RI field activities conducted at the Load Line #1 MRS. The purpose of this RI is to determine whether the Load Line #1 MRS warrants further response action pursuant to CERCLA and the NCP. More specifically, the RI is intended to determine the nature and extent of MEC and MC and subsequently determine the potential hazards and risks posed to likely human and ecological receptors by MEC and MC. The RI also collects or develops additional data, as appropriate, to assist in determining which remediation alternatives, if any, are necessary. As a result of the investigation activities, the objectives of the RI have been satisfied. A summary of the RI results is presented in **Table 10-1**.

Table 10-1
Summary of Remedial Investigation Results

MRS Name	Proposed Investigation Area Size (Acres)	Actual Investigation Area Size (Acres)	Were DQOs Met?	MEC and/or MD Found?	MC Detected?	MC Risk Analysis
Load Line #1	0.41	0.41	Yes	No	Yes	No Further Action

DQO denotes data quality objective.
MC denotes munitions constituents.
MD denotes munitions debris.
MEC denotes munitions and explosives of concern.
MRS denotes munitions response site.

10.1 Summary of Remedial Investigation Activities

The RI compiled and evaluated information from the Load Line #1 MRS relating to the potential presence of MEC and associated MC. The sources of this information were information obtained during previous investigations, including the ASR (USACE, 2004), the HRR (e^2M, 2007), and the SI Report (e^2M, 2008).

The preliminary MEC and MC CSMs were developed during the SI phase of the CERCLA process and were used to identify the data needs and the DQOs as outlined in the Work Plan (Shaw, 2011). The data needs included characterization for MEC and/or MC associated with the former activities at the MRS. The DQOs were developed to ensure the reliability of field sampling, chemical analyses, and physical analyses; the collection of sufficient data; the acceptable quality of data generated for its intended use; and valid assumptions could be inferred from the data.

The DQOs for the Load Line #1 MRS identified the following four decision rules that were implemented in evaluating the MRS: (1) perform a visual survey investigation to identify if MEC source (triple-base propellant) is present on the ground surface, (2) collect increments comprising ISM samples at two sampling units over the entire MRS, (3) collected additional discrete samples (surface and subsurface) in areas with concentrated MEC/MD, and (4) process the information to evaluate whether there are unacceptable risks to human health and the environment associated with MEC and/or MC and make a determination if further investigation is required under the CERCLA process.

Separate full coverage instrument-assisted nonintrusive visual surveys were conducted in April and May 2011, respectively, to identify potential surface MEC and/or MD at the Load Line #1 MRS. No MEC or MD was found on the ground or shallow surface soils during either survey.

Environmental samples for MC were collected at the Load Line #1 MRS following completion of the visual surveys. Two ISM surface soil samples, each comprising one half of the MRS acreage (0.2 acres), were collected at depths between 0 and 0.5 foot. Together, the two ISM sampling units represent 100-percent coverage of the MRS that is the EU area where human and ecological receptors potentially are exposed to the SRCs.

The DQOs stated that discrete samples (surface and subsurface soil) would be collected in areas with concentrated MEC or MD. Since no MEC or MD was identified at the Load Line #1 MRS, additional sampling for MC was not performed.

10.2 Nature and Extent of SRCs

The SRCs for the Load Line #1 MRS were determined for the surface soil samples collected during the RI field activities through the RVAAP data screening process as presented in the FWCUG Report (SAIC, 2010). Lead exceeded the RVAAP BSV in both surface soil samples collected for the RI and was retained as an SRC. The only explosive concentration detected in the RI surface soil samples was nitroguanidine and was retained as an SRC since it is a detected organic.

10.3 Fate and Transport

No MEC or MD was observed at the Load Line #1 MRS during the RI field activities. Since no MEC source is present at the Load Line #1 MRS, MEC fate and transport is not a concern. Although a MEC source was not found during the RI, the identified SRCs were conservatively evaluated as MC associated with triple-base propellant previously encountered at the MRS and fate and transport and potential transport mechanisms were evaluated.

The SRCs in the environmental media collected for the RI at the MRS were lead and nitroguanidine in surface soil (0 to 0.5 foot bgs). Based on current soil conditions at the RVAAP, which consisted primarily of silty clay loam with low permeability and an MRS-specific pH of approximately 8.4, it is expected that lead would tend to bind to the soil and is considered relatively immobile. Therefore, any MC would be expected to be found in the top several inches where it was deposited and subsurface has mostly likely not been impacted. Nitroguanidine is considered mobile in soil; however, the impact to subsurface soils at the MRS has not been evaluated. The low permeability of the soil and the low concentrations detected suggest that significant sources of nitroguanidine were not deposited on or leached into the ground surface as a result of either dumping of triple-base propellants at the MRS or other activities (i.e., munitions loading operations) conducted at this portion of Load Line #1 when the RVAAP was in operation.

10.4 MEC Hazard Assessment

During the RI field activities, 100 percent of the MRS was investigated and no munitions-related items were identified. As a result, the revised MEC Exposure Analysis and CSM indicate that no MEC source has been identified at the MRS. Therefore, the project team determined that calculation of a MEC HA score was not warranted for the Load Line #1 MRS.

10.5 MC Risk Assessment Summary

Following the identification of the SRCs (lead and nitroguanidine) at the Load Line #1 MRS through the RVAAP data screening process, the SRCs were then carried through the HHRA and ERA processes to evaluate for potential receptors. The risk assessments resulted in the following conclusions.

10.5.1 Protection of Human Health

A HHRA was conducted for surface soil samples collected at the Load Line #1 MRS to determine if the identified SRCs were COPCs, and/or COCs that may pose a risk to future human receptors. The OHARNG future use at the MRS is Military Use and Training. As part of the IRP cleanup at this AOC, this site was evaluated for the Risk Assessment Land Use of Mounted Training, No Digging, as documented in the *Final Interim Record of Decision* (USACE, 2007). The AOC is currently being re-evaluated for Unrestricted Guard Use under the IRP. In order to correlate the MMRP with the IRP, the most representative receptor for the MRS is the National Guard Trainee that was evaluated in this RI.

Evaluation of the future land use, in conjunction with the evaluation of agricultural-residential land uses and associated receptors form the basis for identifying COPCs and COCs in this RI. Residential Land Use, specifically the Residential Farmer (Adult and Child)

scenario, is included to evaluate COCs for unrestricted land use at the MRS as required by the CERCLA process.

Neither of the SRCs was identified as COPCs in the first screening step. Therefore, these SRCs were not further evaluated as COCs and are not likely to pose a concern to human receptors.

10.5.2 Protection of Ecological Receptors

Both of the SRCs, lead and nitroguanidine, were identified as COPECs in the soil samples collected for the RI at the Load Line #1 MRS. COPECs are determined in the ERA and may differ from COPCs. Given the conservativeness of the ERA and the low overall concentrations detected, the potential that exposure to the COPECs identified to adversely impact populations of ecological receptors at the Load Line #1 MRS is considered to be very low and not pose a concern to ecological receptors. Therefore, no further investigation (i.e., a Level III Baseline) or action is considered necessary at the Load Line #1 MRS for ecological purposes.

10.6 Conceptual Site Model

The information collected during the RI field activities was used to update the MEC and MC CSMs for the Load Line #1 MRS as presented in the SI Report (e^2M, 2008). The purpose of the CSMs is to identify all complete, potentially complete, or incomplete source-receptor interactions for reasonably anticipated future land use activities at the MRS. An exposure pathway is the course a MEC item or MC takes from a source to a receptor. Each pathway includes a source, activity, access, and receptor.

Two nonintrusive visual surveys were performed over 100 percent of the Load Line #1 MRS during the RI field activities. No MEC or MD items were observed on the ground surface of the MRS during the visual surveys; therefore, the MEC exposure pathway for surface soil is considered incomplete for all receptors.

Since no MEC or MD was identified during the visual survey, and taking into consideration the historical activities that occurred at the MRS, it is expected that triple-base propellants that may be present at the MRS are on the ground surface only. A subsurface investigation was not warranted and, given the lack of a MEC source, the MEC exposure pathway for subsurface soil is considered incomplete for all receptors.

Sampling was performed at the Load Line #1 MRS to further characterize the nature and extent of contamination associated with previous activities at the MRS. The SRCs detected at the MRS consisted of the lead and nitroguanidine in surface soil. Although a MEC source was not found, the identified SRCs may have resulted from degradation of the propellants

due to exposure to the elements. None of the SRC concentrations were determined to pose a hazard to human health or the environment. The MC CSM has been updated to reflect a lack of source and incomplete pathways for the receptors in the terrestrial environment.

10.7 Uncertainties

There are minimal levels of uncertainties associated with the MEC and MC results at the Load Line #1 MRS. The propellants of interest are not ferrous or detectable using a magnetometer; therefore, minimal uncertainty exists regarding whether propellants are present below ground surface. However, given the MRS history, the presence of MEC in the subsurface was not anticipated, as no burial activities were known to occur (e^2M, 2008). The nonintrusive instrument-assisted visual survey conducted during the RI field activities did not find evidence of any surface propellants or other ferrous MEC/MD items, which satisfies the DQOs and reduces uncertainties associated with buried MEC at the MRS.

No MEC or MD was found during the RI field activities. It is therefore uncertain whether the detected SRCs are actually associated with MEC previously identified directly on the ground surface at the MRS or are byproducts associated with the historical activities (munitions loading operations) conducted at this portion of the Load Line #1.

10.8 Conclusions and Recommendations

The following conclusions can be made for the Load Line #1 MRS based on the results of the RI field activities:

- Instrument-assisted nonintrusive visual survey coverage was performed over the entire Load Line #1 MRS during the RI and no subsurface anomalies were detected.
- No physical evidence of MEC or MD was found on the ground surface during the RI and no explosive hazard is anticipated to be present at the MRS.
- Although no MEC source was found during the RI, ISM surface soil samples were analyzed for MC and represent 100-percent coverage of the MRS.
- Detected concentrations of SRCs in surface soil (0 to 0.5 foot) do not pose potential threats to likely receptors at the MRS.

Based on these conclusions, it is determined that the Load Line #1 MRS has been adequately characterized and that the DQOs presented in the Work Plan (Shaw, 2011) have been satisfied; therefore, no further action is recommended for this MRS under the MMRP. The Load Line #1 MRS is collocated with the Load Line #1 AOC and administratively, it is recommended that the environmental data collected at the MRS be made available for the

IRP. Any future actions at the collocated MRS/AOC should be addressed under the IRP. Follow-up documents under the MMRP may include the preparation of a No Further Action Proposed Plan for public review followed by issuance of a Record of Decision.

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Appendix A
Field Documentation

Shaw Environmental & Infrastructure, Inc.

Memorandum

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From: Dave Cobb, Shaw Project Manager

To: Ms. Eileen Mohr, Ohio EPA Project Manager

cc: Todd Fisher, Ohio EPA
Travis McCoun, USACE, Baltimore
Greg Moore, USACE Louisville
Mark Patterson, BRAC
Kim Harriz, NGB
Katie Tait, OHARNG/Camp Ravenna

Date: June 7, 2011

Re: **Visual Survey Results and Proposed Munitions Constituents Sampling Locations for the Load Line 1 MRS (RVAAP-008-R-01)**

Introduction

The purpose of this memorandum is to present the results of the visual survey performed at the Load Line 1 MRS (RVAAP-008-R-01) at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio by Shaw Environmental & Infrastructure, Inc. (Shaw) and present proposed munitions constituents (MC) sampling based on those results. The survey activities were conducted in accordance with the *Final Work Plan for Military Munitions Response Program Remedial Investigation Environmental Services* (Shaw, 2011); hereafter referred to as the "work plan". Shaw's recommendations for proposed sample locations for MC are presented below and will require approval from the Ohio EPA prior to implementation in the field.

Summary of Work

Between April 28 and May 24, 2011, Shaw performed two 100% instrument assisted visual surveys at the Load Line 1 MRS to verify that no remaining triple-based propellant nodules (approximately 1-inch by ¼-inch in size) exists at the northwest side of former Building CB-14. The surveys also included an inspection for any other munitions and explosives of concern (MEC) and munitions debris (MD) items. The initial inspection was performed during inclement weather on April 28, 2011 and it was determined that a second survey would be required due to areas of standing water in the survey area. The second survey was conducted on May 24th. The area surveyed was based on the 0.41 acre area identified in the *Final Site Inspection Report* (e^2M, 2008). Due to the relatively small size of the MRS, the entire 0.41 acre area was inspected. The work plan originally stated that slag associated with the former use of this location as a former railcar loading area would be removed in order to inspect the ground surface below the slag; however, inspection of the area prior to the visual survey revealed that minimal slag was present in the MRS area and no slag removal was required. **Figure 1** presents the Load Line 1 MRS where a 100% visual survey was performed.

The UXO Team that performed the visual surveys consisted of a three-man crew that included a UXO Technician III that was the Team Leader, a UXO Technician II and a global positioning system (GPS) operator. Although, propellant nodules cannot be detected using metal detection instrumentation, a Schonstedt Model GA-52Cx magnetometer was used for MEC avoidance and to confirm that no other MEC/MD items were present at the MRS. The instrumentation used for detecting and logging the locations of any MEC/MD identified consisted of a GPS Trimble GeoXH Handheld.

The surveys consisted of linear sweeps along the length of the MRS with each UXO Team member responsible for five-foot lanes until 100% of the MRS was inspected. Rope lines were laid along the MRS transects in order to ensure that the sweep lanes were straight and accurate. The inspection included members of the UXO Team inspecting thick grass areas on their hands and knees.

Summary of Results

No propellant nodules or other MEC items were observed at the MRS during the visual surveys. Following the second survey, the Unexploded Ordnance Quality Control (UXOQC) manager performed an 80% QC check of the area. No propellant nodules or other MEC items were identified during the QC check.

Proposed Munitions Constituents Sample Locations

In accordance with the work plan and the Sampling and Analysis Plan (SAP) in Appendix D of the work plan, MC sampling will be performed to include incremental sampling (IS) of surface soil. No discrete samples are proposed since no MEC/MD was identified during the visual surveys. The 0.41 acre MRS will be divided (approximately 0.2 acres each) and a total of two IS samples (not including the field duplicate) will be collected. **Figure 1** shows the proposed IS sample locations.

The sample design and parameters for the surface and subsurface discrete samples are presented in the SAP. Samples will be analyzed for potential MC that includes lead via USEPA Method 6010C, explosives using USEPA Method 8330B, nitrocellulose using USEPA Method 9056 and Total Organic Carbon and pH. The samples will also be submitted for geochemical parameters (aluminum, calcium, magnesium, and manganese) using USEPA 6010C. One field duplicate and matrix spike/matrix spike duplicate will be collected for the IS sample type. The samples will be submitted to CT Laboratories for IS processing and analysis in accordance with the SAP.

Reporting of Results

As specified in the work plan, the results of the MC sampling will be incorporated into the Remedial Investigation (RI) report for the Load Line 1 MRS. The RI will determine the nature and extent of MEC and MC at the MRS, determine the risk posed to human health and the environment by MEC and MC identified, if any, and identify if any additional information or data is required for the Feasibility Study to determination remediation alternatives, including evaluation of no action.

Figures

MRS Boundary

Increment Sample Decision Unit

0 50 100 Feet

Projection : NAD_1983_UTM_Zone_17N

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

FIGURE NUMBER 1

LOAD LINE #1 PROPOSAL SAMPLE LOCATIONS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw a world of Solutions

Generated By: JRL Date: 06/06/11 File Path:F:\GISDATA2\MAMS\Ravenna\GIS_Documents\Project_Maps\MMRP\Group1\Field\RVAAP_002_Fig1_LoadLine1_SamplLocsProp.mxd

Project Number: 136147

Shaw Shaw E & I

Soil / Sediment Field Logsheet

Site Name: LOAD LINE #1 Project #: 136147- MMRP

Sample ID: LL1SS-715(I)-0001-SS

Sample Type*: MI

*: SED=Sediment; SUR=Surface soil;
SUB=Subsurface Soil; OTH=Other.
grab=Grab; comp=Composite

Date Sampled: 8-15-11

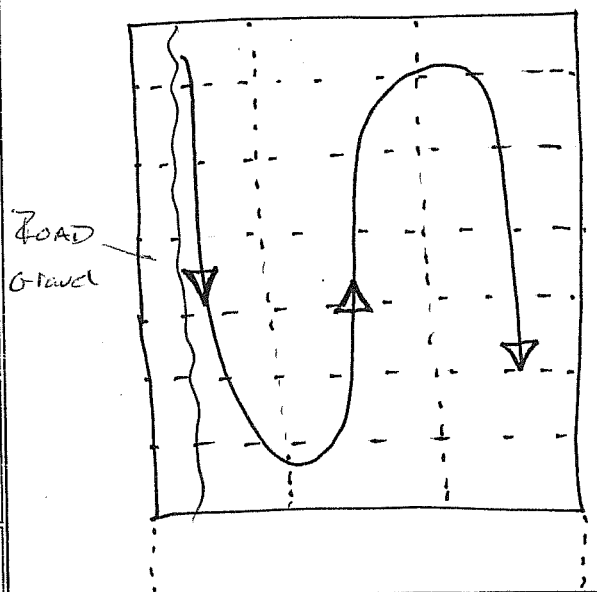
Time Sampled: 1315

Depth (ft bgs): 0 - 6 INCH

Physical description: ORGANICS, DARK BROWN. w/ dark & green/brown dense clay. Some gravel @ ROAD.

Analyses requested:
LEAD -NC
GEO METALS -TOC
EXPLOSIVES -PH

Sample Location Sketch:



Photograph Log #: NA

PID: NA Calibration Date: NA

O2/LEL: NA Calibration Date: NA

Weather: 81° PASSING THUNDERSTORMS

Temperature: 81°F

Sampling Equipment: STEP CORE PROBE

Equipment Decontamination Technique: GROSS WASH, LIQUINOX, WASH, METHANOL, DI

QC Samples: RINSE BLANK (RB) → LL1-718-RB

Analytical Laboratory: CT LAB

Comments:

Field Technician: (Print) C. JONES Date: 8-15-11

Soil / Sediment Field Logsheet

Shaw Shaw E&I

Site Name: LOAD LINE #1 Project #: 136147- MMRP

Sample ID: LL1SS-716(I)-0001-SS

Sample Type*: MI

*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other.
grab=Grab; comp=Composite

Date Sampled: 8-15-11

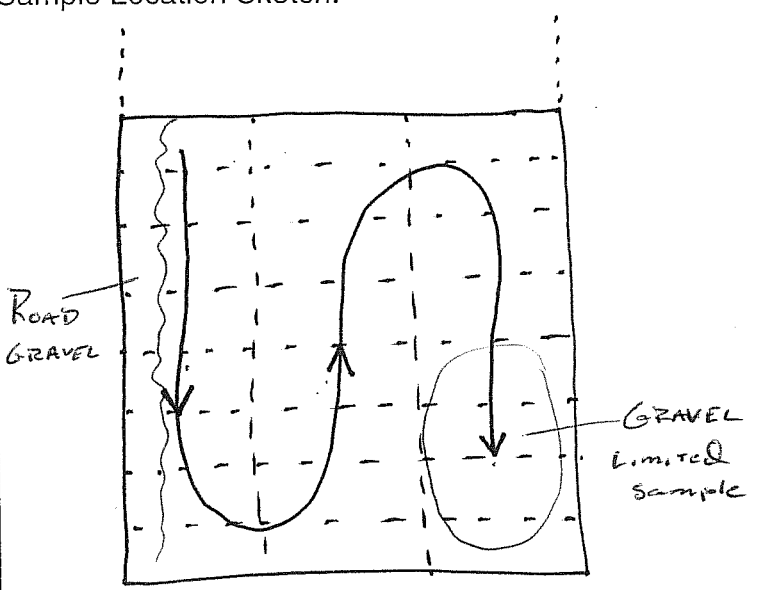
Time Sampled: 1330

Depth (ft bgs): 0 - 6 INCH

Physical description: GRAVEL NEAR ROAD AND IN SE corner. Organics and clay over central part.

Analyses requested:
LEAD -NC
GEO METALS -TOC
EXPLOSIVES -PH

Sample Location Sketch:



Photograph Log #: NA

PID: NA Calibration Date: NA

O2/LEL: NA Calibration Date: NA

Weather: PASSING THUNDERSTORM

Temperature: 81 °F

Sampling Equipment: STEP CORE PROBE

Equipment Decontamination Technique: GROSS WASH, LIQUINOX, WASH, METHANOL, DI

QC Samples: DUP WILL BE LL1SS-717(1)-0001-SS

Analytical Laboratory: CT LAB

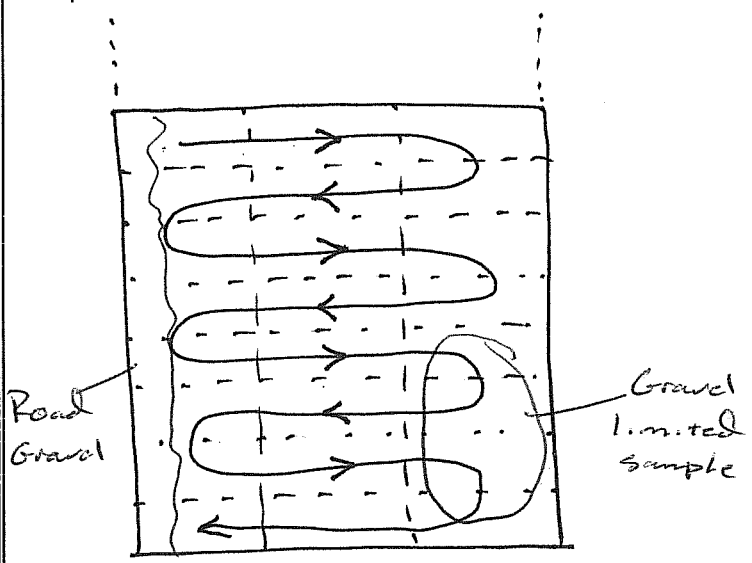
Comments:

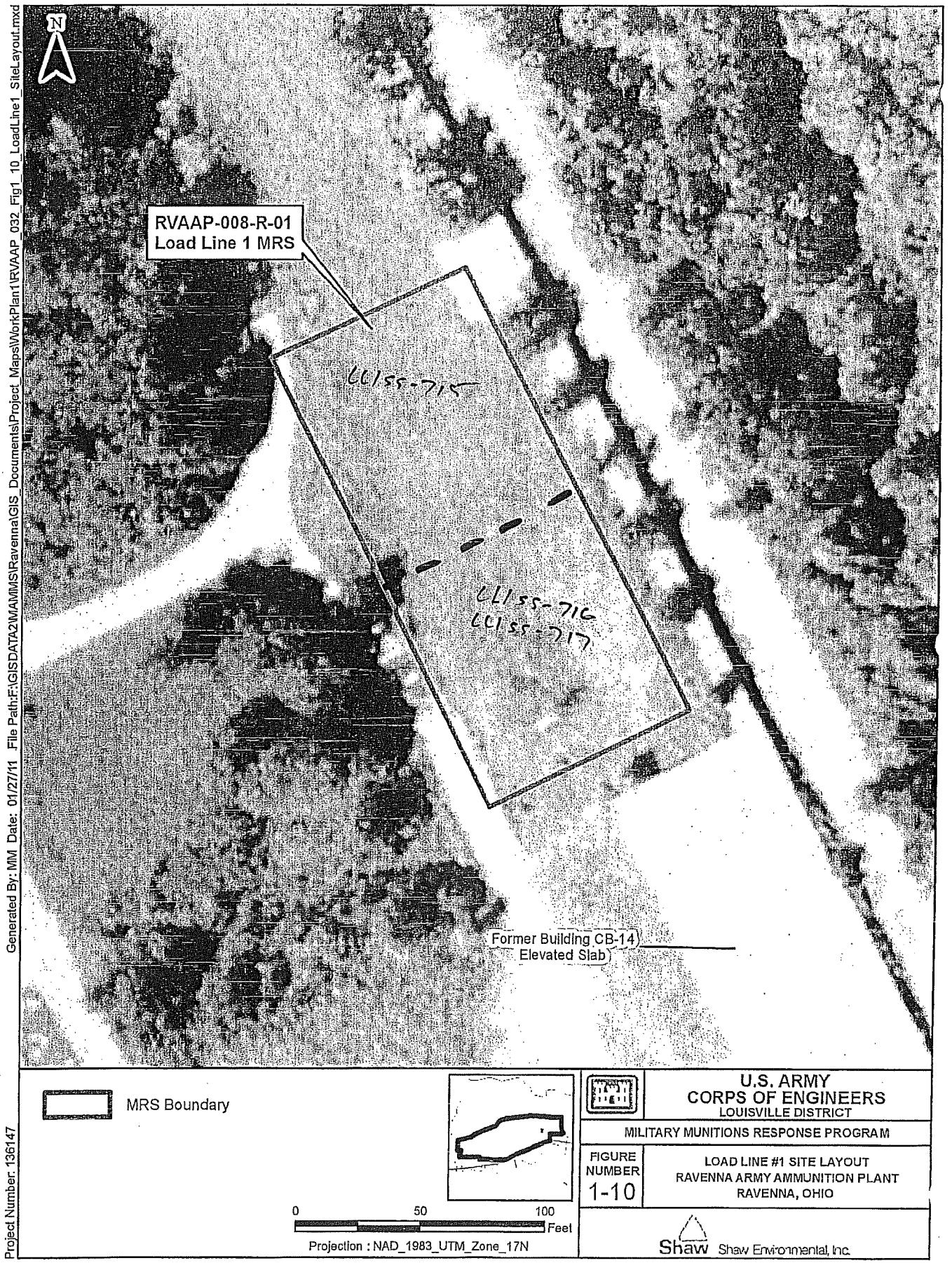
Field Technician: (Print) C. JONES Date: 8-15-11

Shaw Shaw E & I

Soil / Sediment Field Logsheet

Site Name: LOAD LINE #1 Project #: 136147- MMRP

Sample ID: LL1SS-717(I)-0001-SS	Sample Location Sketch: 
Sample Type*: MI	
*: SED=Sediment; SUR=Surface soil; SUB=Subsurface Soil; OTH=Other. grab=Grab; comp=Composite	
Date Sampled: 8-15-11	
Time Sampled: 1350	
Depth (ft bgs): 0 - 6 INCH	
Physical description: Gravel near road and in SE corner. Organics and clay over central portion	
Analyses requested: LEAD -NC; GEO METALS -TOC; EXPLOSIVES -PH	Photograph Log #: NA
PID: NA	Calibration Date: NA
O2/LEL: NA	Calibration Date: NA
Weather: PASSING THUNDERSTORMS	
Temperature: 81 °F	
Sampling Equipment: STEP CORE PROBE	
Equipment Decontamination Technique: GROSS WASH, LIQUINOX WASH, METHANOL, DI	
QC Samples: DUP OF LL1 SS-716(I)-0001-SS	
Analytical Laboratory: CT LAB	
Comments:	
Field Technician: (Print) C. JONES	Date: 8-15-11


N
RVAAP-008-R-01
Load Line 1 MRS
LL155-715
LL155-716
LL155-717
Former Building CB-14
Elevated Slab
Generated By: MM Date: 01/27/11 File Path:F:\GISDATA2\MMMS\Ravenna\GIS_Documents\Project_Maps\WorkPlan1\RVAAP_032_Fig1_10_LoadLine1_SiteLayout.mxd
Project Number: 136147
MRS Boundary
0
50
100
Feet
Projection : NAD_1983_UTM_Zone_17N
U.S. ARMY
CORPS OF ENGINEERS
LOUISVILLE DISTRICT
MILITARY MUNITIONS RESPONSE PROGRAM
FIGURE NUMBER
1-10
LOAD LINE #1 SITE LAYOUT
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
Shaw
Shaw Environmental, Inc.

FIELD SAMPLING AUDIT CHECKLIST

Shaw Audit No.:	136147-01	Audited Organization:	Shaw Sampling Crew (Crispo/Mallory/Harrison)
Shaw Project No.:	136147	Location:	Group 8 MRS, RVAAP
Date of Evaluation:	2/8/12	Name/Position of Evaluator:	Braden Livingstone, UXOQC/SSHO
Audited Activity:	Multi-increment surface soil sampling at the Group 8 MRS		

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
Part 1: Sampling and Analysis Plan (SAP)				
1.1 General Information				
Is there a SAP?	X			
Are there procedures for transportation, handling, protection, storage, retention, and/or disposal of samples, including all provisions necessary to protect the integrity of the sample?	X			
Is there a documented system for uniquely identifying all samples and subsamples to ensure that there can be no confusion regarding the identity of such samples at any time?	X			
Does the sampling process address the factors to be controlled to ensure the validity of the environmental test and calibration results	X			No equipment requiring calibration
Is there a process for documenting corrective actions taken in the field?	X			
1.2 Standard Operating Procedures				
Are there SOPs for field activities available at the location where sampling is taking place and are they accessible to all sample collectors?		X		Not originally on site at beginning of sampling activities.
Have the SOPs been approved for the project?	X			
Part 2: Organization, Management and Personnel (not checked onsite)				
Are the sampling personnel's qualifications and/or training certifications adequate for the tasks performed?	X			
Are names of all sampling personnel recorded?	X			In daily JSA reports
Do sampling personnel meet minimum qualifications specified in the contract?	X			
Are staff training records maintained and up to date?	X			
Part 3: Equipment				
3.1 General Equipment Information				
Is the type of equipment sufficient for the sampling project?	X			Step probe samplers
Is the quantity of equipment sufficient for the sampling project?	X			

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
Is the following information recorded for each piece of equipment that will be used for sampling project:			X	
Maintenance and repair procedures for equipment or instrument?			X	
Routine cleaning procedures?			X	
Filling solution replacement for probes?			X	
Parts replacement for instruments or probes?			X	
Calendar date for each procedure performed?			X	
Names of personnel performing maintenance and repair tasks?			X	
Description of malfunctions associated with any maintenance and repair?			X	
Vendor service records?			X	
Inclusive rental dates, types and unique descriptions of rental equipment?			X	
Is the equipment storage procedure acceptable?	X			Bldg 1036
Is there an existing QC check on sampling equipment?			X	
3.2 Field Calibration				
Is information about all calibration standards and reagents used for field testing linked to the calibration information associated with the field testing measurements for the project?			X	
Are field instruments properly calibrated and calibrations recorded in a bound field log book?			X	
For each instrument unit used for the sampling project, is the following information recorded for all calibrations:			X	
Unique identification (designation code) for the instrument?			X	
Date and time of each calibration and calibration verification?			X	
Instrument reading or result (display value) for all calibration verifications, with appropriate measurement units?			X	
Names of analyst performing each calibration of verification?			X	
Designation of each calibration standard used linked to the associated records for the calibration standard?			X	
The acceptance criteria for each calibration and verification standard used?			X	
The assay specifications or acceptance criteria for any QC standard or sample used to independently verify the calibration of the standard?			X	

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
Are all corrective actions performed on the instrument prior to attempting reverification or recalibration of the instrument linked to the records required for preventive maintenance?			X	
Does the field instrumentation documentation include the standard concentrations used for calibration?			X	
Did all field-testing equipment and instrumentation brought to the field appear to function properly?			X	
Are manufacturer's suggested maintenance activities and any repairs performed and documented for all applicable equipment and instruments?			X	
3.3 Containers				
Are sample containers well organized, properly prepared, protected from contamination, and ready for use?	X			Large zip-loc baggies used to collect MI samples
Are proper sample containers and sizes used for each type of sample?			X	
Are certificates of analysis for pre-cleaned bottles maintained on file?			X	
Are all containers and container caps free of cracks, chips, discolorations and other features that might affect the integrity of the collected samples?			X	
3.4 Sampling Equipment				
Is the appropriate equipment used for the sampling project? Check all relevant equipment used for sample collection, handling, storage and transport.	X			
Is equipment constructed of materials appropriate for the analytes of interest?	X			
Is equipment brought to the field precleaned?	X			
For equipment decontaminated on-site in the field, are the date and time of the cleaning procedure recorded in the field records or referenced in an internal SOP?		X		Step probes are cleaned after each sampling event and stored at Bldg 1036
Are cleaning steps in all procedures used for decontamination documented either by description or reference to an SOP?	X			
Are there current maintenance records for all field equipment?			X	
Part 4: Sampling Event Information				
For all samples, is the following information recorded and maintained in the project files?				
Site name and address?	X			
Date and time of sample collection?	X			
Name of sampler responsible for sample transmittal?	X			

Item to be Evaluated	Y	N	N/A	Comments
Unique field identification code for each sample container or group of containers?	X			
Total number of samples collected?	X			
Required analyses for each sample container or group of containers?			X	
Sample preservation used for each container or group of containers?			X	
Comments about samples, sample sources or other relevant field conditions?	X			
Identification of common carrier used to transport the samples, when applicable?			X	
Are shipping invoices and related records from common carriers archived with the field records, when applicable?	X			
Are sampling locations adequately documented in a bound field log book using indelible ink?	X			Documented in field logs and maintained in project files.
Are photos taken and is a photo log maintained?	X			
4.1 Field QC				
Are trip blanks and/or field blanks collected as specified in the approved sampling plan?	X			
Are field blanks collected after equipment is decontaminated in the field	X			Equipment is cleaned at Bldg 1036
Are field blanks collected if no equipment was cleaned?		X		Equipment is cleaned same day as sampling
Are additional samples for matrix spike/matrix spike duplicate analyses collected?	X			
Are all QC samples collected in the same manner as the routine field samples?	X			
Part 5: Sample Management				
5.1 Collection				
Are the samples taken from a representative point of the source?	X			
Are the samples being collected in accordance with the SAP?	X			
Are samples for different analyte groups collected in the appropriate order?			X	All of sample is in baggie
Are samples collected for all required analyses?	X			
Are samples to be tested for dissolved metals filtered prior to preservation?			X	
Is every effort made to prevent cross-contamination of samples?	X			Some non-conformance observed
Are gloves worn by all samplers handling purging equipment, sampling equipment, measurement equipment, and sample containers?	X			
Are new, clean unpowdered gloves used for each glove change?	X			

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
Is care taken to avoid contact with sample and sample container interiors?			X	
Are VOC sample containers protected from any fuel sources and fuel-powered equipment?			X	No VOCs sampled
Do VOC sample containers remain capped until just prior to sample collection and do they remain capped after sample collection?			X	
Where applicable, are samples collected for measurement of dissolved components, filtered, preserved with acid, and placed on ice within 15 minutes of collection?			X	
5.2 Collection Devices				
Is sample collected using an intermediate collection device?			X	
Are intermediate collection devices rinsed with ample amounts of site water prior to collecting the sample?			X	
Is rinse water from intermediate devices discarded away from and downstream of the sampling location?			X	
Is the use of intermediate collection devices avoided when sampling for VOC's, oil and grease, or microbiologicals, where practical?			X	
Are any intermediate collection devices constructed of material appropriate for the analytes to be measured?			X	
Are sample containers submerged neck first, inverted into the oncoming direction of flow where applicable, slowly filled, and returned to the surface for preservation, if applicable?			X	
5.3 Sample Labeling				
Is each sample container or group of containers tagged or labeled with a unique field identification code that distinguishes the sample from all other samples?	X			
Are the unique identification codes for samples recorded in a manner that links the codes to all other field records associated with the samples?	X			
Is waterproof indelible ink used to label containers?	X			
5.4 Storage				
Are samples for different parameters segregated during storage?			X	
Are samples stored on ice?	X			
Is the cooler clearly labeled?	X			
Are samples properly preserved (if applicable)?			X	
5.5 Preservation				

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
Do all sample preservation techniques conform to SOP or method requirements?	X			Placed on ice
Are all samples properly preserved within 15 minutes, as applicable?	X			
Are the preparation and dispensing of preservatives documented and traceable?			X	
Is preservation information and verification recorded for each sample, as applicable?			X	
Are samples placed on ice immediately after collection, if applicable?	X			
5.6 Delivery				
Are samples protected during delivery to prevent breakage?	X			
Are samples shipped in a timely manner?	X			
5.7 Disposal				
Are wastes generated as a result of the sampling project containerized and stored for proper disposal according to applicable local, state, and federal regulations?	X			Decontamination waste and PPE.
Are all sampling-derived waste containers properly labeled?	X			
Is all sampling-derived waste properly disposed of?			X	Not disposed yet. Stored at Bldg 1036
5.8 Documentation				
Is waterproof ink used for all paper documentation?	X			
Are the date and time of sample collection recorded for all samples?	X			
Are the ambient field conditions recorded for all samples?	X			
Is a specific description of each sampling location (source) recorded?	X			
Does the chain of custody/traffic report include the following: date, time, sample numbers, sampler names, shipping method, number of samples, matrix, and comments?	X			
Is preservation information recorded on the chain of custody/traffic report?	X			
Are copies of traffic reports or COC sent to the proper recipients?	X			
Are deviations, additions, or exclusions from the documented sampling procedure recorded in detail with the associated sampling information?	X			
Are these deviations included in all documents containing environmental test and/or calibration results?			X	
Are these deviations communicated to the appropriate personnel?	X			
Are all errors in documentation (if applicable) corrected and initiated without obliteration?	X			

Item to be Evaluated	Y	N	N/A	Comments
5.9 Field Reagents				
Are the concentration (or other assay value), the vendor catalog number and the description of the standard or reagent recorded for all preformulated solutions, neat liquids, powders, and blank water?			X	
Are certificates of assay, grade and other vendor specifications for all standards and reagents retained and recorded for the standards and reagents?			X	
Are the lot numbers and inclusive dates of use recorded for all reagents, detergents, solvents, and other chemicals used for decontamination and preservation of samples?			X	
Are the expiration dates for all calibration standards and reagents recorded?			X	
Are expired standards and reagents verified prior to use during sample collection?			X	
Are all steps used for preparation of standards or reagents in-house documented either by description or reference to an SOP?			X	
Part 6: Field Analyses				
6.1 General Field Test Information				
Are all field measurement tests and related data recorded and linked to the project, the date, and the sample source?			X	
Are all field measurements recorded with the appropriate units, the value of the test result, the parameter measured, the name of the analyst performing the test, the time of the measurement and the unique identification for the test instrument used?			X	
6.2 pH				
Are all samples requiring pH adjustment tested for proper pH preservation?			X	
Is at least one sample per analyte group requiring pH adjustment tested for proper preservation during repeat sampling?			X	
Is pH paper or a pH electrode inserted into sample containers?			X	
Do the pH meter and electrode system meet SOP specifications for accuracy, reproducibility and design?			X	
Are all measurements corrected for temperature (manual or automatic)?			X	
Is a pH 7 buffer used as the first calibration standard?			X	
For pH, do all calibration verifications meet the acceptance criteria?			X	

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	
Are all sample measurements associated with acceptable calibration verifications?			X	
Is the pH meter system checked on a weekly basis to ensure >90% theoretical electrode slope?			X	
Are the field instrument probes rinsed with deionized or distilled water between standard solutions and between sample measurements?			X	
Are instrument pH readings allowed to stabilize before pH values are recorded?			X	
6.3 Filtration				
Are samples collected for analysis of dissolved components filtered within 15 minutes of collection and before addition of chemical preservatives where appropriate?			X	
Unless otherwise specified, are applicable samples filtered using a 0.45-um pore size?			X	
6.4 Temperature				
Do the temperature measurement devices meet SOP and/or sampling event specifications for design and measurement resolution?			X	
Are all sample measurements associated with calibration verifications of the temperature measurement device at a minimum of two temperatures using a NISTtraceable thermometer?			X	
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	
Are all temperature measurements chronologically associated with acceptable calibration verifications?			X	
Are the temperature device readings allowed to stabilize before measurement values were recorded?			X	
6.5 Conductivity				
Do the specific conductance meter and electrode system meet the SOP and/or sampling event specifications for accuracy and reproducibility?			X	
Do all calibration verifications meet the acceptance criterion?			X	

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log			X	
Are all conductivity measurements chronologically associated with acceptable calibration verifications?			X	
Are all conductivity measurements corrected for temperature (manual or automatic)?			X	
Is the instrument allowed to stabilize before measurement values are recorded?			X	
6.6 Turbidity				
Does the turbidimeter meet the SOP and/or sampling event specifications for accuracy and reproducibility?			X	
Are all sample measurements associated with acceptable calibration verifications?			X	
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	
Are the sample cells (optical cuvettes) inspected for scratches and discarded or coated with a silicone oil mask, as necessary?			X	
Are the sample cells (optical cuvettes) optically matched for calibrations and sample measurements?			X	
Are the sample cells (optical cuvettes) cleaned with detergent and deionized or distilled water between standard solutions and between sample measurements, as applicable?			X	
Are the sample cells (optical cuvettes) rinsed with sample prior to filling with sample for measurement?			X	
Is the exterior of the sample cell (optical cuvette) kept free of fingerprints and dried with a lint-free wipe prior to insertion in the turbidimeter?			X	
6.7 Dissolved Oxygen				
Do the dissolved oxygen meter and electrode system meet the SOP and/or sampling event specifications for accuracy and reproducibility?			X	
Are all sample measurements associated with acceptable calibration verifications?			X	
If the calibration and/or calibration verifications did not meet the acceptance criteria, is the calibration or verification identified as a failure and was this documented in the calibration log?			X	

Item to be Evaluated	*Y*	*N*	*N/A*	*Comments*
Are all measurements corrected for temperature (manual or automatic)?			X	
Are all measurements corrected for salinity, where applicable (manual or automatic)?			X	
Is the salinity (conductivity) sensor calibration verified?			X	
Is the dissolved oxygen electrode stored in a water-saturated air environment when not in use?			X	
Are the dissolved oxygen readings allowed to stabilize before measurement values were recorded?			X	

Shaw a world of Solutions	Title: Quality Surveillance Audit Report	Form No: EIP-Q-006.01_2

Project: RVAAP MMRP **Date:** 2/8/12

Surveillance Title: Incremental Surface Soil Sampling **Location:** Group 8 MRS

Shaw Audit No.: 136147-1

Documents Applicable to Audit
• Final Work Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services, Version 1.0 (December 2011), • Final SAP/QAPP Addendum (Appendix A of Work Plan Addendum), • Shaw SOPs (EI-FS-001, Field Logbook; EIF-FS-003, Chain of Custody; EI-FS-006, Sample Labeling; EI-FS-002, Shipping Packing Non-Hazardous, EI-FS-014, Equipment Decontamination; EI-FS-103, Soil Probe Core Sampling)

Non-Conformance Observed	Corrective Action	Opportunities for Improvement
Applicable Shaw SOPs were not onsite at the beginning of sampling activities.	The sampling crew retrieved the applicable Shaw SOPs from the field office prior to commencing sampling activities.	Having all applicable SOPs and work plan documents on site during sampling activities is useful in achieving project objectives.
Although sampling equipment is wrapped in tin foil to protect from contamination during travel to site, samplers should take greater effort to protect the equipment from sources that may contaminate it.	Sample crew will segregate the samplers from the rest of the equipment brought to the site (coolers, buckets, etc) to better protect the equipment from cross contamination.	Better care of samplers will be helpful to ensure no cross contamination occurs.
Periodic handling of decontaminated equipment with used gloves was observed.	Crew to ensure they use new gloves after each sample location and prior to handling clean sampling equipment.	Putting on new gloves after handling used equipment will be helpful to prevent cross contamination between samples.

Summary Of Audit Results
The purpose of this Audit Report is to determine the degree of conformance with project and external requirements for multi-increment surface soil sampling that are being performed at the Ravenna Army Ammunition Plant, Ravenna, Ohio under the Military Munitions Response Program. The sampling crew audited included Dave Crispo, Harry Harrison and Tom Mallory. In summary, the multi-increment soil sampling event followed the procedures established in the Work Plan Addendum, SAP and SOPs. Minor non-conformances were observed as noted above. These issues were discussed with the sampling crew and corrected in a timely manner. No follow up corrective actions are required. This report has been sent to Dave Cobb, Project Manager, to provide an overview of occurring field activities.

AUDIT COMPLETED BY: _____ DATE: 2/8/12

Appendix B
Data Validation Report

Table of Contents

List of Tables

List of Attachments

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Acronyms and Abbreviations

CCV	continuing calibration verification
DL	detection limit
DoD	Department of Defense
EPA	United States Environmental Protection Agency
ICS	interelement check standard
ICP	inductively coupled plasma
ICV	initial calibration verification
LCG	Louisville Chemistry Guideline, Version V
LCS	laboratory control sample
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
MRS	munitions response site
QC	quality control
QSM	DoD Quality Systems Manual, Version 4.2
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SA	spike added
Shaw	Shaw Environmental & Infrastructure, Inc.
SSR	spiked sample result
SR	sample result
TOC	total organic carbon
USACE	United States Army Corps of Engineers

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1.0 INTRODUCTION

This Data Validation Report presents the analytical data review and validation performed by Shaw Environmental & Infrastructure, Inc. (Shaw) in support of Military Munitions Response Program Phase I Remedial Investigation (RI) field activities for the Load Line #1 Munitions Response Site (MRS) located at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. Shaw subcontracted CT Laboratories, Inc. of Baraboo, Wisconsin to perform chemical analysis of samples collected during this RI. CT Laboratories has current Environmental Laboratory Accreditation Program and National Environmental Laboratory Accreditation Conference accreditations and/or approvals. CT Laboratories also has Navy certification approvals that meet the Department of Defense (DoD) *Quality Systems Manual (QSM) Version 4.2* (DoD, 2010) requirements. The United States Environmental Protection Agency (EPA) publication SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (2007) and DoD QSM 4.2 (2010) provide primary analytical direction for these projects. The *Louisville Chemistry Guideline (LCG)*, Version V (United States Corps of Engineers [USACE], 2002) was used as a guidance document for data review and data validation.

Field sampling for munitions constituents during the RI at the Load Line #1 MRS was conducted on August 11, 2011. In all, Shaw collected three surface soil samples using the Incremental Sampling Method. The SW-846 chemical analytical procedures were followed for analyses of select Target Analyte List metals (lead, aluminum, calcium, magnesium, and manganese), explosives, nitrocellulose, total organic carbon (TOC), and pH parameters for the samples collected for the RI event. **Table 1-1** summarizes the samples collected, data type, associated sample data group and the parameters analyzed.

1.1 Data Review and Validation Steps

The following steps are involved in the data review, verification, and validation process:

- **Step 1, Laboratory Data Review—**The laboratory reviews its data before releasing data packages to Shaw. The purpose is to verify that project-specific reporting requirements have been satisfied.
- **Step 2, Data Validation by Shaw—**Shaw performs a detailed validation process as described in **Section 1.2** of this appendix. Shaw reviews all the analytical data packages for completeness, consistency, and compliance with the project quality assurance requirements presented in the RVAAP *Final Facility-Wide Sampling and Analysis Plan* (Science Applications and International Corporation, 2011) and the project-specific *Final Munitions Constituents Sampling and Analysis Plan/Quality Control Assurance Plan* (Shaw, 2011).

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Table 1-1
Sample Summary Table for RI Samples Collected at Load Line #1 MRS

Sample Location ID	Collection Date	Depth (ft bgs)	Laboratory SDG	Field Duplicates	Metals[1]	Explosives	Nitrocellulose	Total Organic Carbon	pH
LL1SS-715(I)-0001-SS	8/15/11	0–0.5	86608	---	X	X	X	X	X
LL1SS-716(I)-0001-SS	8/15/11	0–0.5	86608	LL1SS-017(I)-0001-SS	X	X	X	X	X

[1] *Metals include analysis for lead, aluminum, manganese, and magnesium.*

ft bgs denotes feet below ground surface.

SDG denotes sample data group.

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1.2 Data Validation Procedure

The following data elements were reviewed as part of the data validation process:

- **Sample Preservation—**Sample chain-of-custody and CT Laboratories sample receipt forms were examined to determine if the samples had been properly preserved.
- **Sample Holding Times—**Holding times were verified by comparing chain-of-custody sampling dates with analysis and/or extraction dates on the analytical data sheet.
- **Initial and Continuing Calibrations—**Analytical data packages were reviewed to confirm that DoD QSM 4.2 and/or CT Laboratories Standard Operation Procedures protocol were met prior to sample analysis. The evaluation process involved checking the number of standards, as well as calibration requirements. In addition, continuing calibration evaluation included the verification of percent difference.
- **Initial Calibration Verification (ICV)—**Data packages were reviewed to verify that an ICV was prepared from a second source and that the recoveries were within acceptable ranges.
- **Interelement Check Standards (ICSA and ICSB)—**Interelement and background correction factors were evaluated by recalculating one or more recoveries from the raw data and verifying that the recalculated values agreed with the laboratory report.
- **Blanks—**Blank results were assessed to determine the existence and magnitude of contamination problems. The evaluation process involved the following:
    a) Reviewing the results of all associated blanks, summary sheet, and raw data.
    b) Verifying that the method blank analysis had been reported per matrix, per concentration level, for each instrument used to analyze samples, and for each extraction batch.
- **Laboratory Control Sample (LCS)—**LCS results were evaluated by reviewing the data package to verify that the results were within the control limits.
- **Surrogates—**Recovery data evaluation involved the following:
    a) Verifying the recoveries were within limits.

b) Determining if the laboratory took appropriate corrective action when surrogate recoveries were outside the limits (i.e., evidence re-injection or re-extraction).

c) Verifying that blank results did not exhibit surrogates recoveries outside the limits.

- **Matrix Spike and Matrix Spike Duplicate (MS/MSD)—**The evaluation process involved the following:

  a) Verifying that the recoveries were within limits.

  b) Checking the data and recalculating *%R* using the following equation:

$$\%R = \frac{(SSR - SR)}{SA} \times 100$$

Where: SSR = spiked sample result
SR = sample result
SA = spike added

- **Inductively Coupled Plasma (ICP) Serial Dilution—**Data were reviewed to determine if dilution results were within 10 percent of sample results.

1.3 Documentation

Shaw has prepared validation checklists for methods addressed in the DoD QSM 4.2 and the CT Laboratories Standard Operation Procedures (explosives, metals, nitrocellulose, TOC, and pH). The checklists and format have been reviewed and approved by the USACE Project Chemist. Data validation checklists are presented in **Attachment 1** of this appendix for environmental and quality control (QC) samples collected at the Load Line #1 MRS.

2.0 DATA VALIDATION RESULTS

The data validation process described in **Section 1.0** of this appendix was completed for all analytical data provided by CT Laboratories. The data package was reviewed by the Shaw Project Chemist, Maqsud Rahman, PhD, a qualified individual. The data validation process ensured the following:

- Data generation and reduction were conducted in a technically correct manner in accordance with the methods used;
- Data were reported in the proper units and with the correct number of significant figures;
- Calculations were verified by a valid calculation program, a spot-check-verified calculation program, or a 100-percent check of all hand calibrations;
- All variances from an accepted method and their rationale were documented and approved;
- Data were reviewed for transcription errors;
- Data package was complete and included sample preparation/extraction records, analysis sequence list, raw data, calculations, calibration data, QC results, and test results;
- QC results were within program-specified limits, or qualified appropriately if outside the limits; and
- Holding times were met and exceptions documented.

Attachment 1 of this appendix presents the data validation documentation for all environmental and QC samples collected at the Load Line #1 MRS. The following subsections summarize significant findings from the data validation process.

2.1 Data Qualifiers

Data qualifiers are assigned based on data validation findings and flagging protocol. Validation qualifiers used are presented in **Table 2-1** through **Table 2-4** of this appendix.

Table 2-1 summarizes the validation qualifiers for explosives by EPA SW-846 Method 8330B. This method utilizes high-performance liquid chromatography.

Table 2-1
Validation Qualifiers for Explosives

Flag	Flagging Criteria
J	When any of the following have NOT been met: a. CCV requirements b. LCS recovery c. Results between primary and secondary column relative percent difference ≤ 40% d. MS recovery within allowable limit e. MSD recovery within allowable limit f. Sample contamination detected outside DL and LOQ result range g. Soil sample triplicate relative standard deviation ≤ 20%
B	Method blank contamination
U	Nondetects
N	Non-target analyte

CCV denotes continuing calibration verification.
DL denotes detection limit.
LCS denotes laboratory control sample.
LOQ denotes limit of quantitation.
MS denotes matrix spike.
MSD denotes matrix spike duplicate.

Table 2-2 summarizes the validation qualifiers for metals by EPA SW-846 Method 6010C. This method utilizes ICP-atomic emission spectrometry.

Table 2-2
Validation Qualifiers for Metals

Flag	Flagging Criteria
J	When any of the following have NOT been met: a. CCV requirements b. LCS recovery c. ICS requirements d. MS recovery within allowable limit e. MSD recovery within allowable limit f. Sample contamination detected outside DL and LOQ result range g. Post-digestion spike recovery within allowable limit
B	Method blank contamination
U	Nondetects

Table 2-2 (continued)
Validation Qualifiers for Metals

Flag	Flagging Criteria
N	Non-target analyte

CCV denotes continuing calibration verification.
DL denotes detection limit.
ICS denotes interelement check standard.
LCS denotes laboratory control sample.
LOQ denotes limit of quantitation.
MS denotes matrix spike.
MSD denotes matrix spike duplicate.

Table 2-3 summarizes the validation qualifiers for nitrocellulose by EPA SW-846 Method 9056M and TOC by L-Kahn/9060A.

Table 2-3
Validation Qualifiers for Nitrocellulose and TOC

Flag	Flagging Criteria
J	When any of the following have NOT been met: a. CCV requirements b. LCS recovery c. MS recovery within allowable limit d. MSD recovery within allowable limit
B	Method blank contamination
U	Nondetects
N	Non-target analyte

CCV denotes continuing calibration verification.
LCS denotes laboratory control sample.
MS denotes matrix spike.
MSD denotes matrix spike duplicate.

Table 2-4 defines data validation qualifiers used in this report.

Table 2-4
Validation Qualifier Definitions

Qualifier	Definitions
U	The analyte was analyzed for, but not detected above, the DL.
J	Estimated. The associated numerical value is the approximate concentration of the analyte in the sample[1].

Table 2-4 (continued)
Validation Qualifier Definitions

Qualifier	Definitions
UJ	Not detected. The detection limits and quantitation limits are approximate.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.

According to DoD Quality Systems Manual, Version 4.2, analytes detected between DL and LOQ need to be "J" qualified.

DL denotes detection limit. *DoD denotes United States Department of Defense.*

LOQ denotes limit of quantitation. *QC denotes quality control.*

Table 2-5 defines qualifier reason codes.

Table 2-5
Validation Qualifier Reason Codes

Reason Code	Descriptions
DL-LOQ	Sample result between detection limit and level of quantitation
FB	Field blank contamination
FD	Field duplicate evaluation criteria not met
HT	Holding time requirement was not met
LCS	Laboratory control sample evaluation criteria not met
MB	Method blank or preparation blank contamination
RB	Rinsate blank contamination
TB	Trip blank contamination
SQL	Sample quantitation limit exceeds decision criteria (for nondetects)
Inorganic Methods	
CB	Calibration blank contamination
CCV	Continuing calibration verification evaluation criteria not met
D	Laboratory duplicate precision evaluation criteria not met
DL	Serial dilution results did not meet evaluation criteria
ICSA	ICSA evaluation criteria not met
ICSB	ICSB evaluation criteria not met
ICV	ICV evaluation criteria not met
MS	MS recovery outside acceptance range
MS/MSD	Both MS and MSD outside acceptable range

Table 2-5 (continued)
Validation Qualifier Reason Codes

Reason Code	Descriptions
PDS	Post-digestion spike recovery outside acceptance range
MSA	Method of standard additions correlation coefficient < 0.995
PB	Preparation blank
	Organic Methods
CCAL	Continuing calibration evaluation criteria not met
ICAL	Initial calibration evaluation criteria not met
ID	Target compound identification criteria not met
IS	Internal standard evaluation criteria not met
MS/SD	MS/MSD accuracy and/or precision criteria not met
SUR	Surrogate recovery outside acceptance range
TUNE	Instrument performance (tuning) criteria not met
P	The detected concentration difference between the primary and secondary column is greater than 40%

ICS denotes intrelement check standard.
ICV denotes initial calibration verification.
MS denotes matrix spike.
MSD denotes matrix spike duplicate.

2.2 Explosives

The explosives data were complete (i.e., all required data elements were reported) and all analyses were in compliance with SW-846 Method 8330B and DoD QSM 4.2 requirements. Data validation findings include the following:

- 1,3,5-Trinitrobenzene (135-TNB) relative percent difference failed due to a higher recovery in the MS and MSD samples. The parent sample (LL1SS-715(I)-0001-SS) was qualified with a "J".
- Sample LL1-718-RB had a surrogate recovery that was more than double the spiked surrogate amount. The method and laboratory blanks, as well as the LCS, had acceptable surrogate recoveries. The sample was re-analyzed on the confirmation column and the surrogate recovery was within the acceptable range, but several peaks were elsewhere in the chromatogram. This indicates that the sample matrix was interfering at the surrogate retention time on the primary column, but eluted elsewhere on the confirmation column.

2.3 Metals

The metals data were complete (i.e., all required data elements were reported) and all analyses were in compliance with SW-846 Method 6010B. The MS/MSD for sample LL1SS-715(I)-0001-SS exceeded recovery limits for lead, magnesium and manganese, but had either serial acceptable dilution and/or post-digestion spike recoveries. Subsequently, their results were reported without qualification in the parent sample.

2.4 Nitrocellulose

The nitrocellulose data were complete (i.e., all required data elements were reported) and all analyses were in compliance with SW-846 Method 9056M and DoD QSM 4.2 requirements. MS/MSD recoveries for sample LL1SS-715(I)-001-SS were 63 percent and 65 percent respectively, and were below the allowable range of 70 to 130 percent. The parent sample result was qualified with a "J" flag.

2.5 Total Organic Carbon

The TOC data were complete (i.e., all required data elements were reported) and all analyses were in compliance with SW-846 Method 9060A. There were no QC outliers.

2.6 pH

The pH data were complete (i.e., all required data elements were reported) and all analyses were performed following SW-846 Method 9040C and. There were no QC outliers.

2.7 Summary of Data Qualifications and Validation Findings

A summary of the sample data qualifications and validation findings for the results of the RI sample collected at the Load Line #1 MRS are presented in **Table 2-6**.

2.8 Completeness and Usability

The percent completeness of field- and laboratory-generated analytical data were assessed using the following formula:

$$= \frac{[(\text{usable samples}) * (\text{total analytes})] - \text{unusable analytes} - [(\text{unusable samples}) * (\text{total analytes})]}{[(\text{total samples}) * (\text{total analytes})]}$$

Since no data have been rejected, 100 percent of the data is usable.

Table 2-6
Summary of Sample Data Qualifications and Validation Findings

Sample ID	Parameter	Results (mg/kg)	Detection Limit (mg/kg)	Laboratory Qualifier	Validation Qualifier	Reason Code[1]
LL1SS-715(I)-0001-SS	1,3,5-Trinitrobenzene	0.13	0.13	UY	UJ	MS/SD
LL1SS-716(I)-0001-SS	Nitroguanidene	0.22	0.061	JP	J	DL-LOQ, P
LL1SS-715(I)-0001-SS	Nitrocellulose	13	13	UM	UJ	MS/MSD

[1] Refer to Table 2-5 for reason codes definitions.
mg/kg denotes milligrams per kilogram.

Laboratory Qualifier Definitions:
J denotes estimated.
M denotes matrix spike or matrix spike duplicate recovery are outside of acceptance limits.
P denotes concentration of analyte differs by more than 40 percent between primary and confirmation analysis.
U denotes analyte concentration was not above the detection limit.
Y denotes raised quantitation or reporting limit is due to limited sample amount or dilution for matrix background interference.

Validation Qualifier Definitions:
J denotes estimated. The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
UJ denotes not detected. The detection limits and quantitation limits are approximate.

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3.0 REFERENCES

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Attachment 1
Data Validation Checklists

1

NITROAROMATICS AND NITRAMINE ANALYSIS
DATA VERIFICATION CHECKLIST
(USING DoD QSM 4.2)

U.S. ARMY CORPS OF ENGINEERS
RAVENNA ARMY AMMUNITION PLANT

Location: Load Line #1 MRS

Laboratory: CT Laboratories **Sampling Date:** Aug 15. 2011 **COC No.** N/A

Report No.: 86608 **Extraction Date:** Aug. 19, 2011 **Analysis Date:** Aug. 23 , 2011

Analytical Method: SW-846 8330B **Matrix:** Soil/Water

Analyte: Nitroaromatics and Nitramine **Sample IDs:** LL1SS-715(I)-0001-SS,

LL1SS-716(I)-0001-SS, LL1SS-717(i)-0001-SS, LL1-718-RB

SAMPLE PREPARATION

	Yes	No
1. Analytical Capability Was analytical capability demonstrated?	[x]	[ ]
2. Limit of Detection (LOD) Were LODs determined and verified?	[x]	[ ]
3. Limit of Quantitation (LOQ)		
a) Were LOQs determined and verified?	[x]	[ ]
b) Were the samples dried to a constant weight?	[x]	[ ]
c) Were the dates, times and ambient temperatures recorded on a daily basis?	[x]	[ ]
d) Were the samples sieved and ground?	[x]	[ ]
4. Soil Grinding Blank		
a) Was a grinding blank processed in-between samples?	[x]	[ ]
b) Were any target analyte present at >1/2 of the reporting limit (RL)?	[x]	[ ]
5. Soil Subsampling Process		
a) Was any subsampling process followed?		
6. Soil Sample Triplicate	[x]	[ ]
a) Was a triplicate analysis performed?		
b) Was the relative standard deviation (RSD) ≤20%?		
7. Aqueous Sample Preparation (when applicable) Was a SPE performed?	[x]	[ ]

SAMPLE ANALYSIS

8. Sample Holding Time Were samples analyzed within holding times?	[x]	[ ]
9. Initial Calibration	[x]	[ ]
a) Did the initial calibration consist of five or more standards?	[x]	[ ]

	Yes	No
b) Was the lowest standard concentration at or below the RL?	[x]	[ ]
c) Was r $\geq$0.995 (if using linear regression)?	[x]	[ ]
d) Was the lowest standard or a CCV reanalyzed after the generation of the calibration curve?	[x]	[ ]
10. Initial Calibration Verification (ICV)	[x]	[ ]
a) Was the ICV run immediately following the ICAL?	[x]	[ ]
b) Was the ICV made of a 2nd source?		
c) Was the mid-level (2nd source) recovery within 80-120%?		
11. Continuing Calibration Verification (CCV)/Mid-Point Calibration		
a) Was a CCV conducted prior to sample analysis?	[x]	[ ]
b) Was a CCV conducted after every ten samples or every 12 hours?	[x]	[ ]
c) Was a CCV conducted after the last sample of the day?	[x]	[ ]
d) Did the CCV meet the minimum requirements (D $\leq$20%)?	[x]	[ ]
12. Method Blank		
a) Was a method blank present in every preparatory batch?	[x]	[ ]
b) Were target analytes detected >1/2 the RL and >1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)?	[ ]	[x]
c) Did the method blank fail the project-specific objectives (>1/2 the RL or > the RL)?	[ ]	[x]
13. Laboratory Control Sample (LCS)		
a) Was an LCS present in every preparatory batch?	[x]	[ ]
b) Did the LCS contain all analytes to be reported?	[x]	[ ]
c) LCS: Were the percent recoveries for LCS within the limits? (Enter out of control recoveries only)	[x]	[ ]

Identification of LCS Standard

Spiked Compound	LCS %R	Acceptable Range (%)
	.	
	.	

	Yes	No
14. Matrix Spike/Matrix Spike Duplicate		
a) MS/MSD: were the percent recoveries within limits? (Enter out of control recoveries only)	[x]	[ ]
b) Were the relative percent differences (RPDs) within control limits?	[ ]	[x]

Identification of Original Sample Used for QC

Sample ID	Compound	Percent Recovery		RPD
		MS	MSD	
LL1SS-715(I)-SS	1,3,5-Trinitrobenzene	96 (75-122)	117 (75-122)	19 (18)

	Yes	No
15. Confirmation Analysis		
a) Was the RPD <40% between the two column results?	[x]	[ ]

	Yes	No
16. Analyte Detection		
a) Were results reported between the DL and the LOQ?	[x]	[ ]
b) Were results reported between the DL and the LOQ flagged as estimated?	[x]	[ ]

Qualifier ands Reason Code

Sample ID	Results (mg/kg)	Detection Limit (mg/kg)	Laboratory Qualifier	Validation Qualifier	Reason Code
LL1SS-715(I)-0001-SS	0.13	0.13	UY	UJ	MS/MSD

Comments (attach additional sheets if necessary):

1. 1,3,5-Trinitrobenzene (135-TNB) RPD failed due to a higher recovery in the matrix spike (MS) and matrix spike duplicate (MSD) samples. The parent sample (LL1SS-715(I)-0001-SS) was qualified with a "J".

2. Sample LL1-718-RB had a surrogate recovery that was more than double the spiked surrogate amount. The method and laboratory blanks, as well as the laboratory control sample, had acceptable surrogate recoveries. The sample was re-analyzed on the confirmation column and the surrogate recovery was within the acceptable range, but several peaks were elsewhere in the chromatogram. This indicates that the sample matrix was interfering at the surrogate retention time on the primary column, but eluted elsewhere on the confirmation column.

Validated/Reviewed by:

Name of Reviewer: Maqsud Rahman, PhD **Date:** November 1, 2011

Signature: Maqsud Rahman

Overall Assessment of the Data Package: Complete

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ICP METALS ANALYSIS DATA VERIFICATION CHECKLIST
(USING DoD QSM 4.2)

U.S. ARMY CORPS OF ENGINEERS
RAVENNA ARMY AMMUNITION PLANT

Location:	Load Line #1 MRS	**SDG No.:**	86608	**Sampling Date:**	August 15, 2011
Laboratory:	CT Laboratories	**COC No.:**	N/A	**Matrix:**	Soil & water
Parameter:	MEC Metals & Geochem Metals			**Analytical Method:**	6010B
Extraction Dates:	August 24, 2011	**Analysis Dates:**	August 25, 2011		

Sample IDs: LL1SS-715(I)-0001-SS, LL1SS-716(I)-0001-SS, LL1SS-717(I)-0001-SS, LL1-718-RB

		Yes	No	N/A
1.	Analytical Capability			
	Was analytical capability demonstrated?	X		
2.	Limit of Detection (LOD)			
	Were LODs determined and verified?	X		
3.	Limit of Quantitation (LOQ)			
	Were LOQs determined and verified?	X		
4.	Instrument Detection Limit (IDL) study			
	Was an IDL study performed?	X		
5.	Sample Holding Time			
	Were samples analyzed within holding times?	X		
6.	Initial Calibration			
	Did the initial calibration consist of:			
	a) One high calibration standard and a blank?	X		
	b) Three or more standards and a blank?	X		
7.	Low Level Calibration Check Standard (daily after 1 point ICAL)			
	Was the percentage "D" ≤20%?			X

	Yes	No	N/A
8. Initial Calibration Verification (ICV)			
a) Was it analyzed after each ICAL and the beginning of each analytical run?	X		
b) Was the mid-level (2nd source) within 90-110?	X		
9. Initial Calibration Blank (ICB)			
Was the ICB analyzed immediately following the ICV?	X		
10. Linear Dynamic Range or High Level Check Standard (every 6 months)			
Was recovery within 90-110?	X		
11. Interelement Check Standard (ICS)			
a) Was ICS-A (interferents only) conducted at the beginning of the analytical sequence?	X		
b) Were concentrations (absolute values) of all non-spiked analytes <LOD?	X		
c) Was ICS-B (interferents and target analytes) within QC limits (80-120)?	X		
12. Continuing Calibration Blank (CCB)			
a) Was a CCB conducted at least every 10 samples?	X		
b) Was a CCB conducted at the end of the analytical sequence?	X		
c) Were all analyte concentrations >LOD?	X		
13. Continuing Calibration Verification (CCV)			
a) Was a CCV conducted at least every 10 samples?	X		
b) Was a CCV conducted at the end of the analytical sequence?	X		
c) Were recoveries between 90-110%?	X		
14. Sample Quality Control			
a) Method Blanks			
1) Was a method blank present in every preparatory batch?	X		
2) Were target analytes detected >1/2 reporting limit (RL), and >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater?		X	
3) Did the method blank fail project-specific objectives (>1/2 the RL or > the RL)?	X		
b) Laboratory Control Sample (LCS)			
1) Was an LCS present in every preparatory batch?	X		
2) Did the LCS contain all analytes to be reported?	X		

	Yes	No	N/A
3) Were percent recoveries for the LCS within the limits?			
(Enter out of control recoveries only)	X		

Identification of LCS Standard

Spiked Compound	LCS (%R)	LCSD (%R)	RPD

c) Matrix Spike (MS)/Matrix Spike Duplicate (MSD)

	Yes	No	N/A
1) Were percent recoveries within limits (80-120)?			
(Enter out of control recoveries only)		X	
2) Were the relative percent differences (RPDs) within the acceptable limit (<20)?			
(Enter out of control recoveries in bold)	X		

Identification of Original Sample Used for QC

Sample ID	Analyte	Percent Recovery		RPD
		MS	MSD	
LL1SS-715(I)-0001-SS	Lead	75 (80-120)	110	7
	Magnesium		78 (80-120)	2
	Manganese		31 (80-120)	3

	Yes	No	N/A
15. Dilution Test			
a) Was a 5-fold serial dilution conducted (one per preparatory batch)?	X		
b) Was there an agreement between diluted and undiluted results (<10%)?		X	
16. Post Digestion Spike Addition			
a) Was a post-digestion spike addition necessary?	X		
b) Were recoveries within acceptable limits (75-125%)?	X		
17. Method of Standard Addition (MSA)			
Was MSA performed on samples when matrix interference is confirmed (where dilution test fails or when concentrations in all samples are <50 times the LOD)?			X

	Yes	No	N/A
18. Analyte Detection			
a) Were any results between the DL and the LOQ?		X	
b) Were any results between the DL and LOQ J flagged?			X
19. Sample Analysis			
Were samples with analyte concentrations higher than the calibration range (E), diluted and re-analyzed?	X		

Comments (attach additional sheets if necessary):

The MS and/or MSDs for sample LL1SS-715(I)-0001-SS exceeded recovery limits for lead, magnesium and manganese. The element in this sample had either acceptable serial dilution results or post digestion spike recoveries. Subsequently, their results were reported without qualification in the parent sample.

Validated/Reviewed by:

Name of Reviewer: Maqsud Rahman, PhD **Date:** November 2, 2011

Signature: Maqsud Rahman

Overall Assessment of the Data Package: Complete

NITROCELLULOSE ANALYSIS DATA VERIFICATION CHECKLIST
(USING CT LABORATORY SOP)

RAVENNA ARMY AMMUNITION PLANT
US ARMY CORPS OF ENGINEERS

Location:	Load Line #1 MRS	**SDG No.:**	86608	**COC No.:**	N/A
Laboratory:	CT Laboratories	**Sampling Date:**	August 15, 2011	**Matrix:**	Soil & Water
Parameter:	Nitrocellulose			**Analytical Method:**	SOP CC-NC
Extraction Dates:	Aug 22, 2011	**Analysis Dates:**	Aug 22, 2011		

Sample IDs: LL1SS-715(I)-0001-SS, LL1SS-716(I)-0001-SS, LL1SS-717(I)-0001-SS, LL1-718-RB

	Yes	No	N/A
1. Was the calibration performed using a minimum of three standards and a blank?	X		
2. Is the standard prep log number noted on the analytical report bench sheet?	X		
3. Was the correlation coefficient $\geq$ 0.995?	X		
4. Were the initial calibration verification (ICV) and initial calibration blank (ICB) run immediately after the calibration check standard?	X		
5. Was the ICV recovery 90-110%?	X		
6. Was the ICB result < limit of detection (LOD)?	X		
7. Were the continuing calibration verifications (CCV's) and the continuing calibration blanks (CCB's) analyzed at least once for every 10 samples?	X		
8. Were the CCV recoveries 90-110%?	X		
9. Were the CCB results <LOD?	X		
10. Was a method blank (MB) analyzed at least once for every 20 samples?	X		
11. Were the MB results <LOD?	X		
12. Was a laboratory control sample (LCS) run at least once for every 20 samples?	X		
13. Was the LCS recovery 80-120% (soil) or 70-130% (water)?	X		
14. Was the MS and/or MSD (when required) prepared at least once for every 20 samples per matrix?	X		

	Yes	No	N/A
15. Was the matrix spike (MS) (and/or matrix spike duplicate [MSD]) recovery 80-120% (soil) or 70-130% (water)?		X	
16. If applicable, was the relative percent difference (RPD) between the MS and MSD 15% (soil) or 20% (water)?	X		
17. Was a sample duplicate prepared at least once for every 20 samples?	X		
18. Was the duplicate within precision limits?	X		

Nitrocellulose Qualifier ands Reason Code

Sample ID	Results (mg/kg)	Detection Limit (mg/kg)	Laboratory Qualifier	Validation Qualifier	Reason Code
LL1SS-715(I)-0001-SS	13	13	UM	UJ	MS/MSD

Comments (attach additional sheets if necessary):

The MS and MSD recoveries for sample LL1SS-715(I)-001-SS were 63% and 65%, respectively, and were below the allow range of 70-130%. The parent sample result was qualified with a "J" flag.

Validated/Reviewed by:

Name of Reviewer: Maqsud Rahman, PhD **Date:** November 2, 2011

Signature: Maqsud Rahman

Overall Assessment of the Data Package: Complete

pH ANALSIS DATA VERIFICATION CHECKLIST
(USING CT LABORATORY SOP)

U.S. ARMY CORPS OF ENGINEERS
RAVENNA ARMY AMMUNITION PLANT

Location Name: Load Line #1 MRS

Laboratory: CT Laboratories **Sampling Date:** Aug 15, 2011 **COC No.** N/A

Report No.: 86608 **Extraction Date:** N/A **Analysis Date:** Aug. 24, 2011

Analytical Method: SOP CC-24B **Matrix:** Soil/Water

Analyte: pH **Analytical Method:** SOP CC-24B **Matrix:** Soil/Water

Sample IDs: **LL1SS-715(I)-0001-SS, LL1SS-716(I)-0001-SS,** LL1SS-717(I)-0001-SS, LL1-718-RB

	Yes	No
1. Was a duplicate run at least once for every 20 samples of the same matrix?	X	
2. Did the duplicates differ from the samples by ≤ 0.10 pH units?		X

Comments (attach additional sheets if necessary):

No QC outlier to report.

Validated/Reviewed by:

Name of Reviewer: Maqsud Rahman, PhD **Date:** November 2, 2011

Signature: Maqsud Rahman

Overall Assessment of the Data Package: Complete

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TOTAL ORGANIC CARBON ANALYSIS DATA VERIFICATION CHECKLIST
(USING CT LABORATORY SOP)

U.S. ARMY CORPS OF ENGINEERS
RAVENNA ARMY AMMUNITION PLANT

Location Name: Load Line #1 MRS

Laboratory: CT Laboratories **Sampling Date:** Aug 15, 2011 **COC No.** N/A

Report No.: 86608 **Extraction Date:** N/A **Analysis Date:** Aug 30, 2011

Analytical Method: SOP CC-TOC Solid **Matrix:** Soil and Water

Analyte: Total Organic Carbon

Sample IDs: LL1SS-715(I)-0001-SS, LL1SS-716(I)-0001-SS, LL1SS-717(I)-0001-SS, LL1-718-RB

		Yes	No
1.	Were the samples acidified prior to analysis?	X	
2.	Was a calibration curve performed using at least three standards and a blank?	X	
3.	Was the correlation coefficient >= 0.995?	X	
4.	Was the initial calibration verification (ICV) standard run at the beginning of the run prior to sample analysis?	X	
5.	Was the ICV recovery 90-110%?	X	
6.	Was the initial calibration blank (ICB) result < limit of detection (LOD)?	X	
7.	Were the continuing calibration verifications (CCV's) and the continuing calibration blanks (CCB's) analyzed at least once for every 10 samples?	X	
8.	Were the CCV recoveries 90-110%?	X	
9.	Were the CCB results < LOD?	X	
10.	Were all positive results that were reported within the calibration's range?	X	
11.	Was the laboratory control sample (LCS) recovery 80-120%?	X	
12.	Were the method blanks (MB) results < LOD?	X	
13.	Were at least one of every 20 samples analyzed in quadruplicate?	X	
14.	Was the percent relative standard deviation (%RSD) on the replicated sample $\pm$ 30%?	X	

Comments (attach additional sheets if necessary):

No QC outliers to report.

Validated/Reviewed by:

Name of Reviewer: Maqsud Rahman, PhD **Date:** November 2, 2011

Signature: Maqsud Rahman

Overall Assessment of the Data Package: Complete

Appendix C
Laboratory Analytical Data

Note: Data submitted on compact disc.

Table C-1
Surface Soil Analytical Data Summary
RVAAP-008-R-01 Load Line #1 MRS

			Location Code:	LL1SS-715(I)		LL1SS-716(I)		LL1SS-717(I)	
			Sample Number:	LL1SS-715(I)-0001-SS		LL1SS-716(I)-0001-SS		LL1SS-717(I)-0001-SS	
			Sample Date:	8/15/2011		8/15/2011		8/15/2011	
			Sample Purpose:	REG		REG		FD	
			Depth (feet bgs):	0 - 0.5		0 - 0.5		0 - 0.5	
Parameter	Units	Surface Soil Background Values		Result	VQ	Result	VQ	Result	VQ
Explosives									
1,3,5-Trinitrobenzene	mg/kg	--		0.25	UJ	0.25	U	0.25	U
1,3-Dinitrobenzene	mg/kg	--		0.2	U	0.2	U	0.2	U
2,4,6-Trinitrotoluene	mg/kg	--		0.2	U	0.2	U	0.2	U
2,4-Dinitrotoluene	mg/kg	--		0.25	U	0.25	U	0.25	U
2,6-Dinitrotoluene	mg/kg	--		0.25	U	0.25	U	0.25	U
2-Amino-4,6-Dinitrotoluene	mg/kg	--		0.2	U	0.2	U	0.2	U
3,5-Dinitroaniline	mg/kg	--		0.2	U	0.2	U	0.2	U
4-Amino-2,6-Dinitrotoluene	mg/kg	--		0.2	U	0.2	U	0.2	U
HMX	mg/kg	--		0.2	U	0.2	U	0.2	U
m-Nitrotoluene	mg/kg	--		0.2	U	0.2	U	0.2	U
Nitrobenzene	mg/kg	--		0.2	U	0.2	U	0.2	U
Nitroglycerin	mg/kg	--		1	U	1	U	1	U
Nitroguanidine	mg/kg	--		0.25	J	0.22	J	0.125	U
o-Nitrotoluene	mg/kg	--		0.25	U	0.25	U	0.25	U
PETN	mg/kg	--		1	U	1	U	1	U
p-Nitrotoluene	mg/kg	--		0.2	U	0.2	U	0.2	U
RDX	mg/kg	--		0.25	U	0.25	U	0.25	U
Tetryl	mg/kg	--		0.2	U	0.2	U	0.2	U
Nitrocellulose									
Nitrocellulose	mg/kg	--		50	UJ	50	U	50	U
MEC Metal									
Lead	mg/kg	26.1		109		70.9		81.2	

Table C-1 (continued)
Surface Soil Analytical Data Summary
RVAAP-008-R-01 Load Line #1 MRS

			Location Code:		LL1SS-715(I)		LL1SS-716(I)		LL1SS-717(I)	
			Sample Number:		LL1SS-715(I)-0001-SS		LL1SS-716(I)-0001-SS		LL1SS-717(I)-0001-SS	
			Sample Date:		8/15/2011		8/15/2011		8/15/2011	
			Sample Purpose:		REG		REG		FD	
			Depth (feet bgs):		0 - 0.5		0 - 0.5		0 - 0.5	
Parameter	**Units**	**Surface Soil Background Values**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**		
Geochemical Parameters										
Aluminum	mg/kg	17,700	10,300		12,000		11,700			
Calcium	mg/kg	15,800	9,560		63,800		54,600			
Magnesium	mg/kg	3,030	2,270		4,830		4,800			
Manganese	mg/kg	1,450	963		1,010		1,100			

Shading and black font indicates a Surface Soil Background Value exceedance.

Validation Qualifiers:

J = Estimated: The analyte was positively identified; the quantitation is estimation.

U = Not detected or the concentration was below the detection limit.

UJ = Not detected. The detection limits and quantiation limits are approximate.

bgs denotes below ground surface

FD denotes field duplicate

mg/kg denotes milligrams per kilogram

VQ denotes validation qualifier

REG denotes regular.

RDX denotes hexahydro-1,3,5-trinitro-1,3,5-triazine.

HMX denotes octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

PETN denotes pentaerythritol tetranitrate.

Table C-2
Rinsate Blank Analytical Data Summary
RVAAP-008-R-01 Load Line #1 MRS

Location Code:		**NA**	
Sample Number:		**LL1SS-718-RB**	
Sample Date:		**8/15/2011**	
Sample Purpose:		**RB**	
Depth (feet bgs):		**NA**	
Parameter	**Units**	**Result**	**VQ**
Explosives			
1,3,5-Trinitrobenzene	µg/L	0.23	U
1,3-Dinitrobenzene	µg/L	0.20	U
2,4,6-Trinitrotoluene	µg/L	0.20	U
2,4-Dinitrotoluene	µg/L	0.30	U
2,6-Dinitrotoluene	µg/L	0.24	U
2-Amino-4,6-Dinitrotoluene	µg/L	0.24	U
3,5-Dinitroaniline	µg/L	0.23	U
4-Amino-2,6-Dinitrotoluene	µg/L	0.24	U
HMX	µg/L	0.25	U
m-Nitrotoluene	µg/L	0.40	U
Nitrobenzene	µg/L	0.22	U
Nitroglycerin	µg/L	2.2	U
Nitroguanidine	µg/L	32	U
o-Nitrotoluene	µg/L	0.23	U
PETN	µg/L	3.0	U
p-Nitrotoluene	µg/L	0.22	U
RDX	µg/L	0.18	U
Tetryl	µg/L	0.21	U
Nitrocellulose			
Nitrocellulose	mg/L	1.1	U
MEC Metal			
Lead	µg/L	1.4	U

Validation Qualifiers:

U = Not detected or the concentration was below the detection limit.

bgs denotes below ground surface

µg/L denotes micrograms per liter

mg/L denotes milligrams per liter

VQ denotes validation qualifier

RB denotes rinsate blank.

RDX denotes hexahydro-1,3,5-trinitro-1,3,5-triazine.

HMX denotes octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

PETN denotes pentaerythritol tetranitrate.

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Appendix D
Investigation Derived Waste Management

Table of Contents

List of Tables

List of Attachments

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Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
FSAP	Facility-Wide Sampling and Analysis Plan
IDW	Investigation-Derived Waste
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
PCB	polychlorinated biphenyl
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
RVAAP	Ravenna Army Ammunition Plant
Shaw	Shaw Environmental & Infrastructure, Inc.
SVOC	semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
Vista	Vista Environmental Services Corporation
VOC	volatile organic compound
VQ	validation qualifier

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1.0 INVESTIGATION-DERIVED WASTE MANAGEMENT

Investigation-Derived Waste (IDW) generated during the remedial investigation activities conducted at the Ravenna Army Ammunition Plant (RVAAP), Ohio, under the Military Munitions Response Program included the following:

- Solid Waste (expendable waste debris) consisting of personal protective equipment (PPE)
- Solid Waste (used absorbent pads) derived from collection of residual liquids from decontamination of sampling equipment

All IDW generated during the remedial investigation activities was managed in accordance with sampling requirements of *Munitions Constituents Sampling and Analysis Plan and Quality Assurance Project Plan* (Shaw Environmental & Infrastructure, Inc. [Shaw], 2011) and Section 7.0 of the *Facility-Wide Sampling and Analysis Plan* (FSAP) (Science Applications International Corporation, 2001).

1.1 IDW Collection and Containerization

Characterization and classification of the different types of IDW was based on the specific protocol described below.

- **Expendable Waste Debris and Spent Absorbent Pads—**Expendable waste debris and spent absorbent pads considered to be potentially contaminated based on visual inspection and use of the waste material was placed in segregated trash bags and stored in a 55-gallon drum sealed with gasketed, ring-topped lid.

A summary of IDW generated is presented in **Table 1**.

Table 1
Summary of Investigation-Derived Waste

Drum ID Number	Container Size and Type	Contents and Volume	Generation Dates
Solid Waste			
Shaw-2012-01	55-gallon open top	PPE and spent absorbent pads (half-full)	8/12/2011–5/9/2012

PPE denotes personal protective equipment.

1.2 Waste Container Labeling

All containerized waste was labeled as specified in Section 7.2 of the FSAP. Label information on each container was written in indelible ink and included, at a minimum, the container number;

contents; source of the waste; source location; project name and site identification; physical characteristics of the waste; and generation dates. The label was placed on the side of the container at a location that was protected from damage or degradation.

1.3 IDW Field Staging

The drum containing IDW was staged at Building 1036. The drum was placed on a wooden pallet at Building 1036 and was labeled as, "On Hold Pending Analysis" until analytical results were received.

1.4 Weekly Inspection Inventories

Shaw contracted Vista Environmental Services Corporation (Vista) to conduct weekly inspection inventories of the containerized IDW in accordance with Section 40, Part 262 of the Code of Federal Regulations (40 CFR 262). The weekly inspections were performed by Vista for the duration of the waste storage at the facility. Once analytical results were received by Shaw, Vista placed the appropriate waste characterization label on the drum.

1.5 IDW Sampling

The IDW sample was analyzed by the following United States Environmental Protection Agency (EPA) methods:

Table 2
Investigation-Derived Waste Analysis Methods

Sample Name	Analysis	Methods
IDW-WC-0001	TCLP Metals TCLP SVOCs TCLP VOCs PCBs Explosives RCRA Characteristics[1]	6010C, 7470A 8270C 8260C 8082A 8330B 9045D, 1010, ASTM D5049, and ASTM D4978

[1] *RCRA Characteristics include analysis for reactive cyanide and sulfide, flashpoint and pH.*
ASTM denotes American Society for Testing and Materials.
PCB denotes polychlorinated biphenyl.
RCRA denotes Resource Conservation and Recovery Act.
SVOC denotes semivolatile organic compound.
TCLP denotes Toxicity Characteristic Leaching Procedure.
VOC denotes volatile organic compound.

The detected analytical results for each of the IDW samples are presented in **Table 3**. The IDW laboratory data report is presented in **Attachment 1** of this appendix.

1.6 Listed Waste Screening

A review of available historical documents and generator knowledge did not support that wastes generated met the listed description as defined in 40 CFR 261, Subpart D. Therefore, the IDW generated was not considered listed.

1.7 Characteristic Waste Screening

The solid waste was evaluated to determine if it exhibited characteristics of a hazardous waste. RCRA characterization was performed on the waste to determine if it was reactive, ignitable, or corrosive. To check for the characteristic of toxicity, the analytical results were compared to the RCRA Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels. All detected analytes were below the toxicity limits and did not exhibit characteristics of a hazardous waste. (**Table 3**).

1.8 IDW Transport and Disposal

Based on the analytical data and the screening criteria discussed above, the drum containing expendable waste debris and used absorbent pads did not exhibit characteristics of a hazardous solid waste. All waste disposal documents were reviewed by the RVAAP Facility Manager prior to off-site disposal in accordance with the RVAAP Waste Management Guidelines. All generated waste was transported off-site for disposal at Vexor Technology, Inc. in Medina, Ohio. The drum was disposed as non-Department-of-Transportation Regulated, Nonhazardous Material. The approved waste profile and nonhazardous waste manifest are provided in **Attachment 2** and **Attachment 3** of this appendix, respectively.

Table 3
Detected Analytes in Investigation-Derived Waste Samples

Sample ID	Sample Date	Test Group	Method	Analyte	Result	VQ	Units	Characteristic Waste Evaluation	
								EPA Hazardous Waste Code	RCRA TCLP Level (mg/L)[1]
IDW-WC-0001	02-Oct-12	Metals	6010C	TCLP Barium	0.034		mg/L	D005	100
		Metals	6010C	TCLP Chromium	0.0006	J	mg/L	D007	5
		Metals	6010C	TCLP Lead	0.0065		mg/kg	D008	5
		Metals	6010C	TCLP Selenium	0.004	B	mg/kg	D010	1

[1] *Toxicity Characteristic Leaching Procedure, 40 CFR 261.24.*

CFR denotes Code of Federal Regulations.

EPA denotes United States Environmental Protection Agency.

mg/kg denotes milligrams per kilogram.

mg/L denotes milligrams per liter.

RCRA denotes Resource Conservation and Recovery Act.

TCLP denotes Toxicity Characteristic Leaching Procedure.

VQ denotes validation qualifier.

Validation Qualifiers:

J denotes the reported result is an estimated value.

B denotes analyte detected in associated method blank.

Attachment 1
IDW Laboratory Data Report

1
2

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ANALYTICAL REPORT

SHAW E&I INC
DAVID CRISPO
100 TECHNOLOGY CENTER DRIVE
STOUGHTON, MA 02072

Project Name: RVAAP MMRP
Project Phase:
Contract #: 2385
Project #: 136147
Folder #: 93596

Page 1 of 5
Arrival Temperature: 2.0
Report Date: 10/22/2012
Date Received: 10/3/2012
Reprint Date: 10/22/2012

Copy: Maqsud.Rahman@shawgrp.com

Purchase Order #: 734474

CT LAB#: 223573 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Metals Results												
TCLP Arsenic	<0.0040	mg/L	0.0040	0.012	0.024	0.024	1.00	U	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Barium	0.034	mg/L	0.00029	0.00090	0.0018	0.0018	1.00		10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Cadmium	<0.00030	mg/L	0.00030	0.0010	0.0020	0.0020	1.00	U	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Chromium	0.0039	mg/L	0.00060	0.0020	0.0040	0.0040	1.00	J	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Lead	0.0065	mg/L	0.0014	0.0020	0.0040	0.0040	1.00		10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Selenium	0.0040	mg/L	0.0022	0.0065	0.013	0.013	1.00	J B	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Silver	<0.00070	mg/L	0.00070	0.0020	0.0040	0.0040	1.00	U	10/9/2012 08:00	10/12/12 15:25	NAH	EPA 6010C ^
TCLP Mercury	<0.000030	mg/L	0.000030	0.000060	0.00012	0.00012	1.00	U	10/9/2012 08:00	10/11/12 12:02	LJF	EPA 7470A
Organic Results												
TCLP 1,1-Dichloroethene	<0.024	mg/L	0.024	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP 1,2-Dichloroethane	<0.030	mg/L	0.030	0.050	0.10	0.10	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP 2-Butanone	<0.24	mg/L	0.24	0.25	0.50	0.50	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Benzene	<0.019	mg/L	0.019	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Carbon tetrachloride	<0.023	mg/L	0.023	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Chlorobenzene	<0.024	mg/L	0.024	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Chloroform	<0.015	mg/L	0.015	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^

Solid sample results reported on a Dry Weight Basis

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SHAW E&I INC
Project Name: RVAAP MMRP
Project Phase:
Project #: 136147

Contract #: 2385
Folder #: 93596

CT LAB#: 223573 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
TCLP Tetrachloroethene	<0.030	mg/L	0.030	0.050	0.10	0.10	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Trichloroethene	<0.021	mg/L	0.021	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP Vinyl chloride	<0.018	mg/L	0.018	0.025	0.050	0.050	100.00	U	10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C ^
TCLP 1,2 Dichloroethane-d4	112	% Recovery	70			120	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP Bromofluorobenzene	107	% Recovery	75			120	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP d8-Toluene	106	% Recovery	85			120	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP Dibromofluoromethane	113	% Recovery	85			115	1.00		10/12/2012 14:20	10/15/12 23:05	RLD	EPA 8260C
TCLP 1,4-Dichlorobenzene	<0.0019	mg/L	0.0019	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2,4,5-Trichlorophenol	<0.011	mg/L	0.011	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2,4,6-Trichlorophenol	<0.010	mg/L	0.010	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2,4-Dinitrotoluene	<0.0021	mg/L	0.0021	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 2-Methylphenol	<0.0086	mg/L	0.0086	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP 3 & 4-Methylphenol	<0.014	mg/L	0.014	0.36	0.90	0.90	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Hexachlorobenzene	<0.0027	mg/L	0.0027	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Hexachlorobutadiene	<0.0018	mg/L	0.0018	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Hexachloroethane	<0.0022	mg/L	0.0022	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Nitrobenzene	<0.0016	mg/L	0.0016	0.0040	0.010	0.010	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Pentachlorophenol	<0.011	mg/L	0.011	0.020	0.050	0.050	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Pyridine	<0.0062	mg/L	0.0062	0.010	0.030	0.030	1.00	U	10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C ^
TCLP Surr: 2,4,6-Tribromophenol	87	% Recovery	40			125	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: 2-Fluorobiphenyl	82	% Recovery	50			110	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: 2-Fluorophenol	52	% Recovery	20			110	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: Nitrobenzene-d5	83	% Recovery	40			110	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: Phenol-d5	36	% Recovery	10			115	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C
TCLP Surr: Terphenyl-d14	84	% Recovery	50			135	1.00		10/9/2012 08:00	10/12/12 15:53	RPN	EPA 8270C

Solid sample results reported on a Dry Weight Basis

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SHAW E&I INC
Project Name: RVAAP MMRP
Project Phase:
Project #: 136147

Contract #: 2385
Folder #: 93596

CT LAB#: 223575 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
Inorganic Results												
Solids, Percent	90.9	%					1.00			10/5/12 13:15	BMS	EPA 8000C
pH	9.05	S.U.					1.00			10/9/12 14:00	CER	EPA 9045D ^
Flashpoint	>140	Deg. F					1.00			10/10/12 15:30	EJC	EPA 1010 ^
Cyanide, Reactive	<22	mg/kg	22			22	1.00	U		10/12/12 09:00	EJC	ASTM D5049 ^
Sulfide Reactive	<110	mg/kg	110			110	1.00	U		10/8/12 16:00	EJC	ASTM D4978 ^
Organic Results												
Aroclor-1016	<11	ug/kg	11	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1221	<22	ug/kg	22	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1232	<30	ug/kg	30	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1242	<32	ug/kg	32	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1248	<32	ug/kg	32	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1254	<25	ug/kg	25	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Aroclor-1260	<13	ug/kg	13	33	110	110	1.00	U	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A ^
Surr: DCBP	26	% Recovery	60			125	1.00	S	10/11/2012 15:00	10/12/12 16:32	JJY	EPA 8082A
1,3,5-Trinitrobenzene	<0.25	mg/kg	0.25	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
1,3-Dinitrobenzene	<0.16	mg/kg	0.16	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2,4,6-Trinitrotoluene	<0.18	mg/kg	0.18	0.39	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2,4-Dinitrotoluene	<0.16	mg/kg	0.16	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2,6-Dinitrotoluene	<0.14	mg/kg	0.14	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2-Amino-4,6-dinitrotoluene	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
2-Nitrotoluene	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
3,5-Dinitroaniline	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
3-Nitrotoluene	<0.22	mg/kg	0.22	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
4-Amino-2,6-dinitrotoluene	<0.16	mg/kg	0.16	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
4-Nitrotoluene	<0.20	mg/kg	0.20	0.39	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B

Solid sample results reported on a Dry Weight Basis

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SHAW E&I INC
Project Name: RVAAP MMRP
Project Phase:
Project #: 136147

Contract #: 2385
Folder #: 93596

CT LAB#: 223575 Sample Description: IDW-WC-0001 Client Sample #: Sampled: 10/2/2012 1200

Analyte	Result	Units	DL	DOD LOD	DOD LOQ	RL	DF	Qualifier	Prep Date/Time	Analysis Date/Time	Analyst	Method
HMX	<0.24	mg/kg	0.24	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
Nitrobenzene	<0.20	mg/kg	0.20	0.39	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
Nitroglycerin	<0.98	mg/kg	0.98	2.4	3.9	3.9	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
PETN	<1.2	mg/kg	1.2	2.4	3.9	3.9	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
RDX	<0.27	mg/kg	0.27	0.59	0.98	0.98	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
Tetryl	<0.18	mg/kg	0.18	0.39	0.59	0.59	1.00	U	10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B
1,2-Dinitrobenzene	99	% Recovery	74			128	1.00		10/11/2012 15:00	10/12/12 18:16	RED	EPA 8330B

Solid sample results reported on a Dry Weight Basis

Notes:
^ Indicates the laboratory is NELAP accredited for this analyte by the indicated matrix and method. DL (detection limit), LOD (limit of detection), loq

(limit of quantitation) as defined by most recent DOD QSM version.
All samples were received intact and properly preserved unless otherwise noted. The results reported relate only to the samples tested. This report shall not be reproduced, except in full, without written approval of this laboratory. The Chain of Custody is attached.

Submitted by: Eric T. Korthals
Project Manager
608-356-2760

This report has been specifically prepared to satisfy project or program requirements. These results are in compliance with NELAC requirements for the parameters where accreditation is required or available, unless noted in the case narrative.

QC Qualifiers

Code	Description
B	Analyte detected in the associated Method Blank.
C	Toxicity present in BOD sample.
D	Diluted Out.
E	Safe, No Total Coliform detected.
F	Unsafe, Total Coliform detected, no E. Coli detected.
G	Unsafe, Total Coliform detected and E. Coli detected.
H	Holding time exceeded.
J	Estimated value.
L	Significant peaks were detected outside the chromatographic window.
M	Matrix spike and/or Matrix Spike Duplicate recovery outside acceptance limits.
N	Insufficient BOD oxygen depletion.
O	Complete BOD oxygen depletion.
P	Concentration of analyte differs more than 40% between primary and confirmation analysis.
Q	Laboratory Control Sample outside acceptance limits.
R	See Narrative at end of report.
S	Surrogate standard recovery outside acceptance limits due to apparent matrix effects.
T	Sample received with improper preservation or temperature.
U	Analyte concentration was below detection limit.
V	Raised Quantitation or Reporting Limit due to limited sample amount or dilution for matrix background interference.
W	Sample amount received was below program minimum.
X	Analyte exceeded calibration range.
Y	Replicate/Duplicate precision outside acceptance limits.
Z	Specified calibration criteria was not met.

Current CT Laboratories Certifications

Illinois NELAP ID# 002413
Kansas NELAP ID# E-10368
Kentucky ID# 0023
Pennsylvania NELAP ID# 68-04201
New Jersey NELAP ID# WI001
North Carolina ID# 674
Wisconsin (WDNR) Chemistry ID# 157066030
Wisconsin (DATCP) Bacteriology ID# 105-289
DoD-ELAP A2LA Cert # 3317.013
Alaska ID # UST-099
Louisiana ID # 115843
Virginia ID# 460203
ISO/IEC 17025-2005 A2LA Cert # 3317.01
GA EPD Stipulation ID 115843, Exp 6-30-13

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QC SUMMARY REPORT

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88561	Analysis Date:	10/08/2012	Prep Batch #:		Matrix:	SOLID
CTLab #:	226712	Analysis Time:	16:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Sulfide Reactive	100	mg/kg			100	100	70 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88561	Analysis Date:	10/08/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	226713	Analysis Time:	16:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Sulfide Reactive	2.00	mg/L			2.00	100	70 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88561	Analysis Date:	10/08/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	226716	Analysis Time:	16:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Sulfide Reactive	2	mg/L		U	0		2		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:		Matrix:	SOLID
CTLab #:	229180	Analysis Time:	09:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	20.0	mg/kg			20.0	100	70 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229181	Analysis Time:	09:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	10.0				10.0	100	70 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Soil

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:		Matrix:	SOLID
CTLab #:	229182	Analysis Time:	09:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	20	mg/kg		U	0.00			8	

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88690	Analysis Date:	10/12/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229183	Analysis Time:	09:00	Prep Date/Time:		Method:	
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Cyanide, Reactive	10			U	0			4	

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88649	Analysis Date:	10/10/2012	Prep Batch #:		Matrix:	SOLID
CTLab #:	226783	Analysis Time:	15:30	Prep Date/Time:		Method:	SW1010
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Flashpoint	78.7	Deg. F			79.8	99	90 --- 110		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88649	Analysis Date:	10/10/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	226784	Analysis Time:	15:30	Prep Date/Time:		Method:	SW1010
Parent Sample #:		Analyst:	EJC	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Flashpoint	78.7	Deg. F			79.8	99	90 --- 110		

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Date Printed: 11/28/2012

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Duplicate

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	TCLP
CTLab #:	225708	Analysis Time:	12:06	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:	223573	Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.0000300	mg/L	BDL	U			0.12	0	20

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	LIQUID
CTLab #:	225707	Analysis Time:	13:36	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:		Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00287	mg/L			0.00300	96	80 --- 120		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	LIQUID
CTLab #:	225706	Analysis Time:	12:00	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:		Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00003	mg/L		U	0		00006		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Matrix Spike Duplicate Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	TCLP
CTLab #:	225710	Analysis Time:	12:10	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:	225709	Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00164	mg/L	BDL		0.00200	82	80 --- 120	6	20

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Matrix Spike Water

Analytical Run #:	88634	Analysis Date:	10/11/2012	Prep Batch #:	42371	Matrix:	TCLP
CTLab #:	225709	Analysis Time:	12:08	Prep Date/Time:	10/10/2012 09:30	Method:	SW7470
Parent Sample #:	223573	Analyst:	LJF	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Mercury	0.00155	mg/L	BDL		0.00200	78	80 --- 120		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Duplicate

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	TCLP
CTLab #:	226815	Analysis Time:	15:32	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:	223573	Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.00400	mg/L	BDL	U			24	0	20
Barium	0.0360	mg/L	34.4				1.80	5	20
Cadmium	0.000300	mg/L	BDL	U			2.0	0	20
Chromium	0.00368	mg/L	3.86				4.0	5	20
Lead	0.00667	mg/L	6.53				4.0	2	20
Selenium	0.00220	mg/L	3.96	U			13.0	200	20
Silver	0.000700	mg/L	BDL	U			4.0	0	20

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	LIQUID
CTLab #:	226813	Analysis Time:	15:18	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:		Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.808	mg/L			0.800	101	80 --- 120		
Barium	0.862	mg/L			0.800	108	80 --- 120		
Cadmium	0.0211	mg/L			0.0200	106	80 --- 120		
Chromium	0.0793	mg/L			0.0800	99	80 --- 120		
Lead	0.199	mg/L			0.200	100	80 --- 120		
Selenium	0.805	mg/L			0.800	101	80 --- 120		
Silver	0.0209	mg/L			0.0200	104	80 --- 120		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	LIQUID
CTLab #:	226812	Analysis Time:	15:21	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:		Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.004	mg/L		U	0		0.012		
Barium	0.00029	mg/L		U	0		00090		
Cadmium	0.0003	mg/L		U	0		.0010		
Chromium	0.0006	mg/L		U	0		.0020		
Lead	0.0014	mg/L		U	0		.0020		
Selenium	0.00404	mg/L			0		.0065		
Silver	0.000967	mg/L			0		.0020		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Matrix Spike Duplicate Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	TCLP
CTLab #:	226817	Analysis Time:	15:38	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:	226816	Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.783	mg/L	BDL		0.800	98	80 --- 120	2	20
Barium	0.883	mg/L	0.034		0.800	106	80 --- 120	2	20
Cadmium	0.0173	mg/L	BDL		0.0200	86	80 --- 120	2	20
Chromium	0.0716	mg/L	0.0039		0.0800	85	80 --- 120	2	20
Lead	0.180	mg/L	0.0065		0.200	87	80 --- 120	1	20
Selenium	0.797	mg/L	0.0040		0.800	99	80 --- 120	1	20
Silver	0.0183	mg/L	BDL		0.0200	92	80 --- 120	5	20

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Matrix Spike Water

Analytical Run #:	88688	Analysis Date:	10/12/2012	Prep Batch #:	42396	Matrix:	TCLP
CTLab #:	226816	Analysis Time:	15:35	Prep Date/Time:	10/11/2012	Method:	SW6010
Parent Sample #:	223573	Analyst:	NAH	Prep Analyst:	LJF		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Arsenic	0.797	mg/L	BDL		0.800	100	80 --- 120		
Barium	0.905	mg/L	0.034		0.800	109	80 --- 120		
Cadmium	0.0176	mg/L	BDL		0.0200	88	80 --- 120		
Chromium	0.0731	mg/L	0.0039		0.0800	86	80 --- 120		
Lead	0.182	mg/L	0.0065		0.200	88	80 --- 120		
Selenium	0.804	mg/L	0.0040		0.800	100	80 --- 120		
Silver	0.0193	mg/L	BDL		0.0200	96	80 --- 120		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88668	Analysis Date:	10/12/2012	Prep Batch #:	42382	Matrix:	LIQUID
CTLab #:	226133	Analysis Time:	15:32	Prep Date/Time:	10/10/2012 08:30	Method:	SW8270
Parent Sample #:		Analyst:	RPN	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,4-Dichlorobenzene	0.0143	mg/L			0.0200	72	30 --- 100		30
2,4,5-Trichlorophenol	0.0175	mg/L			0.0200	88	50 --- 110		30
2,4,6-Trichlorophenol	0.0162	mg/L			0.0200	81	50 --- 115		30
2,4-Dinitrotoluene	0.0158	mg/L			0.0200	79	50 --- 120		30
2-Methylphenol	0.0146	mg/L			0.0200	73	40 --- 110		30
3 & 4-Methylphenol	0.0271	mg/L			0.0400	68	30 --- 110		30
Hexachlorobenzene	0.0101	mg/L			0.0200	50	50 --- 110		30
Hexachlorobutadiene	0.0134	mg/L			0.0200	67	25 --- 105		30
Hexachloroethane	0.0129	mg/L			0.0200	64	30 --- 95		30
Nitrobenzene	0.0165	mg/L			0.0200	82	45 --- 110		30
Pentachlorophenol	0.0178	mg/L			0.0200	89	40 --- 115		30
Pyridine	0.00109	mg/L			0.0200	5	1 --- 78		30

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88668	Analysis Date:	10/18/2012	Prep Batch #:	42382	Matrix:	LIQUID
CTLab #:	226132	Analysis Time:	10:35	Prep Date/Time:	10/10/2012 08:30	Method:	SW8270
Parent Sample #:		Analyst:	RPN	Prep Analyst:	JLH		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,4-Dichlorobenzene	0.00019	mg/L		U	0		.0005		
2,4,5-Trichlorophenol	0.0011	mg/L		U	0		.0025		
2,4,6-Trichlorophenol	0.0010	mg/L		U	0		.0025		
2,4-Dinitrotoluene	0.00021	mg/L		U	0		.0005		
2-Methylphenol	0.00086	mg/L		U	0		.0025		
3 & 4-Methylphenol	0.0014	mg/L		U	0		.0045		
Hexachlorobenzene	0.00027	mg/L		U	0		.0005		
Hexachlorobutadiene	0.00018	mg/L		U	0		.0005		
Hexachloroethane	0.00022	mg/L		U	0		.0005		
Nitrobenzene	0.00016	mg/L		U	0		.0005		
Pentachlorophenol	0.0011	mg/L		U	0		.0025		
Pyridine	0.00062	mg/L		U	0		.0015		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88694	Analysis Date:	10/12/2012	Prep Batch #:	42357	Matrix:	SOLID
CTLab #:	225361	Analysis Time:	17:58	Prep Date/Time:	10/11/2012 15:00	Method:	SW8330B
Parent Sample #:		Analyst:	RED	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,3,5-Trinitrobenzene	1.91	mg/kg			2.00	96	70 --- 126		
1,3-Dinitrobenzene	1.92	mg/kg			2.00	96	74 --- 120		
2,4,6-Trinitrotoluene	1.90	mg/kg			2.00	95	63 --- 128		
2,4-Dinitrotoluene	1.99	mg/kg			2.00	100	69 --- 128		
2,6-Dinitrotoluene	1.98	mg/kg			2.00	99	68 --- 125		
2-Amino-4,6-dinitrotoluene	2.02	mg/kg			2.00	101	73 --- 123		
2-Nitrotoluene	1.94	mg/kg			2.00	97	75 --- 119		
3,5-Dinitroaniline	2.20	mg/kg			2.00	110	54 --- 124		
3-Nitrotoluene	2.09	mg/kg			2.00	104	77 --- 121		
4-Amino-2,6-dinitrotoluene	1.98	mg/kg			2.00	99	66 --- 127		
4-Nitrotoluene	2.02	mg/kg			2.00	101	74 --- 122		
HMX	1.96	mg/kg			2.00	98	66 --- 129		
Nitrobenzene	1.81	mg/kg			2.00	90	72 --- 126		
Nitroglycerin	7.75	mg/kg			8.00	97	66 --- 130		
PETN	7.28	mg/kg			8.00	91	65 --- 134		
RDX	1.93	mg/kg			2.00	96	72 --- 123		
Tetryl	1.92	mg/kg			2.00	96	2 --- 130		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Soil

Analytical Run #:	88694	Analysis Date:	10/12/2012	Prep Batch #:	42357	Matrix:	SOLID
CTLab #:	225360	Analysis Time:	17:39	Prep Date/Time:	10/11/2012 15:00	Method:	SW8330B
Parent Sample #:		Analyst:	RED	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,3,5-Trinitrobenzene	0.13	mg/kg		U			0.25		
1,3-Dinitrobenzene	0.08	mg/kg		U			0.15		
2,4,6-Trinitrotoluene	0.09	mg/kg		U			0.25		
2,4-Dinitrotoluene	0.08	mg/kg		U			0.15		
2,6-Dinitrotoluene	0.07	mg/kg		U			0.15		
2-Amino-4,6-dinitrotoluene	0.09	mg/kg		U			0.15		
2-Nitrotoluene	0.09	mg/kg		U			0.15		
3,5-Dinitroaniline	0.09	mg/kg		U			0.15		
3-Nitrotoluene	0.11	mg/kg		U			0.25		
4-Amino-2,6-dinitrotoluene	0.08	mg/kg		U			0.15		
4-Nitrotoluene	0.10	mg/kg		U			0.25		
HMX	0.12	mg/kg		U			0.25		
Nitrobenzene	0.10	mg/kg		U			0.25		
Nitroglycerin	0.5	mg/kg		U			1.0		
PETN	0.6	mg/kg		U			1.0		
RDX	0.14	mg/kg		U			0.25		
Tetryl	0.09	mg/kg		U			0.15		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Soil

Analytical Run #:	88712	Analysis Date:	10/12/2012	Prep Batch #:	42358	Matrix:	SOLID
CTLab #:	225365	Analysis Time:	15:52	Prep Date/Time:	10/11/2012 15:00	Method:	SW8082
Parent Sample #:		Analyst:	JJY	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Aroclor-1016	474	ug/kg			500	95	40 --- 140		30
Aroclor-1260	517	ug/kg			500	103	60 --- 130		30

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Soil

Analytical Run #:	88712	Analysis Date:	10/12/2012	Prep Batch #:	42358	Matrix:	SOLID
CTLab #:	225364	Analysis Time:	15:33	Prep Date/Time:	10/11/2012 15:00	Method:	SW8082
Parent Sample #:		Analyst:	JJY	Prep Analyst:	RED		

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
Aroclor-1016	10	ug/kg		U	0		50		
Aroclor-1221	20	ug/kg		U	0		50		
Aroclor-1232	27	ug/kg		U	0		50		
Aroclor-1242	29	ug/kg		U	0		50		
Aroclor-1248	29	ug/kg		U	0		50		
Aroclor-1254	23	ug/kg		U	0		50		
Aroclor-1260	12	ug/kg		U	0		50		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Lab Control Spike Water

Analytical Run #:	88733	Analysis Date:	10/15/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229719	Analysis Time:	21:38	Prep Date/Time:		Method:	SW8260C
Parent Sample #:		Analyst:	RLD	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,1-Dichloroethene	1.09	mg/L			1.00	109	70 --- 130		
1,2-Dichloroethane	1.12	mg/L			1.00	112	70 --- 130		
2-Butanone	10.1	mg/L			10.0	101	30 --- 150		
Benzene	1.07	mg/L			1.00	107	80 --- 120		
Carbon tetrachloride	1.11	mg/L			1.00	111	65 --- 140		
Chlorobenzene	1.07	mg/L			1.00	107	80 --- 120		
Chloroform	1.14	mg/L			1.00	114	65 --- 135		
Tetrachloroethene	0.955	mg/L			1.00	96	45 --- 150		
Trichloroethene	1.09	mg/L			1.00	109	70 --- 125		
Vinyl chloride	1.32	mg/L			1.00	132	50 --- 145		

SHAW E&I INC **Project Name: RVAAP MMRP**

SDG #: 0 **Folder #: 93596** **Project Number: 136147**

Method Blank Water

Analytical Run #:	88733	Analysis Date:	10/15/2012	Prep Batch #:		Matrix:	LIQUID
CTLab #:	229721	Analysis Time:	22:07	Prep Date/Time:		Method:	SW8260C
Parent Sample #:		Analyst:	RLD	Prep Analyst:			

Analyte	QC sample result	Units	Parent sample result	Qualifier(s)	Spike Amount Added	% Recovery	Control Limits	RPD	RPD Limit
1,1-Dichloroethene	0.00024	mg/L		U	0		00025		
1,2-Dichloroethane	0.0003	mg/L		U	0		.0005		
2-Butanone	0.0024	mg/L		U	0		.0025		
Benzene	0.00019	mg/L		U	0		00025		
Carbon tetrachloride	0.00023	mg/L		U	0		00025		
Chlorobenzene	0.00024	mg/L		U	0		00025		
Chloroform	0.00015	mg/L		U	0		00025		
Tetrachloroethene	0.0003	mg/L		U	0		.0005		
Trichloroethene	0.00021	mg/L		U	0		00025		
Vinyl chloride	0.00018	mg/L		U	0		00025		

CT LABORATORIES
delivering more than data from your environmental analyses

Sample Condition Report

Folder #: 93596
Client: SHAW E&I INC

Print Date / Time: 10/03/2012 15:35
Received Date / Time / By: 10/03/2012 1259 JLS

Project Name: RVAAP MMRP
Project Phase: IDW

Log-In Date / Time / By: 10/03/2012 1259 JLS
Project #: 136147 PM: ETK

Coolers: 3637
Custody Seals Present : **Y**

Temperature: 2.0 C On Ice: **Y**
COC Present:? **Y** Complete? **Y**

Seal Intact? **Y**
Ship Method: UPS
Adequate Packaging: **Y**

Numbers: SIGNED-DATED
Tracking Number: 1Z6028W22210000350
Temp Blank Enclosed?

Notes: samples received intact and in good condition

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
223573 IDW-WC-0001	AMBER GL	1	/	8270
	Total # of Containers of Type (*AMBER GL*) = 1			

Sample ID / Description	Container Type	Cond. Code	pH OK?/Filtered?	Tests
223575 IDW-WC-0001	UNPRES GL	1	/	EXPL,PCB
	Total # of Containers of Type (*UNPRES GL*) = 1			

Condition Code	*Condition Description*
1	Sample Received OK

93596

Rev. 9/2009

CHAIN OF CUSTODY

Page 1 of 1

Company: Shaw E&I
Project Contact: David Crispo
Telephone: 617 589-8146
Project Name: RVAAP MMRP
Project #: 136147
Location: BLDG 1036
Sampled By: D. CRISPO

CT LABORATORIES

Folder #: 93596
Company: SHAW E&I INC
Project: RVAAP MMRP
Logged By: JLS PM: ET

1230 Lange Court, Baraboo, WI 53913
608-356-2760 Fax 608-356-2766
www.ctlaboratories.com

Program:
QSM RCRA SDWA NPDES
Solid Waste Other MMRP

PO #

Report To: David Crispo
EMAIL: david.crispo@shawgrp.com
Company: Shaw E&I
Address: 150 Royall Street Canton, MA 02021

Invoice To:*
EMAIL:
Company:
Address:

*Party listed is responsible for payment of invoice as per CT Laboratories' terms and conditions

Client Special Instructions
Explosives analysis includes full list

Matrix:
GW - groundwater SW - surface water WW - wastewater DW - drinking water
S - soil/sediment SL - sludge A - air M - misc/waste

Turnaround Time
Normal RUSH*
Date Needed:

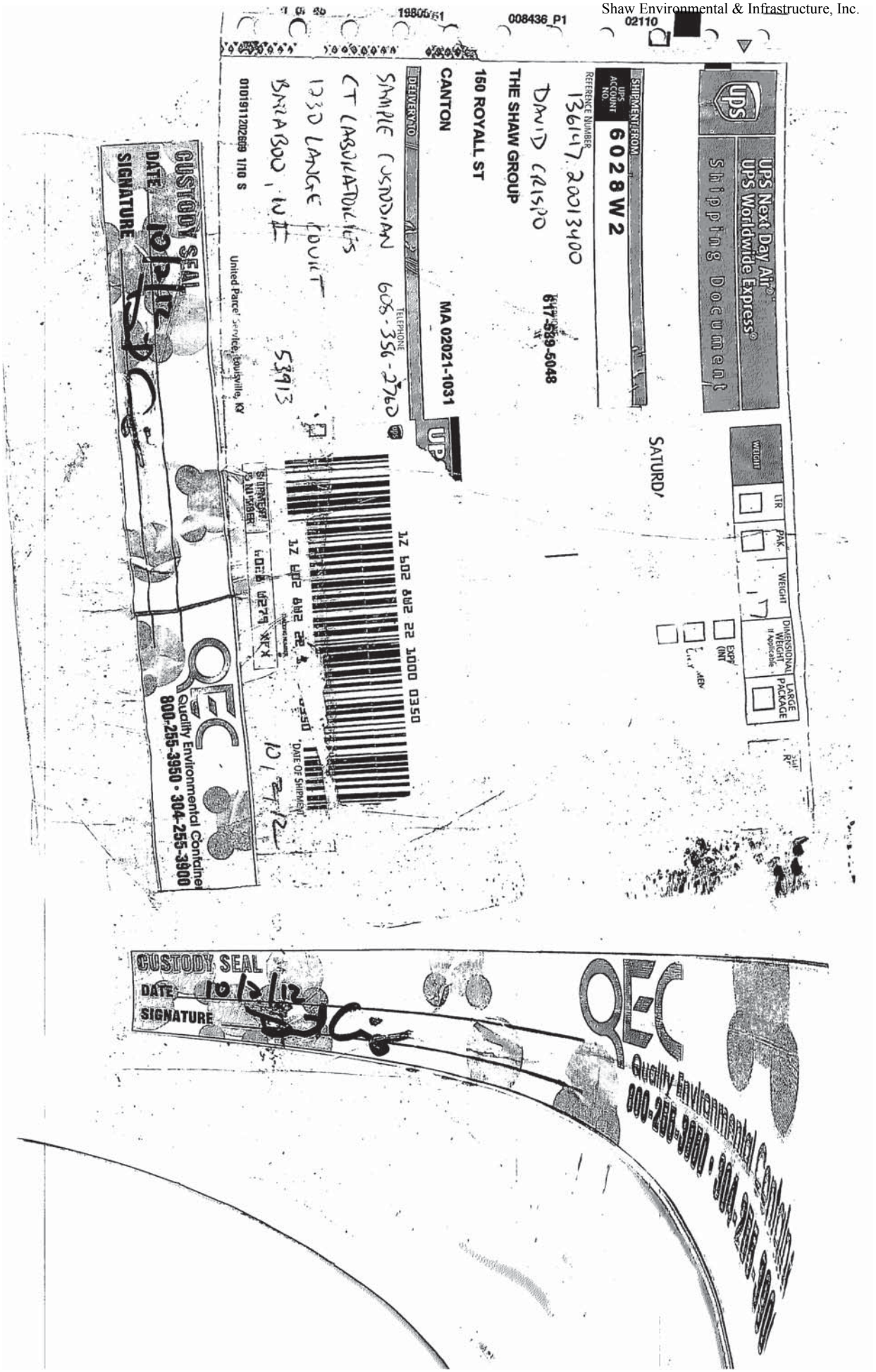
Rush analysis requires prior CT Laboratories' approval
Surcharges:
24 hr 200%
2-3 days 100%
4-9 days 50%

Collection Date	Collection Time	Matrix	Grab/ Comp	Sample ID Description	Filtered? Y/N	ANALYSES REQUESTED: TCLP METALS	TCLP SVOCs	EXPLOSIVES*	PCBs	RCRA Characteristic	VOCs TCLP 10-3-12	Total # Containers	Designated MS/MSD	CT Lab ID # (Lab use only)
						Fill in Spaces with Bottles per Test								
10/2/12	1100	W	C	IDW-WC-0001	—	X	X	X	X	X	X	2	—	~~223573/575~~ 223573/575

Relinquished By: [signature]
Date/Time 10/2/12 / 1500
Received By: UPS
Date/Time 10/2/12 / 1500

Received By:
Date/Time
Received for Laboratory by: [signature]
Date/Time 10/3/12 1257

Lab Use Only
Ice Present Yes No
Temperature 2.0
Cooler # 3637


UPS Next Day Air®
UPS Worldwide Express®
Shipping Document
SATURDAY
SHIPMENT FROM
6028 W 2
DAVID CRISP
817-589-5048
THE SHAW GROUP
150 ROYALL ST
CANTON
MA 02021-1031
DELIVERY TO
SAMPLE SHIPMENT
CT LABORATORIES
1230 LANGE COURT
BARABOO, WI
53913
608-356-2760
1Z 602 8W2 22 1000 0350
United Parcel Service, Louisville, KY
CUSTODY SEAL
DATE 10/12/12
SIGNATURE
QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900

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Attachment 2
IDW Waste Profile

1
2

VEXOR Technology, Inc.
955 West Smith Road
Medina, Ohio 44256
Phone: 330-721-9773
FAX: 330-721-9438
EPA ID# OHD 077772895

Shaw Environmental & Infrastructure, Inc.

MATERIAL CHARACTERIZATION

www.vexortechnology.com

Approval # _____
Sample # _____
Sales Rep _____
Date Submitted _____

Generator RAVENNA ARMY AMMO PLT.
Site Address 8451 S.R. 5
City RAVENNA State OH ZIP 44266
Phone 330 358 3005 Fax _____
EPA ID# OH5210020736 SIC Code _____
Technical Contact DAVID CRISPO
Title CONSULT e-mail david.crispo@shawgrp.com

Bill To Name EMERALD ENVIRONMENTAL
Site Address 1671 ST. CLAIR AVE
City KENT State OH ZIP 44240
Phone 330 677 0785 Fax 330 677 1567
Business Contact CHRIS ARCHACKI
Title _____ e-mail carchacki@emerald-environmental.com

MATERIAL DESCRIPTION

Name and Description of Material: PPE, SPENT ABSORBENT PADS
Process Generating Material: SAMPLING ACTIVITIES U.S. EPA Hazardous Waste: ___Yes X No
Proper DOT shipping name: NON DOT REGULATED MATERIAL
Method of Shipment: ☐ Bulk ☒ Drum ☐ Tote ☐ Cubic Yd Box ☐ Other/Explain: _____
Estimated Annual Volume: 1 Cubic Yards _____ Tons _____ Gallons _____ Drums X Container material (metal, plastic, etc.)
Frequency: ☒ One Time Only ☐ Daily ☐ Weekly ☐ Monthly ☐ Yearly ☐ Other- explain _____ Approx drum weight
Special Handling Instructions: NONE
Preferred Disposal Method: ☒ Landfill ☐ Waste to Energy ☐ Recycling ☐ VEF ☐ Other _____

MATERIAL PROPERTIES AT 78°F

a) Physical State: ☒ Solid ☐ Semi-solid ☐ Powder ☐ Liquid ☐ Phases
b) Reactivity: ☐ Water reactive ☐ Acid Reactive ☐ Alkaline Reactive ☐ Oxidizer ☐ Autosetting ☒ none
c) Flash Point, °F: ☐ ≤ 72 ☐ >72-100 ☐ >100-140 ☐ >140-200 ☐ >200 ☒ NA
d) S. G./Density _____ e) pH: ☐ ≤ 2 ☐ >2 – 6 ☐ >6 – 9 ☐ >9 – <12.5 ☐ ≥12.5 ☒ NA
f) Odor: ☒ None ☐ Mild ☐ Strong : Describe: _____ g) Color _____
h) Total Organic Halogen (TOX) ☒ 0 ppm ☐ >1000 ppm* If this material is considered a "USED OIL" and is to be managed as a USED OIL, please complete the "USED OIL" ADDENDUM and attach to this profile.
i) PCB Content: ☒ 0 ppm ☐ 1-49 ppm* ☐ equal to or > 50 ppm *Supporting analysis and documentation required.

MATERIAL COMPOSITION: List all components, add up to 100%.

Constituent	Range % (wt-vol)	
	Min	Max
PPE: TYVEKS, GLOVES, ETC.	25	75
ABSORBENT PADS	25	75
A combined total should equal 100%		

Above is based on: Generator Knowledge ☒ Analytical Data ☒ MSDS ☐
Please attach analysis, TCLP information and appropriate MSDS sheets.
SAMPLE SUBMITTED WITH THIS PROFILE: Yes ___ No X

CHEMICAL COMPOSITION: NA

Constituent	Range %	
	Min	Max
Sulfur		
Chlorine		
Bromine		
Fluorine		
Nitrogen		
Oxygen		
Carbon		
Ash		
Btu's		
Biomass		

Metals (other than RCRA)

Metal	ppm	Metal	ppm	Metal	ppm	Metal	ppm
Thallium	0	Antimony	0	Beryllium	0	Cobalt	0
Copper		Nickel		Vanadium		Tin	
Zinc		Iron		Manganese		Magnesium	
Molybdenum		Palladium					

MATERIAL CHARACTERIZATION

Approval # _____

*SAMPLED LIQUID ABSORBED IN PADS

RCRA CONTAMINANTS: ☒TCLP ☐TOTAL ☐NONE IN THIS SECTION

EPA #	NAME		REGULATORY LEVEL	ACTUAL	EPA#	NAME		REGULATORY LEVEL	ACTUAL
D004	Arsenic	☐	>5.0		D024	m-Cresol	☐	>200.0	
D005	Barium	☐	>100.0	.034 mg/L	D025	p-Cresol	☐	>200.0	
D006	Cadmium	☐	>1.0		D026	Cresol (total)	☐	>200.0	
D007	Chromium	☐	>5.0	.0039 mg/L	D027	1,4-Dichlorobenzene	☐	>7.5	
D008	Lead	☐	>5.0	.0065 mg/L	D028	1,2-Dichlorethane	☐	>0.5	
D009	Mercury	☐	>0.2		D029	1,2-Dichlorethylene	☐	>.13	
D010	Selenium	☐	>1.0	.0040 mg/L	D030	2,4-Dinitrotoluene	☐	>0.008	
D011	Silver	☐	>5.0		D031	Heptachlor	☐	>0.13	
D012	Endrin	☐	>0.02		D032	Hexachlorobenzene	☐	>0.5	
D013	Lindane	☐	>0.4		D033	Hexachloro-1,3-butadiene	☐	>0.5	
D014	Methoxychlor	☐	>10.0		D034	Hexachloroethane	☐	>3.0	
D015	Toxaphene	☐	>0.05		D035	Methyl Ethyl Ketone	☐	>200.0	
D016	2,4-D	☐	>10.0		D036	Nitrobenzene	☐	>2.0	
D017	2,4,5-TP (Silvex)	☐	>1.0		D037	Petachlorophenol	☐	>100.0	
D018	Benzene	☐	>0.5		D038	Pyridine	☐	>100.0	
D019	Carbon Tetrchloride	☐	>0.5		D039	Tetrchloroethylene	☐	>0.7	
D020	Chlordane	☐	>0.03		D040	Trichloroethylene	☐	>0.5	
D021	Chlorobenzene	☐	>100.0		D041	2,4,5-Trichlorophenol	☐	>400.0	
D022	Chloroform	☐	>6.0		D042	2,4,6-Trichlorophenol	☐	>2.0	
D023	o-Cresol	☐	>200.0		D043	Vinyl Chloride	☐	>0.2	

GENERATOR CERTIFICATION

I hereby certify that to the best of my knowledge and belief, the information contained herein is a true and accurate description of the material being offered for disposal.
Samples of this material submitted to VEXOR are representative of the material described in this profile. I further certify that by utilizing this profile, neither I nor any other employee of the company will deliver for treatment, processing or recycling or attempt to deliver for same any material that is classified as a hazardous waste, medical or infectious waste or any other material that this facility is prohibited from accepting by law.

Authorized Representative Name (Printed) Mark Patterson Company Ravenna AAP

Authorized Representative Signature: Mark Patterson

Title: Facility Manager Date: 11/8/12

For VEXOR Use Only

Reviewed by: _____ Date: _____ Second review: _____ Date:

Approved for treatment (please check and initial) _____ Special Handling (if yes, make process directions in notes): _____

Treatment	Solidification/Landfill	Waste to Energy	VEF	Water	Used oil	Recycling	Other (please note processing)
Check all that apply							

Rejected – reason: _____

Price: _____ per unit: _____ CS initial_____ Price approved by: _____ Date: _____

Notes: _____

Attachment 3
IDW Waste Manifest

1

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
OH5 210 020 736	1	330-677-0785	112812-01

GENERATOR

5. Generator's Name and Mailing Address
Ravenna Army Ammunition Plant
8451 State Route 5
Ravenna, Ohio 44266
Generator's Phone: 330-358-2920

Generator's Site Address (if different than mailing address)
Same

6. Transporter 1 Company Name: Emerald Environmental Services, Inc
U.S. EPA ID Number: OHR 000 102 053

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Vexor Technology
955 West Smith Road
Medina, Ohio 44256
Facility's Phone: 330-721-9773
U.S. EPA ID Number: OHD 077 772 895

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	
1.	Non DOT Regulated, Non Hazardous Material (PPE & Absorbents)	01	DM	20	P	
2.						
3.						
4.						

13. Special Handling Instructions and Additional Information
9-1.) Approval # VEX24393
Job Number 12-12018 for Shaw Environmental

14. **GENERATOR'S CERTIFICATION:** I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.
Generator's/Offeror's Printed/Typed Name: Mark C. Patterson
Signature: Mark C. Patterson
Month 11 Day 28 Year 12

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Paul Herman
Signature: Paul Herman
Month 11 Day 28 Year 12
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

DESIGNATED FACILITY

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
17b. Alternate Facility (or Generator)
U.S. EPA ID Number:
Facility's Phone:
17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name: Daniel Kindall
Signature:
Month 11 Day 28 Year 12

169-BLC-O 5 11977 (Rev. 8/06)

TRANSPORTER #1

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Appendix E
Photograph Documentation Log

Load Line #1 MRS: Piles of concrete rubble from demolition of former CB-14 slab. Picture taken facing the south side of the MRS.

Load Line #1 MRS: Terrain and vegetation at the MRS.

Load Line #1 MRS: Visual survey being performed at the MRS.

Appendix F
Ecological Risk Assessment Tables

Soil Ecological Screening Values
Ravenna Army Ammunition Plant, Ravenna, Ohio

COPEC	Log Kow	CAS Number	Ecological Screening Values for Soil							Is the ESV Protective of Food Chain Effects?
			EPA EcoSSL 2010 [a] (mg/kg)	ORNL PRGs 1997 [b] (mg/kg)	Region 5 ESLs 2003 [c] (mg/kg)	LANL ESLs 2010 [d] (mg/kg)	Talmage et al. 1999 [e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value [g] (mg/kg)	
Explosives										
1,3,5-Trinitrobenzene	1.45	99-35-4	NA	NA	0.376	6.6	9.7	No (Log Kow < 3.0)	0.376	Yes
1,3-Dinitrobenzene	1.63	99-65-0	NA	NA	0.655	0.073	0.41	No (Log Kow < 3.0)	0.655	Yes
2,4,6-Trinitrotoluene	1.99	118-96-7	NA	NA	NA	6.4	5.6	No (Log Kow < 3.0)	6.4	Yes
2,4-Dinitrotoluene	2.18	121-14-2	NA	NA	1.28	0.52	NA	No (Log Kow < 3.0)	1.28	Yes
2,6-Dinitrotoluene	2.18	606-20-2	NA	NA	0.0328	0.37	NA	No (Log Kow < 3.0)	0.0328	Yes
Dinitrotoluene (2,4/2,6-) Mixture (ca)	2.18	25321-14-6	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	Yes
2-Amino-4,6-dinitrotoluene	1.84	35572-78-2	NA	NA	NA	2.1	80	No (Log Kow < 3.0)	2.1	Yes
2-Nitrotoluene	2.36	88-72-2	NA	NA	NA	2	NA	No (Log Kow < 3.0)	2	Yes
3-Nitrotoluene	2.36	99-08-1	NA	NA	NA	2.4	NA	No (Log Kow < 3.0)	2.4	Yes
3,5-Dinitroaniline	1.29	618-87-1	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	
4-Amino-2,6-dinitrotoluene	1.84	19406-51-0	NA	NA	NA	0.73	NA	No (Log Kow < 3.0)	0.73	Yes
4-Nitrotoluene	2.36	99-99-0	NA	NA	NA	4.4	NA	No (Log Kow < 3.0)	4.4	Yes
HMX	0.82	2691-41-0	NA	NA	NA	27	5.6	No (Log Kow < 3.0)	27	Yes
Nitrobenzene	1.81	98-95-3	NA	NA	1.31	2.2	NA	No (Log Kow < 3.0)	1.31	Yes
Nitroglycerin	1.51	55-63-0	NA	NA	NA	71	NA	No (Log Kow < 3.0)	71	Yes
Nitroguanidine	-1.72	556-88-7	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	
PETN	2.38	78-11-5	NA	NA	NA	8600	NA	No (Log Kow < 3.0)	8600	Yes
RDX	0.68	121-82-4	NA	NA	NA	7.5	15	No (Log Kow < 3.0)	7.5	Yes
Tetryl	1.64	479-45-8	NA	NA	NA	0.99	4.4	No (Log Kow < 3.0)	0.99	Yes
Metals										
Aluminum	NA	7429-90-5	Narrative	NA	NA	Narrative	NA	No (not EPA IBC)	NA	NA
Antimony	NA	7440-36-0	0.27	5	0.142	0.05	NA	No (not EPA IBC)	0.27	Yes
Arsenic	NA	7440-38-2	18	9.9	5.7	6.8		**Yes (EPA IBC)**	18	Yes
Barium	NA	7440-39-3	330	283	1.04	110	NA	No (not EPA IBC)	330	Yes
Beryllium	NA	7440-41-7	21	10	1.06	2.5		No (not EPA IBC)	21	Yes
Cadmium	NA	7440-43-9	0.36	4	0.00222	0.27	NA	**Yes (EPA IBC)**	0.36	Yes
Calcium	NA	7440-70-2	NA	NA	NA	NA	NA	No (not EPA IBC)	NA	
Cobalt	NA	7440-48-4	13	20	0.14	13		No (not EPA IBC)	13	Yes
Copper	NA	7440-50-8	28	60	5.4	15	NA	**Yes (EPA IBC)**	28	Yes
Chromium (as Cr^{3+})	NA	7440-47-3	26	0.4	0.4	2.3	NA	No (not EPA IBC)	26	Yes
Chromium (as Cr^{6+})	NA	18540-29-9	130	NA	NA	0.34	NA	**Yes (EPA IBC)**	130	Yes
Iron	NA	4739-89-6	Narrative	NA	NA	NA	NA	No (not EPA IBC)	NA	
Lead	NA	7439-92-1	11	40.5	0.0537	14	NA	**Yes (EPA IBC)**	11	Yes
Magnesium	NA	7439-95-4	NA	NA	NA	NA	NA	No (not EPA IBC)	NA	
Manganese	NA	7439-96-5	220	NA	NA	220	NA	No (not EPA IBC)	220	Yes
Mercury	NA	7439-97-6	NA	0.00051	0.1	0.013	NA	**Yes (OEPA PBT)**	0.00051	
Nickel	NA	7440-02-0	38	30	13.6	9.7	NA	**Yes (EPA IBC)**	38	Yes
Potassium										
Selenium	NA	7782-49-2	0.52	0.21	0.0276	0.52	NA	**Yes (EPA IBC)**	0.52	Yes
Silver	NA	7440-22-4	4.2	2	4.04	2.6	NA	**Yes (EPA IBC)**	4.2	Yes

Soil Ecological Screening Values
Ravenna Army Ammunition Plant, Ravenna, Ohio (continued)

COPEC	Log Kow	CAS Number	Ecological Screening Values for Soil							Is the ESV Protective of Food Chain Effects?
			EPA EcoSSL 2010 [a] (mg/kg)	ORNL PRGs 1997 [b] (mg/kg)	Region 5 ESLs 2003 [c] (mg/kg)	LANL ESLs 2010 [d] (mg/kg)	Talmage et al. 1999 [e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value [g] (mg/kg)	
Explosives										
Sodium	NA		NA	NA	NA	NA	NA	No (not EPA IBC)	Nutrient	
Strontium	NA	7440-24-6	NA	NA	NA	96	NA	No (not EPA IBC)	NA	
Thallium	NA	7440-28-0	NA	1	0.0569	0.032	NA	No (not EPA IBC)	1	Yes
Vanadium	NA	7440-62-2	7.8	2	1.59	0.025	NA	No (not EPA IBC)	7.8	Yes
Zinc	NA	7440-66-0	46	8.5	6.62	48	NA	**Yes (EPA IBC)**	46	Yes
Volatile Organic Compounds										
Chloroethane	1.58	75-00-3	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	
Semivolatile Organic Compounds										
1,2,4-Trichlorobenzene	3.93	120-82-1	NA	20	11.1	0.27	NA	**Yes (Log Kow ≥ 3.0)**	20	No
1,2-Dichlorobenzene	3.28	95-50-1	NA	NA	2.96	0.92	NA	**Yes (Log Kow ≥ 3.0)**	2.96	Yes
1,3-Dichlorobenzene	3.28	541-73-1	NA	NA	37.7	0.73	NA	**Yes (Log Kow ≥ 3.0)**	37.7	Yes
1,4-Dichlorobenzene	3.28	106-46-7	NA	20	0.546	0.88	NA	**Yes (Log Kow ≥ 3.0)**	20	No
2,4,5-Trichlorophenol	3.45	95-95-4	NA	9	14.1	NA	NA	**Yes (Log Kow ≥ 3.0)**	9	No
2,4,6-Trichlorophenol	3.45	88-06-2	NA	4	9.94	NA	NA	**Yes (Log Kow ≥ 3.0)**	4	No
2,4-Dichlorophenol	2.8	120-83-2	NA	NA	87.5	NA	NA	No (Log Kow < 3.0)	87.5	Yes
2,4-Dimethylphenol	2.61	105-67-9	NA	NA	0.01	NA	NA	No (Log Kow < 3.0)	0.01	No
2,4-Dinitrophenol	1.73	51-28-5	NA	20	0.0609	NA	NA	No (Log Kow < 3.0)	20	No
2,4-Dinitrotoluene	2.18	121-14-2	NA	NA	1.28	0.52	NA	No (Log Kow < 3.0)	1.28	No
2,6-Dinitrotoluene	2.18	606-20-2	NA	NA	0.0328	0.37	NA	No (Log Kow < 3.0)	0.0328	No
2-Chloronaphthalene	3.81	91-58-7	NA	NA	0.0122	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.0122	Yes
2-Chlorophenol	2.16	95-57-8	NA	NA	0.243	0.39	NA	No (Log Kow < 3.0)	0.243	Yes
2-Methylnaphthalene	3.72	91-57-6	NA	NA	3.24	2.5	NA	**Yes (Log Kow ≥ 3.0)**	3.24	Yes
2-Methylphenol	2.06	95-48-7	NA	NA	40.4	0.67	NA	No (Log Kow < 3.0)	40.4	Yes
2-Nitroaniline	2.02	88-74-4	NA	NA	74.1	5.4	NA	No (Log Kow < 3.0)	74.1	Yes
2-Nitrophenol	1.91	88-75-5	NA	NA	1.6	NA	NA	No (Log Kow < 3.0)	1.6	Yes
3 & 4-Methylphenol	2.06	CASID30030	NA	NA	3.49	0.69	NA	No (Log Kow < 3.0)	3.49	Yes
3,3'-Dichlorobenzidine	3.21	91-94-1	NA	NA	0.646	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.646	Yes
3-Nitroaniline	1.47	99-09-2	NA	NA	3.16	NA	NA	No (Log Kow < 3.0)	3.16	Yes
4,6-Dinitro-2-methylphenol	2.27	534-52-1	NA	NA	0.144	NA	NA	No (Log Kow < 3.0)	0.144	Yes
4-Bromophenyl-phenyl ether	4.94	101-55-3	NA	NA	NA	NA	NA	**Yes (Log Kow ≥ 3.0)**	NA	
4-Chloro-3-methylphenol	2.7	59-50-7	NA	NA	7.95	NA	NA	No (Log Kow < 3.0)	7.95	Yes
4-Chloroaniline	1.72	106-47-8	NA	NA	1.1	1	NA	No (Log Kow < 3.0)	1.1	Yes
4-Chlorophenyl-phenyl ether	4.69	7005-72-3	NA	NA	NA	NA	NA	**Yes (Log Kow ≥ 3.0)**	NA	
4-Nitroaniline	1.47	100-01-6	NA	NA	21.9	NA	NA	No (Log Kow < 3.0)	21.9	Yes
4-Nitrophenol	1.91	100-02-7	NA	7	5.12	NA	NA	No (Log Kow < 3.0)	7	No
Acenaphthene	4.15	83-32-9	29	20	682	0.25	NA	**Yes (Log Kow ≥ 3.0)**	29	Yes
Acenaphthylene	3.94	208-96-8	29	NA	682	120	NA	**Yes (Log Kow ≥ 3.0)**	29	Yes
Anthracene	4.35	120-12-7	29	NA	1480	6.8	NA	**Yes (Log Kow ≥ 3.0)**	29	Yes
Benzo(a)anthracene	5.52	56-55-3	1.1	NA	5.21	3	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Benzo(a)pyrene	6.11	50-32-8	1.1	NA	1.52	53	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes

Soil Ecological Screening Values
Ravenna Army Ammunition Plant, Ravenna, Ohio (continued)

COPEC	Log Kow	CAS Number	Ecological Screening Values for Soil							
			EPA EcoSSL 2010 [a] (mg/kg)	ORNL PRGs 1997 [b] (mg/kg)	Region 5 ESLs 2003 [c] (mg/kg)	LANL ESLs 2010 [d] (mg/kg)	Talmage et al. 1999 [e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value [g] (mg/kg)	Is the ESV Protective of Food Chain Effects?
Explosives										
Benzo(b)fluoranthene	6.11	205-99-2	1.1	NA	59.8	18	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Benzo(g,h,i)perylene	6.7	191-24-2	1.1	NA	119	24	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Benzo(k)fluoranthene	6.11	207-08-9	1.1	NA	148	62	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Benzoic acid	1.87	65-85-0	NA	NA	NA	1	NA	No (Log Kow < 3.0)	1	Yes
Benzyl alcohol	1.08	100-51-6	NA	NA	65.8	120	NA	No (Log Kow < 3.0)	65.8	Yes
Bis(2-chloroethoxy)methane	1.3	111-91-1	NA	NA	0.302	NA	NA	No (Log Kow < 3.0)	0.302	Yes
Bis(2-chloroethyl)ether	1.56	111-44-4	NA	NA	23.7	NA	NA	No (Log Kow < 3.0)	23.7	Yes
Bis(2-chloroisopropyl)ether	2.39	108-60-1	NA	NA	19.9	NA	NA	No (Log Kow < 3.0)	19.9	Yes
Bis(2-ethylhexyl)phthalate	8.39	117-81-7	NA	NA	0.925	0.02	NA	**Yes (Log Kow ≥ 3.0)**	0.925	Yes
Butylbenzylphthalate	4.84	85-68-7	NA	NA	0.239	90	NA	**Yes (Log Kow ≥ 3.0)**	0.239	Yes
Carbazole	3.23	86-74-8	NA	NA	NA	0.00008	NA	**Yes (Log Kow ≥ 3.0)**	0.00008	Yes
Chrysene	5.52	218-01-9	1.1	NA	4.73	2.4	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Di-n-butylphthalate	4.61	84-74-2	NA	200	0.15	0.011	NA	**Yes (Log Kow ≥ 3.0)**	200	No
Di-n-octylphthalate	8.54	117-84-0	NA	NA	709	1.1	NA	**Yes (Log Kow ≥ 3.0)**	709	
Dibenzo(a,h)anthracene	6.7	53-70-3	1.1	NA	18.4	12	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Dibenzofuran	3.71	132-64-9	NA	NA	NA	6.1	NA	**Yes (Log Kow ≥ 3.0)**	6.1	Yes
Diethylphthalate	2.65	84-66-2	NA	100	24.8	100	NA	No (Log Kow < 3.0)	100	No
Dimethylphthalate	1.66	131-11-3	NA	NA	734	10	NA	No (Log Kow < 3.0)	734	Yes
Fluoranthene	4.93	206-44-0	29	NA	122	10	NA	**Yes (Log Kow ≥ 3.0)**	29	Yes
Fluorene	4.02	86-73-7	29	NA	122	3.7	NA	**Yes (Log Kow ≥ 3.0)**	29	Yes
Hexachlorobenzene	5.86	118-74-1	NA	NA	0.199	0.079	NA	**Yes (Log Kow ≥ 3.0)**	0.199	Yes
Hexachlorobutadiene	4.72	87-68-3	NA	NA	0.0398	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.0398	Yes
Hexachlorocyclopentadiene	4.63	77-47-4	NA	10	0.755	NA	NA	**Yes (Log Kow ≥ 3.0)**	10	No
Hexachloroethane	4.03	67-72-1	NA	NA	0.596	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.596	Yes
Indeno(1,2,3-cd)pyrene	6.7	193-39-5	1.1	NA	109	62	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Isophorone	2.62	78-59-1	NA	NA	139	NA	NA	No (Log Kow < 3.0)	139	Yes
N-Nitroso-di-n-propylamine	1.33	621-64-7	NA	NA	0.544	NA	NA	No (Log Kow < 3.0)	0.544	Yes
N-Nitrosodiphenylamine & Diphn	3.16	86-30-6	NA	NA	0.545	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.545	Yes
Naphthalene	3.17	91-20-3	29	NA	0.0994	1	NA	**Yes (Log Kow ≥ 3.0)**	29	Yes
Nitrobenzene	1.81	98-95-3	NA	NA	1.31	2.2	NA	No (Log Kow < 3.0)	1.31	Yes
Pentachlorophenol	4.74	87-86-5	2.1	3	0.119	0.36	NA	**Yes (Log Kow ≥ 3.0)**	2.1	Yes
Phenanthrene	4.35	85-01-8	29	NA	45.7	5.5	NA	**Yes (Log Kow ≥ 3.0)**	29	Yes
Phenol	1.51	108-95-2	NA	30	120	0.79	NA	No (Log Kow < 3.0)	30	No
Pyrene	4.93	129-00-0	1.1	NA	78.5	10	NA	**Yes (Log Kow ≥ 3.0)**	1.1	Yes
Pesticides										
4,4'-DDD	5.87	72-54-8	0.021	NA	0.758	0.0063	NA	**Yes (Log Kow ≥ 3.0)**	0.021	Yes
4,4'-DDE	6	72-55-9	0.021	NA	0.596	0.11	NA	**Yes (Log Kow ≥ 3.0)**	0.021	Yes
4,4'-DDT	6.79	50-29-3	0.021	NA	0.0035	0.044	NA	**Yes (Log Kow ≥ 3.0)**	0.021	Yes
gamma Chlordane	6.26	5103-74-2	NA	NA	0.224	2.2	NA	**Yes (Log Kow ≥ 3.0)**	0.224	No
Heptachlor	5.86	76-44-8	NA	NA	0.00598	0.059	NA	**Yes (Log Kow ≥ 3.0)**	0.00598	Yes

Soil Ecological Screening Values
Ravenna Army Ammunition Plant, Ravenna, Ohio (continued)

COPEC	Log Kow	CAS Number	Ecological Screening Values for Soil							
			EPA EcoSSL 2010 [a] (mg/kg)	ORNL PRGs 1997 [b] (mg/kg)	Region 5 ESLs 2003 [c] (mg/kg)	LANL ESLs 2010 [d] (mg/kg)	Talmage et al. 1999 [e] (mg/kg)	Persistent, Bioaccumulative, and Toxic Pollutant [f]	Recommended Soil Ecological Screening Value [g] (mg/kg)	Is the ESV Protective of Food Chain Effects?
Explosives										
Lindane	4.26	58-89-9	NA	NA	0.005	0.0094	NA	**Yes (Log Kow ≥ 3.0)**	0.005	No
Methoxychlor	5.67	72-43-5	NA	NA	0.0199	5	NA	**Yes (Log Kow ≥ 3.0)**	0.0199	Yes
PCBs										
Aroclor 1016	5.69	12674-11-2	NA	0.371	0.000332	1	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1221	4.4	11104-28-2	NA	0.371	0.000332	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1232	4.4	11141-16-5	NA	0.371	0.000332	NA	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1242	6.34	53469-21-9	NA	0.371	0.000332	0.041	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1248	6.34	12672-29-6	NA	0.371	0.000332	0.0072	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1254	6.98	11097-69-1	NA	0.371	0.000332	0.041	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
Aroclor 1260	8.27	11096-82-5	NA	0.371	0.000332	0.14	NA	**Yes (Log Kow ≥ 3.0)**	0.371	No
General Chemistry										
Cyanide, Total	57-12-5	57-12-5	NA	NA	1.33	0.1	NA	NA	1.33	Yes
Nitrocellulose										
Nitrocellulose	-4.56	9004-70-0	NA	NA	NA	NA	NA	No (Log Kow < 3.0)	NA	NA
Total Organic Carbon										
Total Organic Carbon	NA	TOC (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
pH	NA	pH (Units)	NA	NA	NA	NA	NA	NA	NA	NA

[a] *EcoSSLs, (EPA, 2008) online updates from http://www.epa.gov/ecotox/ecossl/.*

[b] *ORNL: Efroymson, R.A., Suter II, G.W., Sample, B.E. and Jones, D.S., 1997.* Preliminary Remediation Goals for Ecological Endpoints, *ES/ER/TM-162/R2.*

[c] *ESLs, US EPA Region V, August 2003.*

[d] *LANL, Eco Risk Database, Release 2.5, October 2010.*

[e] *From* Nitroaromatic Munition Compounds: Environmental Effects and Screening Values, *Talmage et al., 1999, Rev. Environ. Contamin. Toxicol., 161: 1-156.*

[f] *Analyte identified as a PBT compound (OEPA DERR ERA Guidance, April 2008).*

[g] *The following hierarchy (based on OEPA DERR ERA Guidance, April 2008) was used to select the soil screening values:*

1. EPA EcoSSL (plants, invertebrates, wildlife)
2. ORNL (1997) [plants, invertebrates, wildlife]
3. USEPA Region 5 ESLs (2003)
4. LANL (2010) [various endpoints]
5. Talmage et al. (1999)

CAS denotes Chemical Abstract Service.
COPEC denotes contaminant of potential ecological concern.
DERR denotes Division of Environmental Response and Revitalization.
EcoSSL denotes Ecological Soil Screening Levels.
EPA denotes United Stated Environmental Protection Agency.

Appendix G
Munitions Response Site Prioritization Protocols Data Tables

Table A

MRS Background Information

DIRECTIONS: Record the background information below for the MRS to be evaluated. Much of this information is available from DoD databases, such as RMIS. If the MRS is located on a FUDS property, the suitable FUDS property information should be substituted. In the MRS summary, briefly describe the UXO, DMM, or MC that are known or suspected to be present, the exposure setting (the MRS's physical environment), any other incidental non-munitions related contaminants found at the MRS (e.g., benzene, trichloroethylene), and any potentially exposed human and ecological receptors. Include a map of the MRS, if one is available.

Munitions Response Site (MRS) Name:	**Load Load #1 (RVAAP-008-R-01)**
Component:	US Army
Installation/Property Name:	**Ravenna Army Ammunition Plant**
Location (City, County, State):	Ravenna, Portage and Trumbull Counties, Ohio
UTM Coordinates (NAD83):	X = 498413.444463 Y = 4561825.177513
Site Name (RMIS ID):	OH213820736
Project Name (Project No.):	Ravenna Army Ammunition Plant Load Line #1 (RVAAP-008-R-01) Remedial Investigation
Date Information Entered/Updated:	1-Oct-2012
Point of Contact (Name/Phone):	Dave Cobb/617.589.5561

Project Phase ("X" only one):										
	PA		**SI**	**X**	**RI**		**FS**		**RD**
	RA-C		**RIP**		**RA-O**		**RC**		**LTM**

Media Evaluated ("X" all that apply):				
	Groundwater (human receptor)		**Sediment (human receptor)**
X	**Surface soil (human receptor)**		**Surface water (ecological receptor)**
	Sediment (ecological receptor)		**Surface water (human receptor)**

MRS Summary

MRS Description: Describe the munitions-related activities that occurred at the installation, the dates of operation, and the UXO, DMM (by type of munition, if known) or munitions constituents (by type, if known) known or suspected to be present):

The Load Line #1 Munitions Response Site (MRS) consists of a 0.41-acre area located to the northwest side of the former building CB-14 where munitions and explosives of concern (MEC) consisting of triple-based propellants were observed on the ground surface and elevated lead concentrations constituting munitions constituents (MC) were detected in surface soil during the 2007 site inspection (SI) field activities. No MEC or munitions debris (MD) was identified at the MRS during the 2011 remedial investigation (RI) field activities (100 percent visual surveys); therefore, no MEC source is present. MC sampling activities were conducted during the RI field activities. Lead and nitroguanidine were found in exceedance of background and identified as site-related chemicals (SRCs). Subsequent human health and ecological risk assessments determined that unreasonable risk to receptors was not present. Based on the results of the RI no further action is recommended for the Load Line #1 MRS.

Description of Pathways for Human and Ecological Receptors:

The revised MEC conceptual site model (CSM) identifies incomplete pathways for all media and receptors at the MRS based on the lack of MEC source (RI Report, Section 9.1.5).

The conservatively identified MC SRCs detected at the MRS consisted of the lead and nitroguanidine in surface soil. Although a MEC source was not found, the MCs may have resulted from corrosion of the propellants due to exposure to the elements. None of the detected concentrations were determined to pose a hazard to human health or the environment. The MC CSM has been updated to reflect a lack of source and incomplete pathways for the receptors in the terrestrial environment (RI Report, Section 9.2).

Although SRCs were detected during the RI field work, the concentrations were considered low and it is unlikely that groundwater has been impacted. No groundwater samples were collected at the Load Line #1 MRS during the RI field work and the groundwater exposure pathway is considered incomplete (RI Report, Section 9.2).

Description of Receptors (Human and Ecological):

Human receptors identified for the Load Line #1 MRS include both current and anticipated future land users. Ecological receptors (biota) for the purposes of the revised MEC CSM, are identified as the listed species in Table 1-3 (RI Report) and unlisted mammals, birds, and wetland species known to be present at the RVAAP and may be present within the MRS based on the type of vegetation and hydrology identified in Sections 1.3.5 and 1.3.7 of the RI Report. Unlisted mammal, bird, and wetland species maybe present on either a permanent or transient basis.

The revised MEC CSM in this RI identifies RVAAP personnel, contract workers, regulatory personnel, and trespassers as current human receptors. Future land use receptor, the National Guard Trainee, has been identified in accordance with the Facility-Wide Human Health Risk Assessment Manual (USACE, 2005); herein, referred to as the HHRAM. Exposure scenarios for the National Guard Trainee are provided in the FWCUG Report (SAIC, 2010). Based on the FWCUG Report, the project team has determined that the National Guard Trainee is the most sensitive of the current and future human receptors that has the potential to be exposed to MEC or MC (RI Report, Section 9.1.4).

Table 1
EHE Module: Munitions Type Data Element Table

Directions: Below are eleven classifications of munitions and their descriptions. Annotate the score(s) that correspond with **all** munitions types known or suspected to be present at the MRS.

Note: The terms *practice munitions* , *small arms* , *physical evidence* , and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
Sensitive	All UXO that are considered likely to function upon any interaction with exposed persons [e.g., submunitions, 40mm high-explosive (HE) grenades, white phosphorous (WP) munitions, high-explosive antitank (HEAT) munitions, and practice munitions with sensitive fuzes, but excluding all other practice munitions].	30	
	All hand grenades containing energetic filler.		
	Bulk primary explosives, or mixtures of these with environmental media, such that the mixture poses an explosive hazard.		
High explosive (used or damaged)	All UXO containing a high-explosive filler (e.g., RDX, Composition B), that are not considered "sensitive."	25	
	All DMM containing a high-explosive filler that have been damaged by burning or detonation, or deteriorated to the point of instability.		
Pyrotechnic (used or damaged)	All UXO containing pyrotechnic fillers other than white phosphorous (e.g., flares, signals, simulators, smoke grenades).	20	
	All DMM containing pyrotechnic fillers other than white phosphorous (e.g., flares, signals, simulators, smoke grenades) that have been damaged by burning or detonation, or deteriorated to the point of instability.		
High explosive (unused)	All DMM containing a high-explosive filler that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.	15	
Propellant	All UXO containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor).	15	
	All DMM containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor) that are damaged by burning or detonation, or deteriorated to the point of instability.		
Bulk secondary high explosives, pyrotechnics, or propellant	All DMM containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor), that are deteriorated.	10	
	Bulk secondary high explosives, pyrotechnic compositions, or propellant (not contained in a munition), or mixtures of these with environmental media such that the mixture poses an explosive hazard.		
Pyrotechnic (not used or damaged)	All DMM containing a pyrotechnic filler (i.e. red phosphorous), other than white phosphorous filler, that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.	10	
Practice	All UXO that are practice munitions that are not associated with a sensitive fuze.	5	
	All DMM that are practice munitions that are not associated with a sensitive fuze and that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.		
Riot control	All UXO or DMM containing a riot control agent filler (e.g., tear gas).	3	
Small arms	All used munitions or DMM that are categorized as small arms ammunition [Physical evidence or historical evidence that no other types of munitions (e.g., grenades, subcaliber training rockets, demolition charges) were used or are present on the MRS is required for selection of this category.].	2	
Evidence of no munitions	Following investigation of the MRS, there is physical evidence that there are no UXO or DMM present, or there is historical evidence indicating that no UXO or DMM are present.	0	0
MUNITIONS TYPE	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 30).		**0**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Munitions Type*** classifications in the space below.

Following the RI field activities, no physical evidence of UXO or DMM (in the form of MEC and/or MD) has been identified. An explosive safety hazard is not anticipated to exist at the Load Line #1 MRS (RI Report, Section 9.1.1).

There is no physical evidence of UXO or DMM at the Load Line #1 MRS; as such, Tables 2-9 are not applicable and have been intentionally omitted according to Active-Army Guidance.

Tables 2 through 9 are intentionally omitted according to Army Guidance.

Table 10

Determining the EHE Module Rating

DIRECTIONS:

1. From Tables 01 - 09, record the data element scores in the **Score** boxes to the right.

2. Add the **Score** boxes for each of the three factors and record this number in the **Value** boxes to the right.

3. Add the three **Value** boxes and record this number in the **EHE Module Total** box below.

4. Identify the appropriate range for the **EHE Module Total** at right.

5. Identify the **EHE Module Rating** that corresponds to the range selected and record this rating in the **EHE Module Rating** box at the lower right corner of this table.

NOTE: An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more data elements, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.

	Source	Score	Value
Explosive Hazard Factor Data Elements			
Munitions Type	Table 01	0	0
Source of Hazard	Table 02	0	
Accessibility Factor Data Elements			
Location of Munitions	Table 03	0	0
Ease of Access	Table 04	0	
Status of Property	Table 05	0	
Receptor Factor Data Elements			
Population Density	Table 06	0	0
Population Near Hazard	Table 07	0	
Types of Activities/Structures	Table 08	0	
Ecological and/or Cultural Resources	Table 09	0	
EHE MODULE TOTAL			**0**

EHE Module Total	EHE Module Rating
92 to 100	A
82 to 91	B
71 to 81	C
60 to 70	D
48 to 59	E
38 to 47	F
less than 38	G
Alternative Module Ratings	Evaluation Pending
	No Longer Required
	No Known or Suspected Explosive Hazard
EHE MODULE RATING	**No Known or Suspected Explosive Hazard**

Table 11

CHE Module: CWM Configuration Data Element Table

Directions: Below are seven classifications of CWM configuration and their descriptions. Annotate the score(s) that correspond to **all** CWM configurations known or suspected to be present at the MRS.

Note: The terms *CWM/UXO*, *CWM/DMM*, *physical evidence*, and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
CWM, explosive configuration either UXO or damaged DMM	The CWM known or suspected of being present at the MRS is (a) explosively configured CWM that are UXO (i.e. CWM/UXO), or (b) explosively configured CWM that are DMM (i.e. CWM/DMM) that have been damaged.	30	
CWM mixed with UXO	The CWM known or suspected of being present at the MRS are explosively configured CWM/DMM that have not been damaged, or nonexplosively configured CWM/DMM, or CWM not configured as a munition, that are commingled with conventional munitions that are UXO.	25	
CWM, explosive configuration that are undamaged DMM	The CWM known or suspected of being present at the MRS are explosively configured CWM/DMM that have not been damaged.	20	
CWM, not explosively configured or CWM, bulk container	The CWM known or suspected of being present at the MRS is (a) nonexplosively configured CWM/DMM, or (b) bulk CWM/DMM (e.g., ton container).	15	
CAIS K941 and CAIS K942	The CWM/DMM known or suspected of being present at the MRS is CAIS K941(toxic gas set M-1) or CAIS K942 (toxic gas set M-2/E11).	12	
CAIS (chemical agent identification sets)	Only CAIS, other than CAIS K941 and K942, are known or suspected of being present at the MRS.	10	
Evidence of no CWM	Following investigation, the physical evidence indicates that CWM are not present at the MRS, or the historical evidence indicates that CWM are not present at the MRS.	0	
CWM CONFIGURATION	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 30).		**0**

DIRECTIONS: Document any MRS-specific data used in selecting the ***CWM Configuration*** classifications in the space below.

There is no known historical or physical evidence of CWM being produced, stored, or used at the RVAAP or the MRS; as such, Tables 12-19 are not applicable and have intentionally omitted according to Active-Army Guidance.

Tables 12 through 19 are intentionally omitted according to Army Guidance.

Table 20

Determining the CHE Module Rating

DIRECTIONS:		Source	Score	Value
1. From Tables 11 - 19, record the data element scores in the **Score** boxes to the right.	**CWM Hazard Factor Data Elements**			
	CWM Configuration	Table 11	0	0
	Sources of CWM	Table 12	0	
2. Add the **Score** boxes for each of the three factors and record this number in the **Value** boxes to the right.	**Accessibility Factor Data Elements**			
	Location of CWM	Table 13	0	0
	Ease of Access	Table 14	0	
	Status of Property	Table 15	0	
3. Add the three **Value** boxes and record this number in the **CHE Module Total** box below.	**Receptor Factor Data Elements**			
	Population Density	Table 16	0	0
	Population Near Hazard	Table 17	0	
	Types of Activities/Structures	Table 18	0	
	Ecological and/or Cultural Resources	Table 19	0	
	CHE MODULE TOTAL			**0**

	CHE Module Total	CHE Module Rating
4. Identify the appropriate range for the **CHE Module Total** at right.	92 to 100	A
	82 to 91	B
	71 to 81	C
	60 to 70	D
5. Identify the **CHE Module Rating** that corresponds to the range selected and record this rating in the **CHE Module Rating** box at the lower right corner of this table.	48 to 59	E
	38 to 47	F
	less than 38	G
NOTE: An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more data elements, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.	Alternative Module Ratings	Evaluation Pending
		No Longer Required
		No Known or Suspected CWM Hazard
	CHE MODULE RATING	**No Known or Suspected CWM Hazard**

Table 21

HHE Module: Groundwater Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's groundwater and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the groundwater, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value	
CHF > 100	H (High)	CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])
100 > CHF >2	M (Medium)	
2 > CHF	L (Low)	

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the groundwater migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the groundwater is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in groundwater has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the groundwater to a potential point of exposure (possibly due to geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the groundwater receptors at the MRS.

Classification	Description	Value
Identified	There is a threatened water supply well downgradient of the source and the groundwater is a current source of drinking water or source of water for other beneficial uses such as irrigation/agriculture (equivalent to Class I or IIA aquifer).	H
Potential	There is no threatened water supply well downgradient of the source and the groundwater is currently or potentially usable for drinking water, irrigation, or agriculture (equivalent to Class I, IIA, or IIB aquifer).	M
Limited	There is no potentially threatened water supply well downgradient of the source and the groundwater is not considered a potential source of drinking water and is of limited beneficial use (equivalent to Class IIIA or IIIB aquifer, or where perched aquifer exists only).	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Groundwater MC Hazard	**X**

Table 22

HHE Module: Surface Water - Human Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface water and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the surface water, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = ∑ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface water has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface water to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface water to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface water to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Surface Water (Human Endpoint) MC Hazard	**X**

Table 23

HHE Module: Sediment - Human Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the site's sediment and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for human endpoints present in the sediment, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	**H (High)**
100 > CHF >2	**M (Medium)**
2 > CHF	**L (Low)**

CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the sediment is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in sediment has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the sediment to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to sediment to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to sediment to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to sediment to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	
Place an "X" in the box to the right if there is no known or suspected Sediment (Human Endpoint) MC Hazard		**X**

Table 24

HHE Module: Surface Water - Ecological Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface water and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for ecological endpoints present in the surface water, select the box at the bottom of the table.

Note: Use either dissolved or total metals analyses.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface water has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface water to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface water to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface water to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Surface Water (Ecological Endpoint) MC Hazard	**X**

Table 25

HHE Module: Sediment - Ecological Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's sediment and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for ecological endpoints present in the sediment, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the sediment is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in sediment has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the sediment to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to sediment to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to sediment to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to sediment to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	
Place an "X" in the box to the right if there is no known or suspected Sediment (Ecological Endpoint) MC Hazard		**X**

Table 26

HHE Module: Surface Soil - Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface soil and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the surface soil, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface soil migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface soil is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface soil has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface soil to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L
MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface soil receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface soil to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface soil to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface soil to which contamination has moved or can move.	L
RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Surface Soil MC Hazard	**X**

Table 27

HHE Module: Supplemental Contaminant Hazard Factor Table

Contaminant Hazard Factor (CHF)

Directions: **Only use this table if there are more than five contaminants present at the MRS.** This is a supplemental table designed to hold information about contaminants that do not fit in the previous tables. Indicate the **media** in which these contaminants are present. Then record all **contaminants**, their **maximum concentrations** and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Calculate and record the **ratio** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** for each medium on the appropriate media-specific tables.

Note: For human exposures to groundwater and surface water, use dissolved, rather than total, metals analyses when both are available. Remember not to add ratios from different media.

Media	Contaminant [CAS No.]	Maximum Concentration	Units	Comparison Value	Units	Ratios
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
				SUBTOTAL FOR SURFACE SOIL		0
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
				SUBTOTAL FOR SEDIMENT		0
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
				SUBTOTAL FOR SURFACE WATER		0
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
				SUBTOTAL FOR GROUNDWATER		0

Table 28

Determining the HHE Module Rating

DIRECTIONS:

1. Record the letter values (H, M, L) for the **Contaminant Hazard**, **Migration Pathway**, and **Receptor Factors** for the media (from Tables 21 - 26) in the corresponding boxes below.
2. Record the media's three-letter combinations in the **Three-Letter-Combination** boxes below (three-letter combinations are arranged from Hs to Ms to Ls).
3. Using the reference provided below, determine each medium's rating (A - G) and record the letter in the corresponding **Media Rating** box below.

Medium (Source)	Contaminant Hazard Factor Value	Migratory Pathway Factor Value	Receptor Factor Value	Three-Letter Combination (Hs-Ms-Ls)	Media Rating (A - G)
Table 21 - Groundwater					
Table 22 - Surface Water (Human Endpoint)					
Table 23 - Sediment (Human Endpoint)					
Table 24 - Surface Water (Ecological Endpoint)					
Table 25 - Sediment (Ecological Endpoint)					
Table 26 - Surface Soil					
			HHE MODULE RATING		**No Known or Suspected MC Hazard**

DIRECTIONS (Continued):

4. Select the single highest **Media Rating** (A is the highest; G is the lowest) and enter the letter in the **HHE Module Rating** box below.

HHE Ratings (for reference only)	
HHH	A
HHM	B
HHL	C
HMM	
HML	D
MMM	
HLL	E
MML	
MLL	F
LLL	G

NOTE: An alternative module rating may be assigned when a module letter rating is used when more information is needed to score one or more media, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.

Alternative Module Ratings	
	Evaluation Pending
	No Longer Required
	No Known or Suspected MC Hazard

Table 29

MRS Priority

DIRECTIONS: In the chart below, enter the letter **rating** for each module recorded in Table 10 (EHE), Table 20 (CHE), and Table 28 (HHE). Enter the corresponding numerical **priority** for each module. If information to determine the module rating is not available, choose the appropriate alternative module rating. The MRS priority is the single highest priority; record this number in the **MRS or Alternative Priority** box at the bottom of the table.

NOTE: An MRS assigned Priority 1 has the highest relative priority; an MRS assigned Priority 8 has the lowest relative priority. Only an MRS with CWM known or suspected to be present can be assigned Priority 1; an MRS that has CWM known or suspected to be present cannot be assigned Priority 8.

EHE Rating	Priority	CHE Rating	Priority	HHE Rating	Priority
		A	1		
A	2	B	2	A	2
B	3	C	3	B	3
C	4	D	4	C	4
D	5	E	5	D	5
E	6	F	6	E	6
F	7	G	7	F	7
G	8			G	8
Evaluation Pending		Evaluation Pending		Evaluation Pending	
No Longer Required		No Longer Required		No Longer Required	
No Known or Suspected Explosive Hazard		No Known or Suspected CWM Hazard		No Known or Suspected MC Hazard	

Reference Table 10:		Reference Table 20:		Reference Table 28:	
EHE Module Rating	Priority	CHE Module Rating	Priority	HHE Module Rating	Priority
No Known or Suspected Explosive Hazard	No Known or Suspected Explosive Hazard	No Known or Suspected CWM Hazard	No Known or Suspected CWM Hazard	No Known or Suspected MC Hazard	No Known or Suspected MC Hazard

MRS or Alternative Priority	No Longer Required